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## Effect of Solar Greenhouses as a Renewable Source of Energy-A Review

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**ABSTRACT:** The major application in the solar greenhouses effect is to provide proper environment under adverse climatic conditions for growth and production of crops, vegetables and flower plants. The increase in environmental pollution and the varied variety of climatic conditions destroys the growth of crops. With the extensive improvement in the renewable source of energy(solar energy), helps to improve the quality and quantity of the production. The greenhouses receive necessary sunlight from the sun required for photosynthesis and also supplementary heat during cold months. In tropical countries the solar insolation and ambient temperatures are quite high and therefore, summer greenhouses can be designed in such a way that the inside temperature remains low and the plants receive sufficient sunlight for photosynthesis. Some solar greenhouses are also designed to conserve water resources. Plant growth depends on light intensity, temperature, humidity, air movement, watering and nutrients which will be properly provided in solar greenhouses. The parameters like orientation and tilt or considered for greenhouse design. Glass or plastic greenhouses are preferred. This scheme was found to be beneficial all over the world in all climatic conditions by the sun as it is renewable source of solar energy.

### I. INTRODUCTION

Solar energy can also be used for cooling buildings or for refrigeration required for preserving food, cooking food, used as solar water heater, for drying of food, solar desalination, for industrial process and solar greenhouses etc... Basics of plant growth depends on several parameters, the important ones are light intensity, its spectral quality and period, temperature and humidity of surroundings, air temperature, CO<sub>2</sub> levels, nutrients etc... A greenhouse can provide maximum advantage of each of these parameters. For e.g. controlled and optimum dose of CO<sub>2</sub> can increase the yield considerably compared to the open outside environment. So it is essential to know the basic requirements of a plant so that proper environment in the greenhouse can be created.

Many parameters to be considered in the design of a greenhouse, orientation and tilt, modes of heat transfer, glass or plastic material used for greenhouse, direction of greenhouse and other factors. The main use of greenhouse is to grow plants in controlled environment. Therefore, the structure and the cover of the greenhouse should be such that it must always be subservient to its main purpose. Not only the shape of the greenhouse which effects its indoor environment but there are several parameters such as: location, dimensions and orientation of greenhouse; number and material of cover; type of heating system and fuel used; ventilation; optimum space utilization; use of movable insulation during night time utilizing never concepts like this of thermal curtain at night time and using insulation on the north side walls along with some reflecting material on the inner side.

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## II. BASICS OF PLANT GROWTH

### 2.1 Light intensity:

Water, light energy and carbon di oxide is used by plants to coverts them in carbohydrate and oxygen. The process is known as photosynthesis and occurs in the green chloroplast within cells.

Light energy + water + CO<sub>2</sub> → carbohydrate + oxygen

In the respiration process which is the reverse of photosynthesis, energy is realized which is used by the plant for various functions of growth such as nutrients uptake, protein formation, division of cells etc.. When all the parameters like CO<sub>2</sub> level, temperature and water are optimized for the photosynthetic process in a plant, then it is the light intensity which effect the plant growth. Light intensity varies from place to place, but it generally varies from zero at the beginning of the day to about 100, 000 to 150,000 lux at known time. Light intensity on cloudy days is quite low. At low or high light intensity compared to the optimum level the process of growth slows down limiting the plant growth and yield because of the chloroplast are injured. Different optimum light intensity.

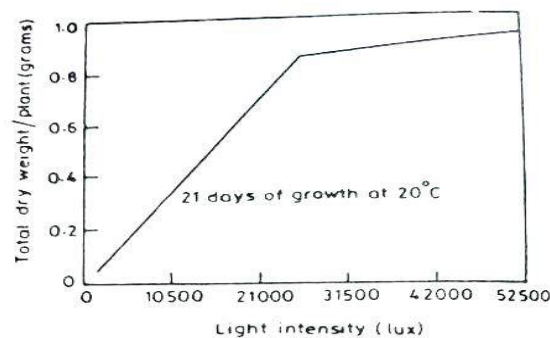


Fig.1

### 2.2 Temperature:

For every crop there is an optimum temperature at which the enzymes which are heat sensitive and are responsible for biochemical reaction in the plant are optimally active. Photosynthesis and respiration are the two processes by which the plants grow. Temperature of plant surrounding and soil required for plant growth is very much depended on light intensity, humidity of surrounding and air velocity. The temperature may affect the movement of minerals, water and food in roots, stems and leaves and can affect the photosynthesis. For different stages of plant development like growth, germination, plant development, flowering, fruit setting different ideal temperature are required. Variation of 5<sup>0</sup>C will not affect the plant growth. Soil temperature will also affect the absorption of water from the soil by the plant.

### 2.3 Humidity:

The relative humidity of air between 30% and 70% is ideal for plant growth. Humidity provides better environment for photogenic organisms for making the plants susceptible to diseases.

High humidity with high temperature are even more harmful since keeping the plants cool from overheating, the plant must lose the moisture by transpiration which will not happen because of high relative humidity. The saplings and germinating seeds need very high humidity (100%) but as these grow the relative humidity should be gradually reduced.

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### 2.4 Carbon Dioxide:

The amount of CO<sub>2</sub> present in the plant environment considerably affects the plant growth. The CO<sub>2</sub> present in the normal atmosphere is 0.03 to 0.04 per cent and is essential for photosynthesis. The amount CO<sub>2</sub> required for optimum plant growth depends on the plant type, state of development, temperature, light intensity, leaf area, air velocity, humidity, water stress etc. while the concentration of CO<sub>2</sub> in the greenhouses depends on the diffusion of air into and out of the greenhouses structure, soil respiration and rates of photosynthetic uptake.

### 2.5 Air Movement:

Although air movement does not directly affect the plant growth but due to its effect on transpiration, evaporation of water from soil, CO<sub>2</sub> availability, tearing of leaves, cooling effects etc. the air velocity also affects the boundary layer thickness of the leaves of the plant through which the plant transpires and water vapour diffuses to the outside air and through which atmospheric CO<sub>2</sub> required for photosynthesis enters the plant. The effect of wind speed on the plant growth is shown in fig 2.

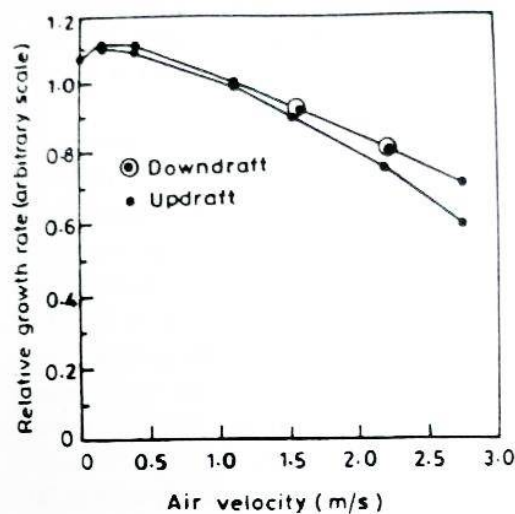


Fig.2

### 2.6 Watering:

Watering of plant is considered to be the easiest operation, generally done by an unexperienced person but if it is not done properly, like watering at wrong time or in less or more growth, the shape and quantity affect not only the quality of the crop but also the crop may be spoiled. If the water stress prolong, the leaves may drop off and the plant may die. If water is supplied more frequently and in large quantities the plant may become unnecessarily taller, resistance to disease reduced and the lack of oxygen in the root system may damage the roots. Water requirement and its frequency of application depends on the plant type, plant density, time of year, plants moisture needs etc. It is difficult to know when to irrigate and amount of water to be used but experience helps a lot.

## III. GREENHOUSE DESIGN

### 3.1 Orientation and Tilt:

The orientation of a solar greenhouse mainly depend on the type of plants to be grown in the greenhouse, the light and heat requirements of the plants, size of the business, season in which greenhouse is to be used, degree of

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automation desired, topography, local climate and materials for construction. In a winter greenhouse, where the average outside air temperature is much lower than that of the optimum temperature required for the plant growth, the shape of the greenhouse is so optimized, that it receives adequate sunlight required by plant and minimize the heat losses.

### 3.2 Modes of Heat Transfer:

The greenhouse should be designed to minimize the input of solar radiation which will require large glazing area. Increasing the glazing area would also mean increasing heat loss from greenhouse to outside. Therefore, the glazing area should be such as to transmit enough solar radiation to provide adequate sunlight and heat required by the greenhouse. Since the solar radiation is intermittent and is available only during the daytime a provision of storage should be made to store the solar heat required during night time or whenever required. There are several ways of heat loss from greenhouse as in shown in fig 3.

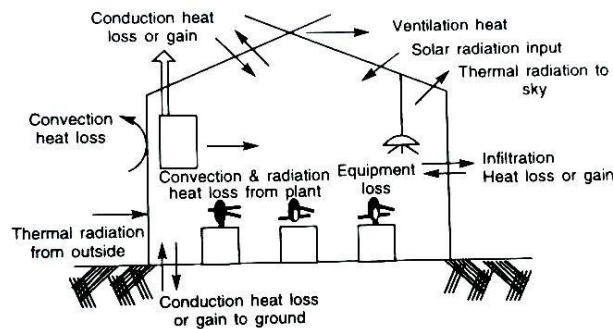


Fig 3

Before the year 1950 only glass greenhouses existed. The glass greenhouse styles depend on a number of parameters including size of glass sheet available, climatic conditions of the place, light and heat requirement, type of automation required in the greenhouse, crop to be grown, season in which the greenhouse to be used, type and material of frame to be used etc. Some basic styles of greenhouses are given in the fig 4.

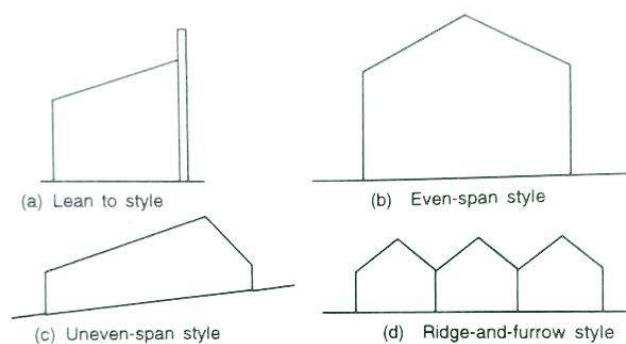


Fig 4

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## IV. PERFORMANCE PREDICTION OF CROP YIELD AND THERMAL

### ENVIRONMENT IN GREENHOUSE:

There are several variables outside and inside the greenhouse which influence the thermal environment of the greenhouse and finally the crop yield. Several attempts are made in the past to develop the mathematical models representing functional relations among the variables and the greenhouse environment in the hope to help the designer for a better greenhouse. Recently, Cooper and Fuller have developed a generalized computer model for predicting the performance of greenhouses applicable to a wide range of climatic conditions. This model can be used for determining the amount of photosynthate produced by a crop since the model responds to photosynthetically active radiation, leaf temperature and carbon dioxide level. This generalized model which is modular in nature and incorporates both solar heating and evaporative cooling system along with a rock pile storage unit.

Because of complexity of heat and mass transfer mechanism in greenhouse it is very difficult to model the greenhouse as a single component and therefore, the greenhouse components like growing medium, floor, crop, greenhouse air, greenhouse cover modeled independently and their interaction with each other is facilitated by organizational nature of **TRNSYS** program which is still a powerful simulation program.

## V. CONCLUSION

solar greenhouses concept is used in many fields for various applications some of them are listed below

1. Dual roof solar green houses
2. Solar drying of agricultural products
3. Solar cooling technology etc

These are some of the major applications of solar greenhouses

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