# ENVIRONMENT MONITORING AND ESTIMATION OF WATER REQUIREMENT INSIDE A POLYHOUSE THROUGH INTERNET

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## ABSTRACT

Polyhouse cultivation gives higher yield, higher productivity, better quality produce and production throughout the year. Capsicum (*Capsicum annum L.)* is a valuable vegetable crop with excellent prospect both for the domestic and export market. To ensure its regular and off-season supply, technology for growing of capsicum under protected conditions needs to be standardized. Irrigation is one of the most important inputs, which affects the yield and quality of agricultural produce from polyhouse. Efficient irrigation in polyhouse can be achieved by accurate estimates of evapotranspiration. The important factors to control the polyhouse evapotranspiration are solar radiation, air temperature, relative humidity and wind speed. Control and monitoring of environmental parameters inside a Polyhouse, so as to ensure continuous maintenance of favorable crop atmosphere is the objective of the work presented in this paper. The objective is achieved through the use of internet based technology. The polyhouse has a direct effect on air temperature, and relative humidity and an indirect effect on soil temperature and soil moisture inside the polyhouse. Climatic parameter inside a polyhouse need to be controlled to ensure timely and abundant yields. The present study has been undertaken to study the effects of climatic variability on the evapotranspiration and to determine the schedule of irrigation of drip irrigated capsicum in a naturally ventilated polyhouse. Web enabled automatic weather station having sensors for real time online measurement of soil temperature, soil moisture, ambient temperature, humidity, leaf wetness, solar insolation, was installed inside the polyhouse. Capsicum (*Capsicum annum L.)* was transplanted inside the polyhouse and crop evapotranspiration was estimated. The system also allows transmission of process parameters, including sending a SMS on a mobile phone. The concept encompasses data acquisition through a sensor network, data storage, post processing and online transmission of data to multiple users logged on to web-browsers. Further, control of process parameters of a Polyhouse control of pumps and accessories and ventilators in real time was also possible. From, this study it is concluded that the total crop water requirement of capsicum under inside polyhouse was about 20-40 % less than outside the polyhouse. Farmers do require expert guidance to use this new technology of Polyhouse farming. This methodology of farming reduces dependency on rainfall and makes the optimum use of land and water resources; typical gains may be three times as much as those of traditional farming.

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## INTRODUCTION

Modern technology, mobile phone and internet can play a vital role in modern agriculture. No other technology has made such an impact on modern society. Internet and web based services form one of the core foundations of a successful information technology based society. The web is not only used to gain visibility, share information, sell products and conduct business, but it can also be used to improve the way we design engineering systems, manufacture them and test the final products. A balanced and Justified usage of internet facilities can lead to reduction in design the system and subsequent improvement of overall quality. Computer based weather data acquisition, web based experiments and virtual instrumentation and control applications have been an active area of interest in recent years particularly in agriculture.

Simultaneously, we have seen the exponential growth in mobile telephony in the last decade. It is natural that internet and mobile technology are going through a phase of fusion. India is the second largest mobile market in the world after China, with over 490 million subscribers of mobile telephones. In the context of large developing countries like India, it is increasingly becoming clear that mobile telephony coupled with internet services will prove to be one of the most efficient systems for penetration of services, products and knowledge to large number of farmers, depends on agriculture. Mechanization and modernization of agriculture must infuse these two technologies so as to make considerable impact in the agriculture. Indian farmers face several challenges such as small land holding, intermittent power supply, poor yields due to reliance on inefficient methods of farming, too much reliance on natural phenomena such as rainfall and lack of knowledge of modern methods of agriculture. In conventional agronomical practices, the crops are being grown in the open field under natural conditions where the crops are more susceptible to sudden changes in climate i.e. temperature, humidity, light intensity, photo period and other conditions due to which the quality, yield of a particular crop can get affected and may be decreased.

Polyhouse farming is an alternative new technique in agriculture gaining foothold in rural India and can be successfully employed for niche areas of agriculture. Polyhouse cultivation as well as other modes of controlled environment cultivation has been evolved to create favorable micro-climates, which favours the crop production, could be possible all through the year or part of the year as required. The primary environmental parameter traditionally controlled is temperature, usually providing heat to overcome extreme cold conditions. However, environmental control can also include cooling to mitigate excessive temperatures, light control either shading or adding supplemental light, carbon dioxide levels, relative humidity, water, plant nutrients and pest control.

A typical Polyhouse is varies from 400 - 10,000 $m^2$ suited for farmers with small and marginal land holding. A low- to medium - cost Polyhouse could cost between Rs. 375 to Rs. 1475 $m^2$, whereas a high-cost, fully-automated Polyhouse costs Rs. 2,000 $m^2$. Most Indian farmers cannot afford such high costs therefore Government of India through National Horticulture Mission (NHM) under Ministry of Agriculture is providing assistance to farmers up to 50 % to promote use of such systems. Farmers do require expert guidance to use this new technology of Polyhouse farming. This methodology of farming reduces dependency on rainfall and makes the optimum use of land and water resources; typical gains may be three times those of traditional farming. Parameters such as soil moisture, nutrients, sunlight, humidity, air temperature, dry bulb and wet bulb temperature etc., inside a polyhouse needs to be controlled to ensure timely and abundant yields. Information on the installation of the polyhouse, its economic viability, availability of subsidies for erecting them, and other technical information is available to some extent.

Cha´vez et al. (2009) made effort to monitor irrigation and other control systems for areas having scarcity of water. At present there are very few companies/service providers who are involved in such control, monitoring and automation of Polyhouses in India. However;

few examples can be seen in states of Maharashtra, Gujarat and Tamil Nadu. Popularity of Polyhouses because of support in NHM will naturally lead to increase in demand for better control and automation.

Web enabled automatic weather station having sensors for real time online measurement of soil temperature, soil moisture, ambient temperature, humidity, leaf wetness, solar insolation was installed inside the polyhouse. Capsicum (*Capsicum annum L.)* was transplanted inside the polyhouse and crop evapotranspiration was estimated. System also allows transmission of process parameters, including sending a SMS on a mobile phone. The concept encompasses data acquisition of through a sensor network, data storage, post processing and online transmission of data to multiple users logged on to web-browsers. Efforts were also made to study the effects of climatic variability on the evapotranspiration and to determine the schedule of irrigation of drip irrigated capsicum in a naturally ventilated polyhouse through automation and monitoring of climatic parameters.

## Material And Methods

**Field experimentation**

The present study was conducted at Precision Farming Development Centre, Water Technology Centre, Indian, India Agricultural Research Institute (IARI), New Delhi during 2009-10 and 2010-11. IARI is situated in between the latitudes of $28^0$37'22"N and $38^0$39'05"N and longitudes of $77^0$8'45" and $77^0$10'24"E at an average elevation of 230 m above the mean sea level.

The mean annual temperature is 25 $^0$C. An absolute maximum temperature of $45^0$C in the month of May
/ June and minimum of $2^0$C during the month of January. The mean annual rainfall is 714 mm. The average relative humidity varies from 34.1 to 97.9 per cent and average wind speed from 0.45 to 3.96 m/s. The Electrical Conductivity (EC) and pH of irrigation water was 2.5 dS/m and 7.5, respectively. Irrigation was given by inline drip irrigation system. Irrigations were applied as per the measured evapotranspiration rate during the experimental period.

Sweet Pepper (capsicum) was chosen as a polyhouse test crop. Nursery of capsicum was raised in the polyhouse, in soil less media in plastic trays to produce disease free seedlings. For nursery raising coco peat, vermiculite and perlite mixer was used in the ratio of 3:1:1. The 4-5 week seedlings were transplanted in the polyhouse in the second week of September in polyhouse. A PVC sub main line (45 mm diameter) was laid for the experimental area. The lateral pipes of 16 mm diameter were taken out from the sub main line for the irrigation of capsicum crop inside the polyhouse. The lateral lines were placed at 120 cm interval. The inline drip system having dripper's discharging capacity of 1.6 lph at a spacing of 30 cm were used. The fertigation system consists of irrigation controller, solution tank, electrical pump, filter, valve, connector, distribution pipes and drippers. A fertilizer solution of 10 kg N, 7.5 kg $P_2O_5$ and 5 kg $K_2O$ was prepared using Urea, Single super phosphate and Muriate of potash, respectively for application in 250 $m^2$ polyhouse.

## Polyhouse automation

The present study was conducted in 10m x 25m naturally ventilated Quonset-type polyhouse. The polyhouse was made of galvanized steel tube structural frames, with 200 micron inch ultraviolet stabilized sheet as a cladding material. It was oriented approximately east-west. Polyhouse protects the agricultural crops from sudden change in weather and regulates the environment inside the Polyhouse. This helps to grow the crops without any external obstruction. Therefore, monitoring and control are the core element of a polyhouse technology. Polyhouse automation control system will refer to a network of sensors and controllers/actuators, which in turn will detect the environmental changes of the polyhouse and take necessary action against predefined set of normal values.

Sensor networking can be achieved through a wired network or wireless sensor networks. With deep penetration of internet services to remote area, it is possible to convert a field server into a web server. In such cases, a field server will have its own Internet Protocol address. Such a system greatly increases the versatility of the monitoring and control strategy. The need for continuous in-situ monitoring by personnel is eliminated to a large extent, as farmers can be remotely connected to the polyhouse environment through a simple internet connection. Such a system can also be easily extended so that the control and monitoring of specified parameters can not only be done through the internet, but farmers can also use their mobile telephones to accomplish the same task. Benefit of using the mobile phone is that there is no limit to the distance as well as connection. Mobile telephones for e-mail communication for sending alarm signals, if required to many clients who may be temporarily unconnected to the web server. These signals are generated by the process server in conjunction with primary databases, containing alarm parameters, and forwarded to the web server for further transmission.

In PFDC farm, Water Technology Centre, IARI, Web enabled automatic weather station (WAWS) having sensors for real time online measurement of soil temperature, soil moisture, ambient temperature, humidity, leaf wetness, solar insolation was installed inside the polyhouse (Figure 1). WAWS consist of a weather proof enclosure containing the data logger, meteorological sensors with an attached solar panel mounted upon a mast. This station is connected with GPRS based internet connection. SMS alert messages can be received in cell phones. It sends data periodically to a web based database. Station settings and data handling needs only web browser with identity and password. The system allows the remote user, connected through the internet to the WAWS, to fully access the GUI appearing on his/her web browser to online monitor the processes taking place in the Polyhouse. While the data acquisition occurs on the on-site Field server, the remote user has complete data monitoring and their values. Individual web browsers, with permission to control, can initiate the measurement or automation application, as desired. Other logged-in users also can view the real time data.

**Figure 1.** Polyhouse having Web enabled automatic weather station with capsicum crop

## Results And Discussions

### Microclimate inside and outside the polyhouse

The daily data recorded by weather sensors under the polyhouse are presented in the Figure 2. Similar data table can be get for hourly interval to monitor the climatic condition inside the polyhouse (Table 1 and 2). On an average, the air temperature difference between inside and outside the polyhouse was about 2–8$^{o}$ C. The air temperature inside the polyhouse was higher than outside the polyhouse. On the contrary, the relative humidity inside the polyhouse humidity was almost same during the summer but it was about 7.5 % lower than the outside environment during winter season. Morgan and Leonard (2000) listed that 33 $^{o}$C as the inhibition temperature for fruit set in pepper. In the winter when ambient temperature was very low and it was not possible to grow capsicum in that situation, polyhouse a technology which improves the yield tremendously.

Wind speed in the polyhouse as expected, was nil in the polyhouse. The advantages of low wind speed include low evapotranspiration rate that means lesser water requirements (Abou-Hadid et. al., 1994). On an average, the daily measured solar radiation inside the polyhouse was 10.9 MJ $m^{-2}day^{-1}$ compared to 13 MJ $m^{-2}$ $day^{-1}$ for the open environment. It means that the plants inside the polyhouse received about 18-20 % less energy in the form of net solar radiation than outside the polyhouse. The type of roof material used caused the reduction of the total solar radiation in the polyhouse. The reduction of solar energy received by the plants also results in the reduced evapotranspiration.

The total water requirement inside and outside the polyhouse at different stages are presented in Table 3. The total crop water requirement of capsicum under drip irrigation inside and outside the polyhouse was estimated to be 546.6 mm and 407 mm, respectively. Four growth stages were considered for capsicum. They were the initial stage, developmental stage, middle and maturity stage. The crop duration was extended significantly in the polyhouse from 117 days to 218 days. Users can have maximum picking and regular yield in polyhouse. The initial stage excluding seedlings at the nursery lasted for 25 days. The developmental growth stage lasted for 30 days. The mid-season growth stage (flowering and fruiting) stage lasted for 39 days and the maturity stage lasted for 24 days. But in the polyhouse initial, developmental, middle and maturity stages were of 30, 34, 84 and 70 days, respectively. Maturity stage was later characterized by senescence and drying of leaves after the harvesting was over. Grimes and Williams (1990) also asserted that water requirement for hot pepper per growing season ranges between 400 mm and 500 mm depending on the season of planting and the climatic conditions prevailing in the area.

The results obtained from this study shows that regular monitoring of polyhouse can save water at least 40, 24.3, 30.4 and 47.6 % in initial, developmental, middle and maturity stages, respectively (Table 3).

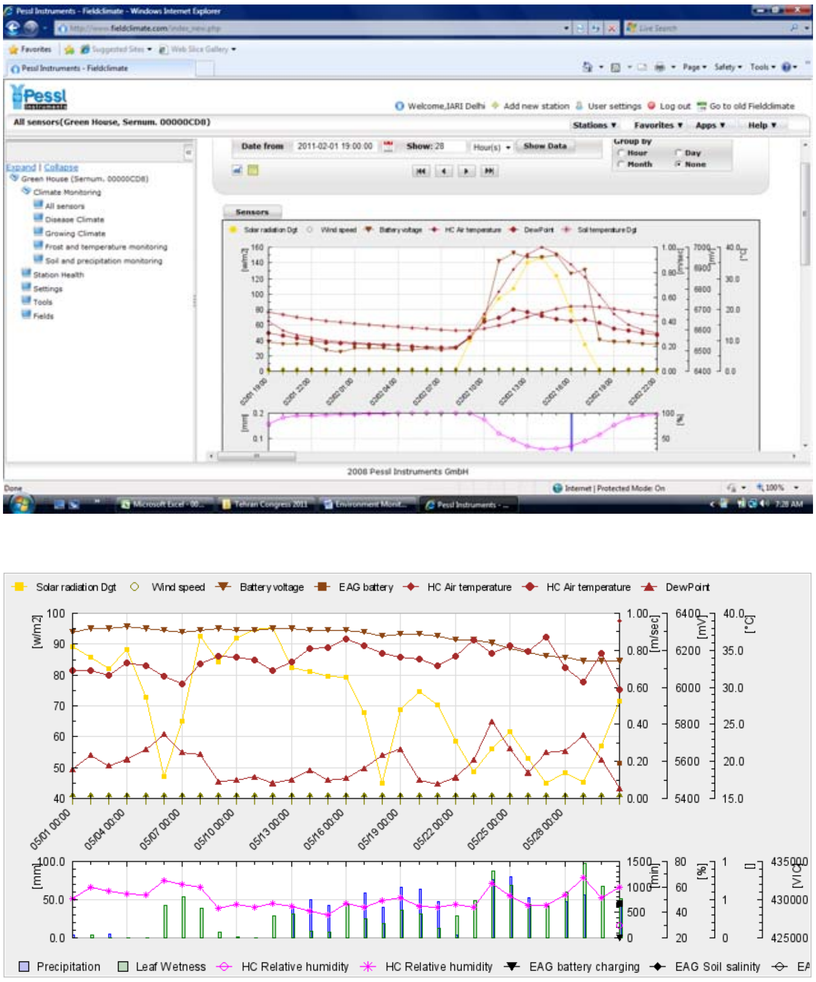


**Figure 2. Weather data monitored during May 1 to May 30, 2010**

**Table 1.** Daily weather data monitored in the polyhouse (taken from website)

| Date | Solar radiation Dgt | Precipitation | Wind speed | | Battery voltage | Leaf Wetness | HC Air temperature | | | HC Relative humidity | Dew Point | | Soil temperature Dgt | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | [W/m²] | [mm] | [m/sec] | | [mV] | [min] | [°C] | | | [%] | [°C] | | [°C] | | |
| | average | sum | Avg. | Max. | last | time | Avg. | Min. | Max. | Avg. | Avg. | Min. | Avg. | Min. | Max. |
| 1/1/2011 | 29 | 0 | 0 | 0 | 6532 | 0 | 15.1 | 8.1 | 30.1 | 87.0 | 12.1 | 8.1 | 15.7 | 14.0 | 18.7 |
| 1/2/2011 | 19 | 0 | 0 | 0 | 6522 | | 13.6 | 9.5 | 26.3 | 85.0 | 10.5 | 8.6 | 15.0 | 13.7 | 17.1 |
| 1/3/2011 | 25 | 0 | 0 | 0 | 6522 | | 13.6 | 6.1 | 28.8 | 85.0 | 10.6 | 6.0 | 14.8 | 13.1 | 17.7 |
| 1/4/2011 | 21 | 0 | 0 | 0 | 6522 | | 10.5 | 3.3 | 25.9 | 88.0 | 8.0 | 3.2 | 13.0 | 10.8 | 15.6 |
| 1/5/2011 | 21 | 0 | 0 | 0 | 6522 | | 11.3 | 5.2 | 25.2 | 87.0 | 8.6 | 4.6 | 12.9 | 11.4 | 15.4 |
| 1/6/2011 | 25 | 0 | 0 | 0 | 6512 | | 12.4 | 6.0 | 29.4 | 87.0 | 9.6 | 5.6 | 13.3 | 11.6 | 16.4 |
| 1/7/2011 | 23 | 0 | 0 | 0 | 6522 | | 12.4 | 5.3 | 30.1 | 88.0 | 9.8 | 5.2 | 13.3 | 11.3 | 16.5 |
| 1/8/2011 | 18 | 0 | 0 | 0 | 6522 | 0 | 10.2 | 4.6 | 22.0 | 92.0 | 8.5 | 4.5 | 12.5 | 11.3 | 14.8 |
| 1/9/2011 | 8 | 0 | 0 | 0 | 6494 | 0 | 9.7 | 5.4 | 18.3 | 94.0 | 8.6 | 5.4 | 11.8 | 11.2 | 13.2 |
| 1/10/2011 | 27 | 0 | 0 | 0 | 6532 | | 12.4 | 6.2 | 29.2 | 85.0 | 9.0 | 6.2 | 12.4 | 10.5 | 15.5 |
| 1/11/2011 | 31 | 0 | 0 | 0 | 6522 | | 13.4 | 4.7 | 33.6 | 81.0 | 8.7 | 4.7 | 13.0 | 10.2 | 16.8 |
| 1/12/2011 | 28 | 0.2 | 0 | 0 | 6512 | | 14.2 | 3.6 | 36.1 | 83.0 | 10.1 | 3.5 | 13.6 | 10.2 | 17.6 |
| 1/13/2011 | 23 | 0 | 0 | 0 | 6512 | 0 | 15.1 | 5.3 | 33.2 | 85.0 | 11.6 | 5.2 | 14.2 | 11.2 | 17.8 |
| 1/14/2011 | 25 | 0 | 0 | 0 | 6512 | 0 | 16.9 | 9.5 | 32.3 | 85.0 | 13.7 | 9.4 | 15.7 | 13.3 | 18.9 |
| 1/15/2011 | 32 | 0 | 0 | 0 | 6512 | 20 | 15.9 | 7.6 | 32.8 | 85.0 | 12.2 | 6.4 | 16.0 | 14.1 | 19.0 |
| 1/16/2011 | 37 | 0 | 0 | 0 | 6532 | 0 | 16.7 | 8.3 | 31.5 | 74.0 | 10.3 | 5.7 | 15.1 | 13.7 | 17.5 |
| 1/17/2011 | 51 | 0 | 0 | 0 | 6512 | 0 | 19.4 | 8.6 | 33.6 | 64.0 | 10.3 | 7.6 | 15.2 | 11.8 | 17.6 |
| 1/18/2011 | 31 | 0 | 0 | 0 | 6512 | 0 | 15.5 | 3.7 | 38.7 | 78.0 | 9.7 | 3.6 | 14.5 | 10.9 | 18.7 |
| 1/19/2011 | 31 | 0 | 0 | 0 | 6512 | 0 | 14.2 | 4.7 | 32.1 | 78.0 | 8.5 | 4.6 | 14.3 | 11.4 | 17.7 |
| 1/20/2011 | 28 | 0 | 0 | 0 | 6522 | 0 | 14.5 | 4.3 | 34.5 | 77.0 | 8.8 | 4.2 | 14.3 | 11.0 | 18.3 |
| 1/21/2011 | 27 | 0 | 0 | 0 | 6512 | 0 | 16.1 | 5.1 | 38.6 | 78.0 | 10.6 | 5.1 | 14.8 | 11.4 | 18.9 |
| 1/22/2011 | 26 | 0 | 0 | 0 | 6522 | 0 | 17.8 | 7.4 | 37.3 | 76.0 | 12.0 | 7.4 | 15.8 | 12.9 | 19.6 |
| 1/23/2011 | 26 | 0 | 0 | 0 | 6522 | 0 | 17.4 | 7.6 | 36.4 | 80.0 | 12.3 | 7.6 | 16.6 | 13.7 | 20.0 |
| 1/24/2011 | 30 | 0 | 0 | 0 | 6522 | | 16.1 | 6.8 | 34.7 | 77.0 | 10.3 | 6.7 | 15.8 | 12.8 | 19.6 |
| 1/25/2011 | 21 | 0 | 0 | 0 | 6512 | | 14.7 | 5.0 | 31.4 | 80.0 | 10.1 | 4.9 | 15.0 | 11.8 | 18.8 |
| 1/26/2011 | 25 | 0 | 0 | 0 | 6522 | | 16.6 | 7.2 | 36.0 | 75.0 | 10.5 | 7.1 | 15.8 | 13.0 | 19.2 |
| 1/27/2011 | 21 | 0 | 0 | 0 | 6522 | | 13.8 | 5.6 | 27.5 | 81.0 | 9.5 | 5.5 | 14.7 | 12.1 | 17.4 |
| 1/28/2011 | 27 | 0 | 0 | 0 | 6512 | | 15.4 | 4.5 | 36.9 | 78.0 | 9.9 | 4.5 | 14.6 | 11.1 | 18.9 |
| 1/29/2011 | 22 | 0 | 0 | 0 | 6522 | | 15.1 | 5.4 | 33.7 | 81.0 | 10.7 | 5.3 | 14.9 | 11.7 | 18.2 |
| 1/30/2011 | 25 | 0 | 0 | 0 | 6522 | | 17.3 | 8.6 | 35.6 | 83.0 | 13.2 | 8.3 | 16.2 | 13.8 | 19.8 |
| 1/31/2011 | 35 | 0 | 0 | 0 | 6522 | | 17.2 | 7.0 | 37.5 | 79.0 | 11.8 | 7.0 | 16.2 | 13.0 | 20.2 |

**Table 2.** Sample sheet showing weather data recorded every hour inside poly house on Dec. 1, 2010

| All sensors(Green House, Sernum. 00000CD8) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Solar radiation Dgt | Precipitation | Wind speed | | HC Air temperature | | | HC Relative humidity | Dew Point | | Soil temperature Dgt | | |
| | [W/m²] | [mm] | [m/sec] | | [°C] | | | [%] | [°C] | | [°C] | | |
| | AvG. | sum | Avg. | Max. | Avg. | Min. | Max. | Avg. | Avg. | Min | Avg. | Min | Max |
| 12/1/2010 1:00 | 0 | 0 | 0 | 0 | 9.35 | 9.25 | 9.55 | 100 | 9.3 | 9.2 | 15.4 | 15.3 | 15.6 |
| 12/1/2010 2:00 | 0 | 0 | 0 | 0 | 9.07 | 8.93 | 9.25 | 100 | 9 | 8.9 | 15.1 | 15 | 15.3 |
| 12/1/2010 3:00 | 0 | 0 | 0 | 0 | 8.7 | 8.57 | 8.89 | 100 | 8.6 | 8.5 | 14.7 | 14.6 | 14.9 |
| 12/1/2010 4:00 | 0 | 0 | 0 | 0 | 8.51 | 8.41 | 8.58 | 100 | 8.4 | 8.4 | 14.5 | 14.4 | 14.6 |
| 12/1/2010 5:00 | 0 | 0 | 0 | 0 | 8.25 | 8.11 | 8.38 | 100 | 8.2 | 8.1 | 14.2 | 14.1 | 14.3 |
| 12/1/2010 6:00 | 0 | 0 | 0 | 0 | 7.89 | 7.76 | 8.05 | 100 | 7.8 | 7.7 | 13.9 | 13.8 | 14.1 |
| 12/1/2010 7:00 | 0 | 0 | 0 | 0 | 7.61 | 7.5 | 7.73 | 100 | 7.5 | 7.5 | 13.6 | 13.6 | 13.8 |
| 12/1/2010 8:00 | 9 | 0 | 0 | 0 | 7.89 | 7.48 | 8.8 | 100 | 7.8 | 7.4 | 13.5 | 13.5 | 13.6 |
| 12/1/2010 9:00 | 50 | 0 | 0 | 0 | 12.09 | 9.12 | 14.73 | 99 | 11.9 | 9.1 | 14 | 13.5 | 14.7 |
| 12/1/2010 10:00 | 81 | 0 | 0 | 0 | 18.66 | 15.29 | 22.16 | 74 | 13.7 | 12.9 | 15.4 | 14.8 | 16.1 |
| 12/1/2010 11:00 | 107 | 0 | 0 | 0 | 25.11 | 22.72 | 26.85 | 47 | 12.7 | 10.7 | 16.6 | 16.2 | 17.2 |
| 12/1/2010 12:00 | 131 | 0 | 0 | 0 | 27.3 | 24.99 | 31.1 | 39 | 11.7 | 10.6 | 17.9 | 17.3 | 18.6 |
| 12/1/2010 13:00 | 161 | 0 | 0 | 0 | 32.61 | 31.75 | 33.57 | 28 | 11.5 | 10.6 | 18.5 | 18.2 | 18.8 |
| 12/1/2010 14:00 | 147 | 0 | 0 | 0 | 34.51 | 33.87 | 34.91 | 25 | 11.4 | 8.9 | 19.4 | 18.9 | 19.9 |
| 12/1/2010 15:00 | 109 | 0 | 0 | 0 | 33.44 | 32.52 | 34.51 | 27 | 11.2 | 9.8 | 20.1 | 19.9 | 20.4 |
| 12/1/2010 16:00 | 59 | 0 | 0 | 0 | 30.56 | 28.1 | 32.38 | 32 | 11.8 | 10.2 | 20.5 | 20.4 | 20.6 |
| 12/1/2010 17:00 | 17 | 0 | 0 | 0 | 24.51 | 21.14 | 27.63 | 54 | 14 | 11.2 | 20.4 | 20.3 | 20.6 |
| 12/1/2010 18:00 | 0 | 0 | 0 | 0 | 17.67 | 15.32 | 20.5 | 74 | 12.8 | 11.7 | 19.9 | 19.6 | 20.3 |
| 12/1/2010 19:00 | 0 | 0 | 0 | 0 | 13.52 | 12.42 | 14.98 | 89 | 11.5 | 11.2 | 19.2 | 18.9 | 19.6 |
| 12/1/2010 20:00 | 0 | 0 | 0 | 0 | 11.69 | 11.21 | 12.28 | 96 | 10.8 | 10.7 | 18.5 | 18.2 | 18.8 |
| 12/1/2010 21:00 | 0 | 0 | 0 | 0 | 10.82 | 10.51 | 11.14 | 98 | 10.3 | 10.2 | 17.9 | 17.6 | 18.2 |
| 12/1/2010 22:00 | 0 | 0 | 0 | 0 | 10.28 | 10.06 | 10.47 | 99 | 10 | 9.9 | 17.3 | 17.2 | 17.6 |
| 12/1/2010 23:00 | 0 | 0 | 0 | 0 | 9.83 | 9.6 | 10.03 | 100 | 9.6 | 9.5 | 16.9 | 16.7 | 17.1 |
| 12/2/2010 0:00 | 0 | 0 | 0 | 0 | 9.38 | 9.38 | 9.38 | 100 | 9.3 | 9.3 | 16.3 | 16.3 | 16.3 |

**Table 3.** Total water requirement of capsicum at varying crop growth stages

| S. No | Stages | Days after Transplanting | | $ET_c$, mm/day | | Saving in ETc in the polyhouse , % |
|---|---|---|---|---|---|---|
| | | Outside | Inside | Outside | Inside | |
| 1 | Initial | 0-25 | 0-30 | 1.20 | 0.72 | 40.0 |
| 2 | Development | 26-55 | 31-65 | 2.45 | 1.85 | 24.3 |
| 3 | Middle | 56-95 | 66-150 | 5.03 | 3.50 | 30.4 |
| 4 | Maturity | 96-120 | 150-220 | 4.58 | 2.40 | 47.6 |

## SUMMARY AND CONCLUSIONS

Web is changing the way we take measurements and distribute results. Few options exist for remotely controlling applications of water requirement in polyhouse. We try to incorporate the web into control of polyhouse micro climate. Internet based application for control and monitoring of a Polyhouse farm has been successfully demonstrated. At present, initial cost is major concern. However, on one side, cost of such systems is decreasing at a rapid pace. Capsicum (*Capsicum annum L.)* is a valuable vegetable crop with excellent prospect both for the domestic and export market can be grown in polyhouse. To ensure its regular and off-season supply, technology for growing of capsicum under protected conditions was standardized. Irrigation is one of the most important inputs, which affects the yield and quality of agricultural produce from polyhouse. Efficient irrigation in polyhouse can be achieved by accurate estimates of evapotranspiration. The system is also typically suited for India as well as other developing nations where farming is a major source of income and needs continues attention.

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