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Microclimate and irrigation requirement under greenhouses in Egypt

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EXTENDED ABSTRACT

Introduction

Greenhouse production of vegetables and fruits is a very important horticulture activity in Egypt. The employment of greenhouses results in a rise in production per land, water and nutrient units, higher fruit quality, longer production periods, and keeps supply during off-season (El-Gayar et al., 2019). Good agricultural practices of protected cultivation farming are perhaps the main alternatives in countries in the Mediterranean region, such as Egypt, which needs to improve the profitability from the cultivated area to fulfil the gradually increasing need for nourishment for the expanding populace and preserve the regular assets (Abdrabbo et al., 2019). Managing the microclimate and irrigation system in greenhouses is considered a major challenge faced by growers due to the differences of cover materials (polyethylene, screen and shade nets) compared to open field conditions. The main opportunities of greenhouse production are to provide the local market with high quality fresh vegetables and fruits, export and create significant job opportunities for new agriculture graduates, technicians and labourers.

Methods and Materials

Dominating climate in Egypt:-

Climate in Egypt is described by a hot and dry summer season and a cold climate during winter with moderate humidity and low precipitation. Precipitation rate decreased gradually from the North toward the South (Abdrabbo et al., 2012). Table (1) presents the ambient climatic conditions including air temperature, relative humidity (RH%), precipitation, and evapotranspiration for Dokki location, Giza, represent middle Egypt region. Climatic data was collected from automated stations belonging to the Central Laboratory for Agricultural Climate. The greenhouses dimensions were 40 m length, 9 m width and 3.5 m height. The air temperature under greenhouses and relative humidity were measured using digital thermo-hygrograph. Irrigation requirement was calculated according to FAO 56 method.

Table 1. Climatic data for Dokki (Giza governorate) in the Middle Egypt region

Climate season	Max Temp.	Min Temp.	RH (%)	Preciptation (mm)	ETo mm/day
Winter	21.4	8.6	56.3	25.4	2.4
Spring	31.3	15.4	52.3	5.5	5.5
Summer	35.7	19.7	57.7	0.0	5.3
Autumn	25.7	12.7	64.0	14.1	2.5

Results and Discussion

Manage temperature and humidity during growing season:-

Figure 1 demonstrates the air temperature and relative humidity under different greenhouse covers during the year. This data shows the polyethylene (PE) cover led to increased air temperature and relative humidity compared to the screen net cover as well as open field conditions. This data can help the growers and investors to select the proper cover for concerned crops. The temperature under white net cover was slightly higher than the open field during the daytime while the air temperature under the shade net was lower by 2 ºC than the open field. Greenhouse design in Egypt should deal with the high daytime temperatures during early summer especially under high frequency of heat waves in the last ten years (El-Afandi and Abdrabbo,2015) and low air temperatures during winter (Table 1 and Figure1). Greenhouse structures covered by screen or shade nets are considered one of convenient practices to be adopted especially during the summer season. Lower air temperature under shade net depends on the darkness factor of the screen material. Shading nets applied will be effective in relieving the heat load of the greenhouse and then reduce heat stress for cultivated crops. However, using a proper screen net allows effective ventilation to permit sufficient airflow through screen openings (Abulsoud et al., 2014). The effect of screen net is to reduce heat stress for plants during summer season due to lower air temperature and avoid direct exposure to solar radiation (El-Gayar et al., 2019). Hybrid greenhouse system instead of its advantages to avoid the over-heat during the summer and trapping the heat in winter but unfortunately is not adopted in Egypt regarding the high cost and the lack of knowledge for the major horticulturist.

Irrigation management under greenhouses:-

Determining the proper irrigation water for plants based on the weather data, crop type, growth stage and soil characteristics is a vital challenge for greenhouses managers. Table (2) illustrates the irrigation water requirement for different crops during the season for Dokki area – Giza governorate, Egypt. Rescheduling of irrigation is needed during the summer season due to heat wave events. Despite the fact that most growers apply higher quantities of irrigation water than the actual needs, the crops face water stress because of the wrong irrigation interval especially under high

temperature events during daytime. Using soil moisture sensors can help to improve irrigation water management for the farmers. The data show that the lowest air temperatures are always recorded during winter season (Table 1), slowly increasing during spring to arrive at the highest temperature during summer. The impact of greenhouse cover on air temperature led to direct impact on crop water requirement. Evapotranspiration follows practically a similar pattern as air temperature (Abdrabbo et al., 2019)

Table (2) Average irrigation requirements for different cultivated plants under greenhouses

	Average irrigation requirements (Liter/plant/ day)		
Growth Stage	**Early season**	**Mid. Season**	**Maturity**
Lettuce	0.5	0.7	1.1
Celery	0.6	0.8	1.4
Red cabbage	0.4	0.6	1.2
Tomato	0.7	1.2	4.0
Pepper	0.6	1.1	3.6
Squash	0.6	0.8	3.0
Broccoli	0.5	1.0	2.0
Dwarf Mango	20.0	40.0	60.0
Cucumber	0.5	1.5	4.0

Common crops under greenhouses in Egypt:-

The greenhouses expanded significantly in the last few years in Egypt which led to increased local production of some vegetable crops such as cucumber, pepper, tomato and green beans. The high production led to a decrease in the price of the produced crops with higher competition. Some growers have start to cultivate tropical fruits such as mango, orange and banana to obtain significantly high income from land and water units. More crops should be adopted under greenhouses such as medicinal and ornamental crops such as basil, cut flowers etc. Table 2 shows the common crops which are cultivated under greenhouses and the average irrigation water requirement for each crop during different physiological stages (Abdrabbo, et al. 2019).

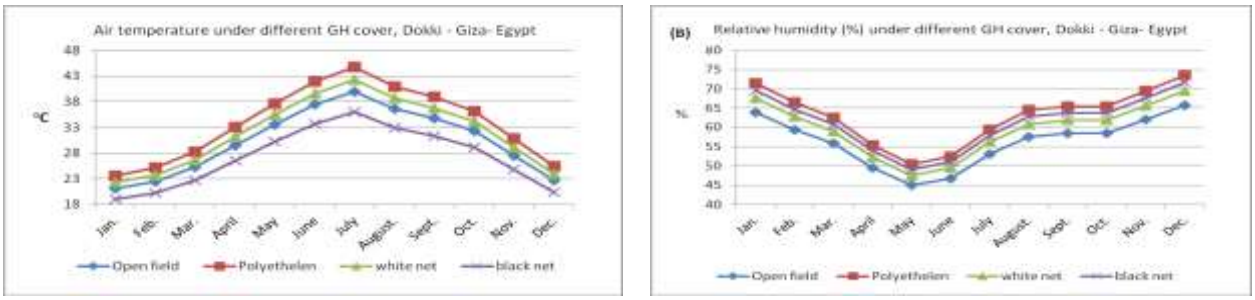

Figure 1. Comparison of (a) air temperature and (b) relative humidity under different greenhouse cover in Dokki, Giza, Egypt

Conclusions

The current work demonstrated some of management practices in terms of micro-climate under different greenhouse covers, irrigation water requirement and common crops under greenhouse in Egypt. Increase in air temperature during summer season led to increase the irrigation water requirements due to increase the evapotranspiration value during hot daytime which increased with increasing temperature under greenhouses.

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