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EFFECT OF POLY-GREENHOUSE SHADING RATIOS ON GERMINATION AND YIELD OF TOMATO UNDER FAYOUM DEPRESSION CLIMATIC CONDITIONS

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ABSTRACT

Four similar experimental poly-greenhouse models with different shading rations and ventilation gaps were used and compared with the open field condition. One of the four poly-greenhouse models was covered by a single layer of polyethylene (without shading), and the others three models were covered with an external black screen shade net sheets of 25%, 63% and 75% shading ratios, during the winter months. While, three poly-greenhouse models were covered only with black screen shade net sheets of 25%, 63% and 75% shading ratios during the summer months. The thermal performance of the greenhouse models and their effects on seedlings germination and yield of tomato (GSI Seed, Hybrid Tomato, Nora-765) were investigated under Fayoum depression climatic conditions during the winter and summer months of 2009.

The obtained results indicated that the air temperature inside the un-shaded model was almost higher than in shaded models and ambient temperature during the winter months (January to May). The air temperature inside the greenhouse models covered only by black screen shade net sheets of 63% and 75% shading ratios were down the ambient temperature during the summer months (June to October) with ventilation rate during the night time. All shading ratios caused to increase the relative humidity inside the greenhouse models, especially with 63% and 75% shading ratios. As shading ratio increased the light intensity decreased, and thus, the light intensity was adequate when it decreased by 63% and 75%, which is satisfactory for seedlings germination, plant growth and yield of tomato at the summer months. Poly-greenhouse with single layer of polyethylene was found more suitable for seedlings germination,

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plant growth and yield of tomato than those with the other shading ratios and open field condition during the winter months. Poly-greenhouse covered only by black screen sheets (especially with 63% or 75% shading ratios) was found more suitable for better seedlings germination, plant growth and yield of tomato than this with 25% shading ratio and open field condition in the summer months.

INTRODUCTION

Fayoum depression has a private climatic condition, where, the great gap data between minimum and maximum ambient temperature during the 24 hours of day, especially during the winter season.

Greenhouse is a climate controlled; it can provide an excellent controlled environment for plant production. Greenhouse structure, orientation, heating and ventilation are key factors in its successful operation. Light is one of the most important environmental parameters that represent the climate of the greenhouse. The shading is a very important factor in reducing air temperature because it absorbs some of solar radiation entering the greenhouse, especially during summer**.** Tomato is a very popular crop for production in greenhouses and the demand for it is usually strong. It is a warm season crop requiring a temperature from 15 ^{o}C to 30 ^{o}C.

Rosa et al. (1989) reported that solar radiation inside the greenhouse depends strongly upon its orientation. A greenhouse with its axis aligned along the north-south direction collects more radiation in summer and less in winter than the greenhouse with its axis aligned along the east-west direction. **Papadakis et al., (1996)** mentioned that mechanical ventilation is not economic because of its cost in term of energy use and maintenance. Natural ventilation is a cheap, practical method and very commonly method used to ensure a near optimal greenhouse climate during both summer and winter. **Young and Hee (1999)** indicated that the control of air temperature in the greenhouse depends on the ventilation during the day-time. Also, the amount of solar radiation transmitted into the greenhouse during the day-time was different in each type of structure being affected mainly by the covering material. Thus, the plastic covering decreased the transmittance of solar radiation into the glasshouse by 64.7% as compared the incident solar radiation flux. **Willits (2001)** found that shade cloths would reduce energy gains by the greenhouse in the direct proportion to the shade rating of the cloth. **Kittas et al., (2003)** mentioned that the high ventilation rates and shading contribute to reduce the temperature gradients created by the fan and pad cooling system inside the greenhouse. On other hand, increasing the ventilation rate reduces temperature gradients but enhances plant transpiration and could also, contribute to water stress. Stronger shading reduces the transpiration demand, but it proportionally reduces photosynthetic rate, and consequently, the expected yield. **Wikipedia (2007)** indicated that one of the most aspects of greenhouse design is to provide a covering with controlled differences between the transparency in the solar radiation band and the terrestrial thermal radiation band for the purpose of either raising or lowering the temperature inside the greenhouse**. El-Nono et al., (2008)** indicated that new yellow and blue polyethylene (PE) films (150 micron thickness) reduced the average indoor light intensity by an average of 23.25% and 36.98% as compared with the average outdoor light intensity, respectively. **Adbel-Galil and Mourad (2009)** reported that the air temperature under 63% and 75% shading were near the ambient temperature during the winter months without ventilation during the night time, but they were down the ambient temperature during the summer months with ventilation rate during the night time. All shading ratios caused to increase the relative humidity inside the greenhouse, especially with 63% and 75% shading ratios.

IB Libner (1989) reported that the optimum temperature required for most vegetable seeds germination ranged from 15.5^{o}C to 35 ^{o}C. **Garcia (1994)** studied the germination rate of T. grandiflorum seeds at 5 different temperatures (15, 20, 25, 30 and 35^{o}C) in 3 different substrates (sand, sawdust and vermiculite) in the dark. He indicated that seed germination was inhibited at 15^{o}C, but was accelerated at 35^{o}C although this temperature damaged the cotyledons and the radicals. The best germination temperature was between 20^{o}C to 30^{o}C dependant on the type of substrates used **El-Batawi et al. (2004)** studied the effect of heating the air inside the greenhouse at night on the seedlings germination of pumpkin; eggplant and tomato comparing with their germinations in both unheated greenhouse and outside the greenhouse (8^{o}C to 13^{o}C). They reported that the heated greenhouse at night (14^{o}C to 20^{o}C) produced 100% germination for all seedlings, while in unheated greenhouse; the seedling germination was 100% 91% and 25% for pumpkin, eggplant and tomato, respectively. On the other hand, the germination ratio outside the greenhouse (open field) was 100%, 65% and 0.0% for pumpkin, eggplant and tomato, respectively. **Kenneth et al. (2005)** reported that tomato seedlings germinated under controlled greenhouse conditions were closed to the same shape, size, length and color and more resistance to diseases than the open field germinated tomato seedlings**. Willits (2003) and Abdel-Galil and Abo-Habaga (2007)** indicated that the greenhouse covered by black and green screen sheets (63% shade net) increased the germination percentage and the growth rate of tomato seedlings comparing with the greenhouse covered by transparent plastic film and the open field.

Maeglsson and Adata (1977) stated that the day temperature of 43 ^{o}C during April in the greenhouse caused premature flowering and fruit drops**. Moss (1982)** reported low yield of tomato in lower temperature regime for glasshouse. **Nimje and Shyam (1993)** reported poor yield of tomato under greenhouse as compared to open field crop because of higher temperature during growth, flowering and fruiting period in the greenhouse. **Singh (1997)** indicated that the ambient air temperature is considered the most important factor of all climatic factors affecting vegetable production. It affects growth and development of vegetables in term of seed germination, development of economic parts, flowering, pollination, fruit set, quality of production, seed production, seed storage, seed dormancy and occurrence of disease and pests. **Mortensen (2000)** mentioned that humidity affects growth of greenhouse crops mainly through its impact on leaf size and light interception rather than through a direct impact on photosynthesis by increased stomata. Plant leaf area can either increase or decrease under long-term high humidity exposure**.**

The major aim of this research is to study the effect of temperature and different shading ratios in the poly-greenhouses in comparison with open field on the performance of seedling germination and yield of tomato under Fayoum depression climatic conditions.

MATERIALS AND METHODS

Experimental work was carried out at El-Azab village, which is located at 5 Km south of Fayoum city, Egypt, (Latitude of 29.18^o N and Longitude angle of 30.3^o). The results data was collected through the periods from 1 st January to 15 th May and form 15th June to 30th October, 2009.

The following items may be appearing the thermal behavior inside the poly-greenhouse models affected by different shading ratios and their effects on the performance of seedlings germination, growth rate of tomato plants and yield of tomato under Fayoum depression climatic conditions.

1. Experimental models:

The experimental work was carried out using four poly- greenhouse models at the winter months and three of them at the summer months, to study the performance of the greenhouse models under different shading ratio conditions, and their effects on meteorological conditions inside the greenhouse models (air temperature T_i, relative humidity, Rh_i and internal light intensity, L_i) and on the seedlings germination, the growth rate of tomato plants and yield of tomato. The greenhouse models made of water galvanized pipes of 2.5 cm diameter, and the models dimensions of 5 m long, 3 m width and 2 m height. The ventilation system was a natural, where, there are two doors in the narrow sides of each model, which kept open during the day-light and closed at night, especially during the winter season. To prevent a heat losses as possible from the ground of the greenhouse models, a black plastic sheets of 0.5 mm thick (mulch) were used to cover the ground of the greenhouse models during the seedlings germination periods. The four models covered with a single layer of transparent polyethylene treated against ultra violet radiation effect (200 micron thickness and 0.96 g/cm^3 density), three greenhouse models of them were covered with an external black screen shade net sheets of 25%, 63% and 75% shading ratios during the winter months. Three greenhouse models were covered only with black screen shade net sheets of 25%, 63% and 75% shading ratios for using them during the summer months. The distance between the models was 3 m and they oriented to face east-west direction (the long axes are aligned north-south). To maintain the durability of structural frame and the greenhouse covering materials, a tension galvanized wires (2.5 mm diameter) were tied and fixed throughout the pipes and the curvatures of the greenhouse models frames. During the experimental periods, all the greenhouse models were under the same operation conditions, but the variation only in shading cover ratios (un-shading, 25%, 63% and 75% shading ratios). The schematic diagram of the greenhouse model and the three black screen net shading sheets are illustrated in Fig. (1), and the treatments followed and their specifications are shown in Table (1).

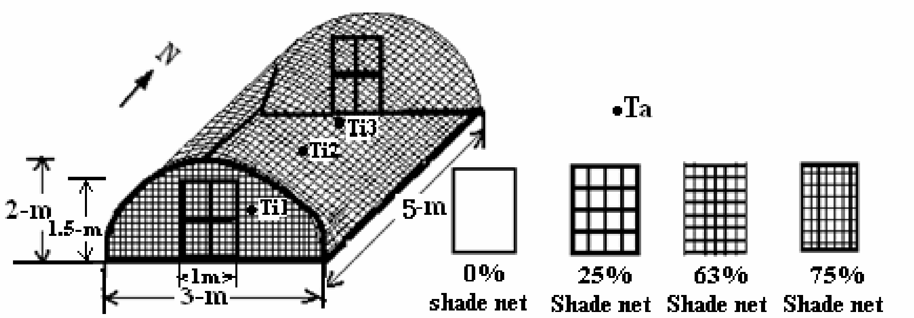

Fig. (1): Schematic diagram of a greenhouse model and the different shading ratios

Table (1): The treatments and their specifications

Winter Months	
Treatments	Specifications
T1	Fully covered with white UV-polyethylene film.
T2	Fully covered with white UV-polyethylene film with an external black screen shade net sheets of 25%.
T3	Fully covered with white UV-polyethylene film with an external black screen shade net sheets of 63%.
T4	Fully covered with white UV-polyethylene film with an external black screen shade net sheets of 75%.
T5	Open field condition (control).
Summer Months	
Treatments	Specifications
T1	Fully covered with black screen shade net sheets of 25%.
T2	Fully covered with black screen shade net sheets of 63%.
T3	Fully covered with black screen shade net sheets of 75%.
T4	Open field condition (control).

2. Measurements of meteorological conditions:

Global solar radiation (I, W/m^2), air temperature (T, ^{o}C), light intensity (L, lux), and relative humidity (Rh, %) were measured daily from sunrise to sunset inside and outside the greenhouse models as follows:

2.1. Solar radiation:

The solar radiation intensity was measured daily every one hour interval only outside the greenhouse models, using a data acquisition system with an accuracy of 0.1 W/m^2.

2.2. Air temperature:

The air temperatures were measured daily every two hour interval outside and inside the greenhouse models. Inside each model, there are three measured positions (Center ($_{Ti2}$) and 1.25 meter far from the greenhouse doors ($_{Ti1}$ and $_{Ti3}$)). The measuring sensors were put above the ground by one meter. A thermocouple recordable was used for measuring (VE 310, with an accuracy of 0.1 ^{o}C).

2.3. Light intensity:

A digital Luxmeter (unit: lux, measuring 1-150000 lux, with an accuracy of 1 lux), was used to record the light intensity inside and outside the greenhouse models. The light intensity was measured every two hours.

2.4. Relative humidity:

A digital thermo-hygrometer with measuring range of 2% - 98%.was used to record the relative humidity ratio inside the greenhouse models.

3. Seeds germination and cultivation of tomato seedlings:

The hybrid variety (*GSI Seed, Nora-765*) of tomato seeds was germinated under poly-greenhouses having different shading ratios and in an open field condition. A 1:1:1 (by volume) commercial mixture of vermiculite, perlite and peat was used as a growing media for germinating tomato seeds. Before using this media, it was completely mixed in order to makes it homogeneous and uniform in texture, and after that the seedling trays were filled by this mixture. Each seedling tray was having gross dimensions of 60-cm long, 40-cm wide and 10-cm deep, with a total volume of 0.024 cm^3. Each seedling tray was contained 196 holes for tomato seeds sowing with narrow holes at the bottom of the tray for excess water drainage. The tomato seeds were manually sowed in the marked seedlings trays, and covered by 2-cm vermiculate film for wetting the seeds and improving the uniformity of emergence. Six seedlings trays were placed above a bench in the middle of each poly-greenhouse and in the open air field condition as a control. All the seedlings trays were grown under the same conditions in terms of type of seedling trays, sowing method, irrigation and the other agricultural processes. The germination percentage of tomato seedlings was calculated after 20 days of sowing date by using the following equation:

$$\text{Germination ratio (\%)} = \frac{\text{Number of seedligs in the seedling try}}{\text{Number of sowing holes in the seedling try}} \times 100$$

To estimate the growth rate of tomato seedlings for each treatment, the seedlings height and number of leaves per seedling were recorded after 25 days of sowing date on randomly selected 10 seedlings in each try.

One-month-old seedlings of tomato (*GSI Seed, Nora-765*) were transplanted in the same poly-greenhouses and open field condition. Each plot measured 5-m × 3-m, which having four rows with 0.8-m × 0.8-m spacing between plants and rows. All the experimental treatments were under the same conditions (irrigation, fertilization, crop protection and any recommendation of the other agricultural processes). Observations on plant height, number of nodes, number of flowers per plant, average fruit weight, yield per plant and dry matter production were recorded on randomly selected 10 plants in each plot.

RESULTS AND DISCUSSIONS

Experimental work was carried out at El-Azab village, which is located at 5 Km south of Fayoum city, Egypt, (Latitude of 29.18^{o} N and Longitude angle of 30.3^{o}). The results data was collected through the period of 1st January to 15 May for winter and form 15th June to 30th October, for summer (2009).

1. Effect of solar radiation on temperatures of the greenhouse models:

Figures 2 and 3 show the effect of solar radiation intensity on the temperatures inside the poly-greenhouses models under different shading ratios (0, 25%, 63% and 75%), during the experimental day time. Fig. (2) shows the recorded data of 30th January, 2009, as the winter day sample, and Fig. (3) shows the collected data of 30th July, 2009, as the summer day sample. It's known that, as the solar radiation (I) increases the ambient air temperature (T_a) increases, as indicated at Figures 2, 3. As shown in Fig. (2), it's clear that, the temperatures inside the poly-greenhouse model with only polyethylene cover ($T_{un\text{-}sh}$, zero shading) had a major recorded data comparison with the different temperatures inside the poly-greenhouse models under various shading ratios. $T_{un\text{-}sh}$ was greater than ambient temperature by approximately 5–7^{o}C. Also, Figures 2 indicated that, the recording temperatures of 25% shading ($T_{25\%\text{-}sh}$) were down of un-shading data by 2-3^{o}C approximately, while the lowest temperatures were recorded under both of 63% and 75% shading ratios. As shown in Fig. (3), the recording temperatures of 25% shading ($T_{25\%\text{-}sh}$) were down of ambient temperature by 3-4^{o}C approximately. The minor data was recorded with 63% and 75% shading ratios, where, the temperatures under 75% shading ($T_{75\%\text{-}sh}$) were under the ambient temperature curve by 8^{o}C to 10^{o}C approximately, but the temperatures under the 63% shading were under the ambient temperature curve by 6^{o}C to 8^{o}C approximately.

An exponentional form was resulted by Excell-2003 software for best fit curve of solar radiation intensity (I) with different temperatures outside and inside the greenhouse models. The Equation formula as follows:

$$T = a\, T^b \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

The correlation factor (R^2) and the (A) and (B) constants of Equation (1) under different shading ratios for winter and summer day samples are shown in Figures 2 and 3. In general, as solar intensity increased, the higher trend of different temperatures increased. Obviously, the temperatures inside the poly-greenhouse model with only polyethylene cover ($T_{un\text{-}sh}$, zero shading) was over the ambient temperature curve during the winter months (without ventilation during the night time), but the temperatures under 63% and 75% shading were down the ambient temperature curve during the summer months (with ventilation during 24 hrs of day time).

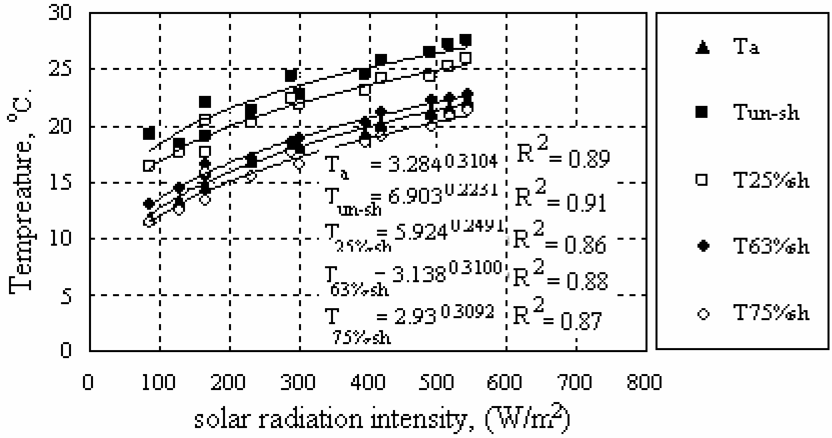

Fig. (2): Effect of solar radiation intensity on temperatures of greenhouse models during the experimental day of 30 Jan., 2009.

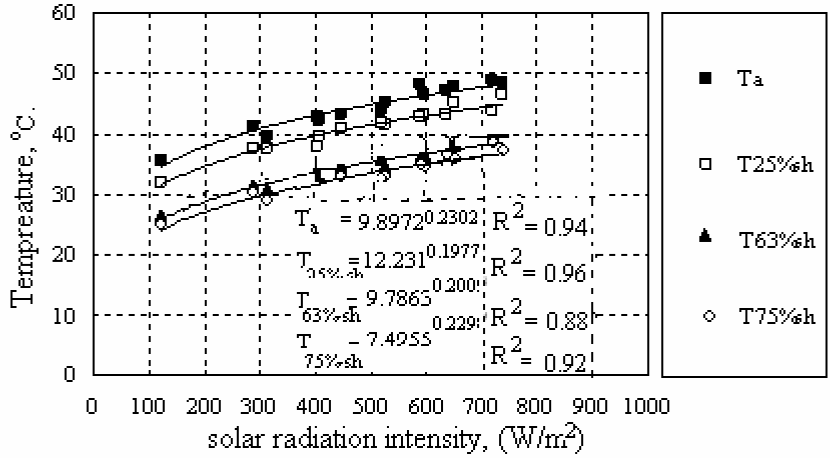

Fig. (3): Effect of solar radiation intensity on temperatures of greenhouse models during the experimental day of 30 July, 2009.

2. Effect of shading ratios:

2.1. Effect of shading on temperatures inside the greenhouse models.

Different shading ratios in the poly-greenhouse models and open field condition influenced the air temperature. Figures 4 and 5 show the recording data during the day of 30th of January and 30th of July, 2009. As shown in Fig. (4), it's clear that, all trends of temperatures were below the ambient temperature curve; else temperatures inside the poly-greenhouse model with only polyethylene cover (zero shading) was over the ambient curve during the period from 8am to sunset (6pm). On the other hand, approximately, all temperatures data were near through the night hours (from 8pm to sunrise). Obviously, not only the temperature within polyethylene greenhouse (T_{un-sh}) was higher than ambient temperature, but also, they were almost parallel from 8am to sunset. The maximum differential data was obtained at 2 pm by 5°C to 8°C between T_a and T_{un-sh}. As shown in Fig. (5), it's clear that, the trend of ambient temperature curve was almost over all trends of temperatures inside the greenhouses models during the day-time.

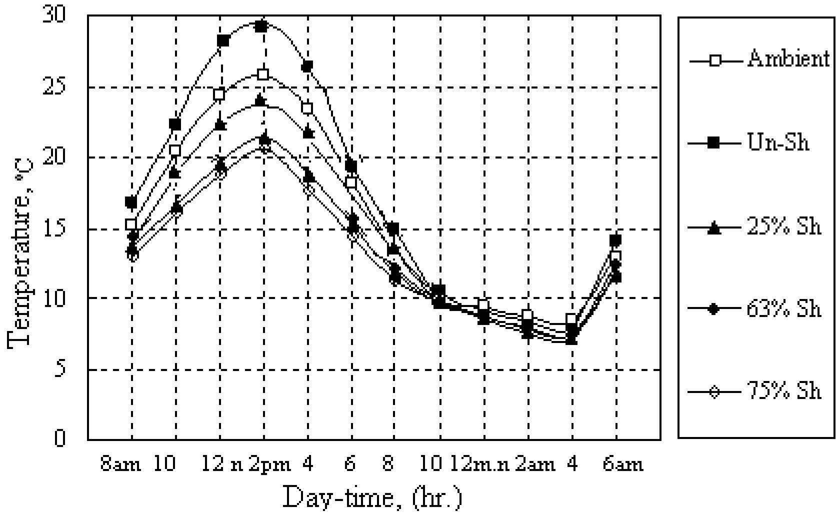

Fig. (4): Temperatures trend inside the greenhouse models compared to open field condition during the day-time (30 Jan., 2009).

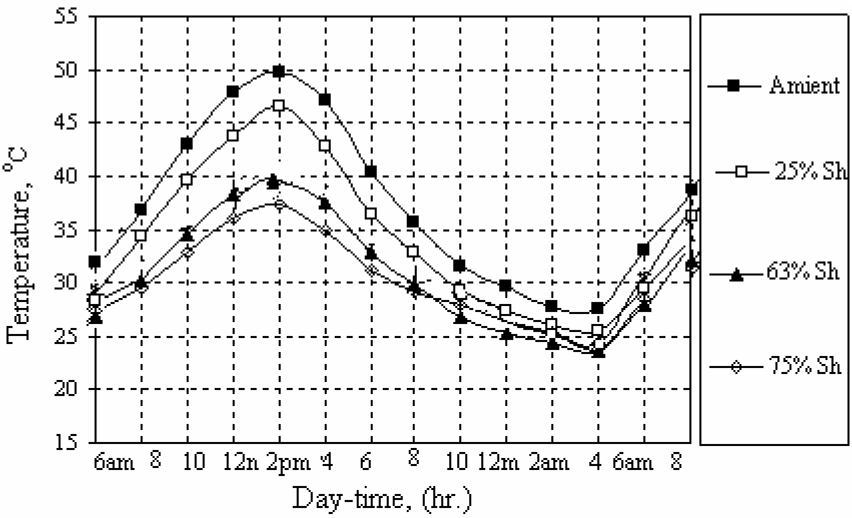

Fig. (5): Temperatures trend inside the greenhouse models compared to open field condition during the day-time (30 July, 2009).

The 63% and 75% shading ratios gave the lowest temperatures, especially during the periods from sunrise (6am) to sunset (8pm). Finally, we can say that, increasing of shading ratios caused to decrease the temperatures inside the greenhouses models during the day time from sunrise to sunset, and the thermal equilibrium was obtained during the night hours.

2.2. Effect of shading ratios on relative humidity inside the greenhouse models:

The relative humidity behavior under shading conditions was appeared at Figures 6 and7, during the day time of 30th January and 30th July, 2009. As shown in Fig. (6), it's clear that, the greenhouse model with polyethylene cover (zero-shading) only was lower than the ambient relative humidity, while all shaded greenhouse models were higher relative humidity than the ambient relative humidity during the winter months. Figure (7) show that all shaded greenhouse models were higher relative humidity than the ambient relative humidity during the summer months. Obviously, the maximum relative humidity was recorded inside the greenhouse model with 75% shading ratio during the day time. Thus, we can say that, the seedlings and tomato plants didn't suffer during their growth at the summer months, especially with 63% and 75% shading ratios, because all shading ratios caused to increase the relative humidity inside the greenhouse.

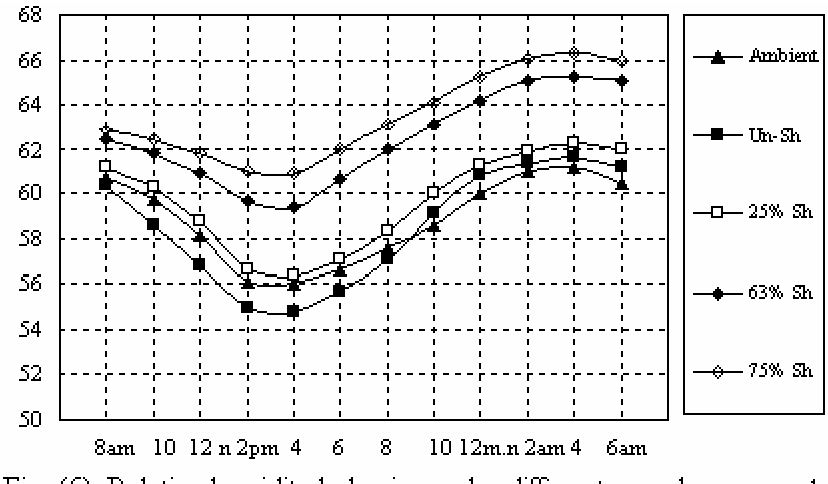

Fig. (6): Relative humidity behavior under different greenhouse models shading conditions during the day-time (30 Jan., 2009).

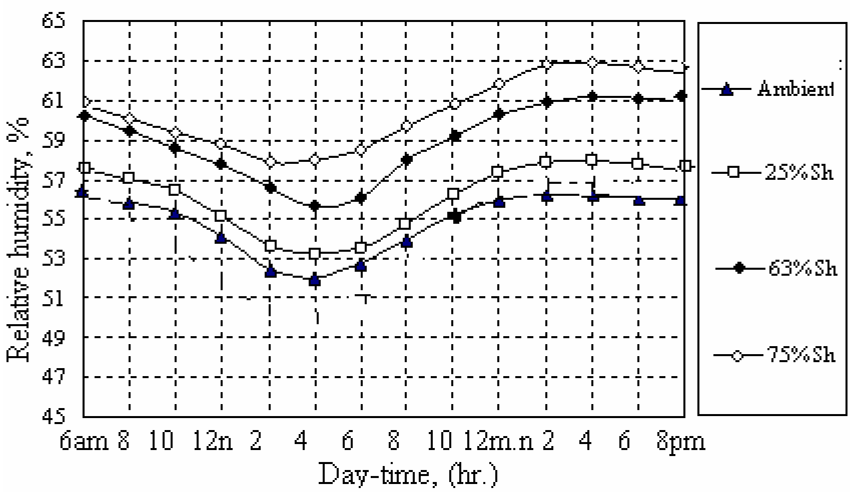

Fig. (7): Relative humidity behavior under didfferent greenhouse models shading conditioins during the day-time (30 July, 2009).

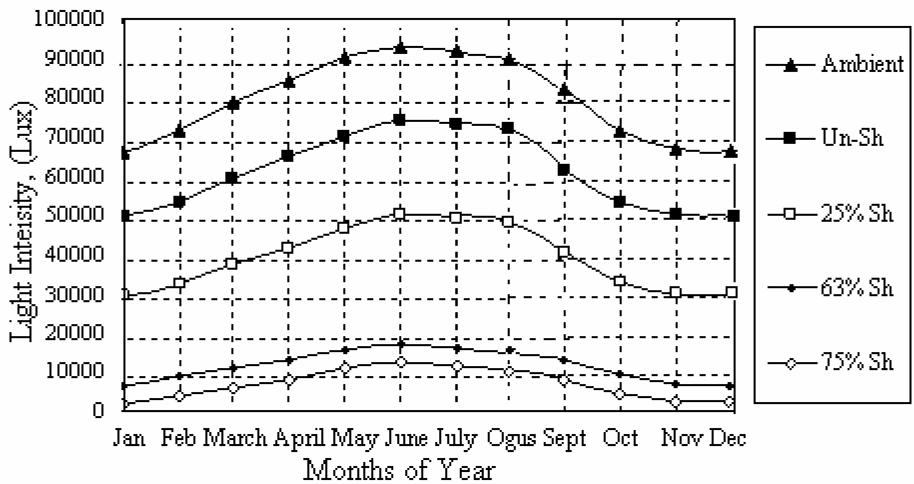

Fig. (8): Effect of shading ratios on the light intenisity inside the greenhouse models during the experimental periods.

2.3. Effect of shading ratios on light intensity inside the greenhouse models:

It's known that, as shading ratio increased the light intensity decreased, as shown in Figure (8). It's clear that, the ambient light intensity was the highest curve, and the other light intensities inside the greenhouse models with/and without shading were under the ambient light data during the experimental months. Also, it's obtained that, the maximum data of light intensity was recorded during June and July, and the minimum data was recorded during December and January.

3. Germination and growth rate of tomato seedlings under different shading conditions:

The germination percentage of tomato seedlings for all treatments was calculated after 20 days of sowing date for both winter and summer treatments, and the obtained data are listed in Tables (2). For winter months, the obtained data appeared that, the tomato seeds which germinated under the un-shaded greenhouse model had an increasing germination ratio (96.4%) compared to those germinated under shaded greenhouse models and open field condition. Consequently, the un-shaded greenhouse model increased the number of tomato seedlings by 2.0%, 10.7%, 15.8% and 23.9% as compared by the shaded models (25%, 63%, and 75%) and the open field conditions, respectively. For summer months, the obtained data appeared that, the tomato seeds which germinated under shaded greenhouse models (especially with 63% and 75% shading ratios) had an increasing germination ratios compared to those germinated under shaded greenhouse model with 25% and open field conditions. The germination percentages were significantly higher in both greenhouse models covered by black screen sheets only (with 63% and 75% shade net), where they were 89.8% and 91.3%, respectively. Consequently, the shaded greenhouse model covered with 63% and 75% shade net increased the number of tomato seedlings by 10.2% and 11.7 % as compared by the shaded greenhouse model covered with 25% shade net, respectively, but they increased the number of tomato seedlings by 22.5 % and 24.0 % as compared by the open field conditions, respectively. These differences in germination percentages of tomato seedlings under different shaded greenhouse models may be attributed to the absorption rate of nutrient elements, the reaction rate of various metabolic processes which mainly dependent upon the ambient air surrounding the seedling, and uptake of water by root-system which strongly affected by the interior environmental factors (Nelson, 1990).

Table (2): Germination ratio of tomato seedlings under different shading ratios for the winter and summer month's treatments, 2009

Treatment	Winter months, 2009		Summer months, 2009	
	Ave. No. of seedlings / treatment	Germination ratio, (%)*	Ave. No. of seedlings / treatment	Germination ratio, (%)*
T1	189	96.4	-	-
T2	185	94.4	156	79.6
T3	168	85.7	176	89.8
T4	158	80.6	179	91.3
T5	142	72.5	132	67.3

- **No. of sown seeds per try = 196 seeds.**

The growth rate of tomato seedlings for all treatments was calculated after 20 days of sowing date for both winter and summer treatments, and the obtained data are listed in Tables (3). For winter months, the obtained data appeared that, the tomato seedlings which grown under un-shaded greenhouse model (Fully covered with white UV-polyethylene film) had an increasing height and number of leaves per plant compared to those grown under all shaded greenhouse models and open field conditions. In contrast, for the summer months, tomato seedlings which grown under shaded greenhouse models (especially with 63% and 75% shading ratios) showed increasing in plant height and number of leaves per plant compared to those grown under greenhouse model covered by shaded 25% shading ratio and open field conditions.

Finally, we can say that, the un-shaded greenhouse model and 25% shading ratio caused to increase the seedling height and number of leaves per seedling in the winter months, but all shading ratios caused to increase the growth rate of tomato seedlings in the summer months.

Table (3): Growth rate of tomato seedlings under different shading ratios for the winter and summer month's treatments, 2009

Treatment	Winter months, 2009		Summer months, 2009	
	Ave. height of seedlings, (cm)	Ave. No. of leaves / seedling	Ave. height of seedlings, (cm)	Ave. No. of leaves / seedling
T1	16.2	8	-	-
T2	15.9	8	13.5	6
T3	14.7	7	14.8	7
T4	14.7	6	14.9	7
T5	14.2	5	12.6	5

4. Plant growth and yield of tomato under different shading conditions:

Tables 4 shows the effect of poly-green house models covered with different shading ratios (25%, 63% and 75%) on the plant growth and yield of tomato for winter and summer months (2009). The obtained data appeared highly significant differences among the treatments for both of the winter and summer months. For both of winter and summer months, low plant growth rate and yield of tomato were recorded in the open field condition (T5), when compared to the other treatments. For winter months, wide variations were noticed for the plant height (68.5 – 86.8 cm), flowers number (76.9 – 186.4), average fruit weight (66.9 – 96.1 g), yield per plant (1004.6 – 2128.4 g) and dry matter per plant (76.5 – 164.6 g). The un-shaded greenhouse model (T1) registered the highest yield (2128.4 g/plant) followed by the shaded model covered with an external black screen shade net sheets of 25%.shading ratio (T2) with a yield of (2010.2 g/plant), where the highest fruit weight (96.1 g) of T1 and T2 (91.8 g) had contributed for high yield for both of the treatments. For summer months, it's clear that, highest growth rate (plant height and flowers per plant) and the highest fruit yield (86.3 and 85.6 g) were recorded in the two greenhouse models fully covered with black screen shade net sheets of 75% and 63%, (T3 and T2) respectively. Consequently, the highest average fruit weight of T3 (86.3 g) and T2 (85.6 g) had contributed for high yield in both of the tow treatments. **Demir et al. (1998)** reported that the average fruit weight was responsible for increasing the yield and favorable factors contributing to increase the yield to such great extent. **Phookan et al. (1998)** found that the highest yield of vaishali tomato was obtained by using the plastic-house condition.

Finally, it was concluded that, the yield of tomato could be increased with the use of un-shaded greenhouse (Fully covered with white UV-polyethylene) in the winter months. It is also found that the shaded greenhouse with 25% shading ratio can also be taken for cultivation this crop during these months. In contrast, the yield of tomato could be increased with the use of greenhouses covered by black screen sheets only (especially with 63% and 75% shading ratios) in the summer months. Generally, under any type of poly-greenhouses, environment should be partially controlled through opening and closing of the greenhouse doors during the day-time to facilitate proper ventilation for favoring the crop growth. It was also noticed that, the growth rate and yield of tomato was higher in the winter months compared to summer months.

Table (4): Growth rates of plants and Yield of tomato under different shading ratios for the winter and summer month's treatments.

Treatment	Plant height, (cm)	Flowers/ plant	Ave. fruit weight, (gm)	Yield/plant, (gm)	Dry matter / plant,(gm)
	Winter months (January to May), 2009				
T1	86.8	186.4	96.1	2128.4	164.6
T2	83.7	180.2	91.8	2010.2	147.8
T3	76.4	164.3	87.6	1646.7	135.2
T4	73.6	158.9	88.3	1566.1	98.6
T5	68.5	76.9	66.9	1004.6	76.5
	Summer months (June to October), 2009				
T1	88.6	188.5	75.8	1643.3	71.3
T2	92.3	196.2	85.6	2006.9	78.9
T3	92.8	198.6	86.3	2008.8	74.2
T4	69.2	76.6	57.9	987.6	44.0

CONCLUSION

1. Fayoum depression has a private climatic condition, where, the great gab data between minimum and maximum ambient temperature during the 24 hours of day, especially during the winter months, so the ventilation un-used during the night hrs.
2. The air temperature inside the poly-greenhouse models was the most important denominate environment parameter affecting the seedlings germination, the growth rate of tomato plants and their yields.
3. Increasing of shading ratios caused to decrease the temperatures inside the greenhouses models during the day time (from sunrise to sunset), and the thermal equilibrium was obtained during the night hours.
4. The temperatures inside the poly-greenhouse models with different shading ratios were over the ambient temperature curve during the winter months, but they were down it during the summer months.
5. All shading ratios caused to increase the relative humidity inside the

greenhouse. So the tomato plants didn't suffer during their growth period, especially with 63% and 75% shading ratios during the summer months.

6. As shading ratio increased the light intensity decreased, and thus, the light intensity was adequate when it decreased by using 63% and 75% shading net sheets only, which is satisfactory for growth of tomato plants, especially at the summer months.
7. It was found that the yield of tomato could be increased with the use of the un-shaded poly-greenhouse (fully covered with UV film sheets) and the poly-greenhouse covered with external 25% shade net sheets at the winter months.
8. The poly-greenhouses covered only by black screen sheets (especially with 63% or 75% shading ratios) were found more suitable for better seedlings germination, plant growth and yield of tomato than this with 25% shading ratio and open field condition in the summer months.
9. Under all types of poly-greenhouses, environment should be controlled through opening and closing doors during the day-time to facilitate proper ventilation for favoring plant growth.
10. It was also noticed that, the seedlings germination, the plant growth rate and yield of tomato was higher in the winter months compared to those obtained in the summer months.

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الملخص العربى

تأثير نسب تظليل الصوبات البلاستيكية على إنبات ومعدل نمو شتلات الطماطم وكمية المحصول الناتج منها تحت الظروف المناخية لمنخفض الفيوم

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تم تصميم وتثبيت أربع هياكل مصغرة ومتماثلة من المواسير المجلفنة (قطر 2.5 سم) على شكل نصف أسطوانى أبعاد كل منها (5 م طول × 3 م عرض × 2 م إرتفاع), كنماذج تجريبية للصوبات البلاستيكية المستخدمة فى هذا البحث, وذلك بغرض إستغلالها لدراسة أداء الصوبات البلاستيكية ذات نسب التظليل المختلفة, وأفضل الظروف لإنبات ونمو شتلات الطماطم وزيادة كمية المحصول الناتج من هذه الشتلات فى الصوبات تحت الظروف المناخية لمنخفض الفيوم. تم عمل بابين بكل نموذج لإستخدامهما أثناء عمليات الخدمة وكفتحات تهويه. فى شهور الشتاء (يناير – مايو), تم تغطية الأربع نماذج بغطاء من البولى إيثيلين المقاوم للأشعة فوق البنفسجية (سمك 200 ميكرون , كثافة 0.96 ج/سم^3) وعمل التظليل الخارجى فوق الغطاء البلاستيك بإستخدام شباك السيران الأسود لثلاث نماذج منها بنسب تظليل مختلفة (25% , 63% , 75%), بينما ترك النموذج الرابع بدون تظليل للمقارنة. فى شهور الصيف (يونية – أكتوبر), أستخدمت فقط ثلاث صوبات ذات نسب تظليل مختلفة (25% , 63% , 75%), وذلك بعد رفع غطاء البولى إيثيلين الداخلى. أستخدمت بذور طماطم من نوع (*GSI Seed, Hybrid Tomato, Nora-765*), تم زراعتها يدويا فى صوانى لعمل الشتلات بمعدل 6 صوانى فى كل صوبة, وقد تم زراعة الشتلات الناتجة من كل صوبة فى نفس الصوبة. وقد عوملت جميع شتلات ونباتات الطماطم داخل الصوبات بنفس المعاملات من حيث الرى والتسميد و العمليات الزراعية الأخرى الموصى بها.

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تم دراسة تأثير نسب التظليل الخارجى للصوبة البلاستيكية على درجة حرارتها ونسبة الرطوبة وشدة الأضاءة داخلها, وكذلك نسبة إنبات ومعدل نمو شتلات الطماطم وكمية المحصول الناتج منها خلال شهور الشتاء والصيف لعام 2009.

<u>وقد أوضحت أهم النتائج مايلى:</u>

1. تم إجراء هذا البحث تحت الظروف المناخية الخاصة لمنخفض الفيوم, حيث يوجد تفاوت كبير بين درجتى الحرارة العظمى والصغرى خلال اليوم الواحد (24 ساعة), خاصة فى فصل الشتاء.
2. تأثرت درجات الحرارة داخل الصوبات بشدة الإشعاع الشمسى, وكانت درجات الحرارة داخل نماذج الصوبات أعلى من درجة حرارة الجو المحيط فى فصل الشتاء, بينما كانت أقل منها فى فصل الصيف (مع التحكم في عملية التهوية أثناء ساعات النهار والليل).
3. أدت زيادة نسبة التظليل إلى إنخفاض درجات الحرارة داخل الصوبة عن درجة حرارة الجو المحيط أثناء فترات النهار وخاصة فى فصل الصيف, بينما كان يحدث الأتزان الحرارى بين درجات الحرارة فى الصوبات ودرجة حرارة الجو الخارجى أثناء الليل.
4. أدى التظليل إلى تقليل شدة الإضاءة داخل الصوبات, وقد وفر التظليل بنسبتى 63%, 75% شدة الإضاءة المناسبة لنمو النباتات فى منتصف النهار (12 ظهراً إلى 5 عصراً) فى شهور الصيف. بينما وفر التظليل بنسبة 25% % شدة الإضاءة المناسبة لنمو النباتات فى منتصف النهار (12 ظهراً إلى 3 عصراً) فى شهور الشتاء (يناير– مايو).
5. حققت الصوبة البلاستيكية المغطاة بغطاء من البولى إيثيلين المقاوم للأشعة فوق البنفسجية ذات اللون الأبيض بدون تظليل نجاحا كبيرا فى زيادة نسبة إنبات ومعدل نمو الشتلات وكمية محصول الطماطم الناتج منها فى شهور الشتاء (يناير – مايو), وذلك من خلال المحافظة على درجة حرارة الهواء داخل الصوبة تقريبا حول درجة الحرارة المثلى لإنبات الشتلات ونموها فى فصل الشتاء (أثناء النهار والليل), مما يجعل لهذه الأغطية أهمية كبرى لإنتاج شتلات الطماطم شتاءا تحت الظروف المناخية لمنخفض الفيوم.
6. أدى التظليل الخارجى بنسبة 25% للصوبة البلاستيكية المغطاة بغطاء من البولى إيثيلين المقاوم للأشعة فوق البنفسجية ذات اللون الأبيض نتائج أفضل مقارنة بالصوبتين ذات نسبتى التظليل ال 63% و 75% خلال شهور الشتاء, من حيث درجات الحرارة وشدة الأضاءة, مما أثر على معدل نمو النباتات وكمية محصول الطماطم الناتج منها.
7. أعطت الصوبتين المغطتين بغطاء من السيران فقط ذات نسبتى التظليل 63% و 75% أفضل النتائج خلال شهورالصيف, من حيث درجات الحرارة والرطوبة وشدة الإضاءة، مما أثر علي زيادة نسبة إنبات شتلات الطماطم ومعدل نمو الشتلات وكمية المحصول الناتج منها.
8. أدت زيادة نسبة الرطوبة داخل الصوبتين المظللتين بنسبتى تظليل 63% و 75% إلى عدم إجهاد شتلات ونباتات الطماطم, مما زاد من معدل نموها وكمية المحصول الناتج منها مقارنة بالصوبة ذات نسبة تظليل 25% وظروف الحقل المفتوح, فى فصل الصيف.
9. بصفة عامة, كانت نسبة إنبات شتلات الطماطم وكمية المحصول الناتج منها فى الصوبتين البلاستيكيتين المغطتين بغطاء من البولى إيثيلين المقاوم للأشعة فوق البنفسجية ذات اللون الأبيض بدون تظليل وذات نسبة التظليل 25% فى شهور الشتاء أفضل مقارنة بالصوبتين المغطتين بغطاء السيران الأسود ذات نسبتى التظليل 63% , 75% فى شهور الصيف.