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EFFECT OF EXTERNAL SHADING FOR GREENHOUSE ON GROWTH AND QUALITY OF SOME ORNAMENTAL PLANTS

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ABSTRACT

Effects of single layer of polyethylene without shading and single layer of polyethylene with external net shading, as greenhouse covers, on growth, productivity and microclimatic requirements of Aglaonema crispum, Diffenbachia amoena, Ficus benjamin, Schefflera actinophylla, and Codiaeum variegatum were investigated during the period from September 2005 to March 2006,.Light intensity was reduced for shaded constructer as compared with the unshaded by 23.5 Klx in which the Light transmission was higher than in the unshaded greenhouse (USHG). Relative humidity (RH) in the shaded greenhouse (SHG) was higher than in (USHG) it increased by 2 – 5 % .Air temperature in USHG was higher than in SHG during the period from 12.00pm to 4:00 pm. Under shading conation, the air temperature was reduced by 3 – 5 C ^{o}. The growth parameter of Diffenbachia amoena, Schefflera actinophylla and Aglaonema crispum in SHG were higher than those grown in USHG. The growth of Ficus benjamina, and Codiaeum variegatum in SHG was higher than for those grown in USHG. Quality of growth for all studied plants was higher under shaded greenhouse .as a recommendation it was found that using single layer of polyethylene compared with External net shading was the most advisable conditions for good quality of indoor plants.

***Keywords**: greenhouse, Shading, Growth, Quality, ornamental Plants, environmental conditions*

INTRODUCTION

Achieving maximum yield per unit area has become a high research priority. Greenhouse makes it possible to increase crop productivity by maintaining a favorable environment for plants.

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This technique has become more popular than in the past. By controlling or modifying the environmental parameters affecting plant growth .When the environment controlled, crops can be produced for specific market dates at high quality, which can be maintained by eliminating many of the variations and hazards associated with weather. Temperature can be regulated with varying degrees of precision; mechanical damage from wind and rain was avoided; injury from plant diseases and insects is reduced but not eliminated. Growing media, moisture content, and fertility levels can be adjusted to meet plant requirements. The precision with which the environment is regulated determined by the ability of the grower to manage the greenhouse's equipment and controls.

Healthy houseplants can add value to our lives by improving indoor air quality as well as aesthetics to the interior of our homes. They provide psychological satisfaction to the caregiver in getting something to bloom, produce new growth, provide fond memories of a friend or loved one. Indoor plants help creation of a pleasant home environment. Using small plants can add color and scenery to windows or tables, while larger ones soften and blend with groups of furniture, leading to creation of cool and spacious feeling, even in the warmest weather.

Houseplants are popular indoor decorations, because of their attractive and constantly changing, they add a softness of line and provide a bit of nature indoors. However, the ideal location of a plant for decoration may not be the ideal spot for plant growth, so that Lack of adequate light is the most common factor limiting the growth of plants in many areas.

Walker et al. (1983) speculated that shade cloths would reduce energy gains by the greenhouse in direct proportion to the shade rating of the cloth (percentage of light blockage); however, **Willits and Peet (2000) and Willits (2001**) found that shade cloths, even white plastic, reduced energy gains less than the shade rating would suggest. This was attributed to an increase in cloth temperature resulting from the absorption of solar energy. They also found that wetting the surface of the cloth significantly improved the cooling performance of shade cloths, which they attributed primarily to a reduction in cloth temperature due to water evaporation. They argued that reduced short-wave transmissivity of the water film trapped in the cloth. Shade is a very important factor in reducing leaf and air temperature because it absorbs some of the solar radiation entering the greenhouse during summer **(Al-Helal and Al-Musalam, 2003; Kittas et al., 2003; and Willits, 2003). Peterson et al. (1986)** found that trees grown under high light intensities had smaller thicker leaves with two distinct palisade layers, while shade grown leaves had only one palisade layer. **Willits and Peet (1993)** showed that externally mounted black polyethylene films were less than 50% effective in reducing energy and temperature gains compared their commercially given values, while white shading cloths were only slightly more effective. ***Kittas et al. (2003*)** mentioned that high ventilation rates and shading contribute to reduce the temperature gradients created by the fan and pad cooling system inside a greenhouse. But there are some drawbacks. Increasing 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.

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. Leaf area can either increase or decrease under long-term high humidity exposure. ***Papadakis et al. (1996)*** mentioned that mechanical ventilation is not economic because of its cost in terms of energy use and maintenance. Natural ventilation is a cheap and practical method and is very commonly used to ensure a near optimal greenhouse climate during both summer and winter. **Herwig (1992)** mentioned that there are plants require high relative humidity *Aglaonema crispum,Diffenbachia amoena,Schefflera species,* and *Codiaeum variegatum* however there are almost exclusively greenhouse having the minimum relative humidity 60 %.,also there are plants which require half shade *Diffenbachia amoena, Ficus benjamina ,* and *Schefflera species*

There has been much research and design about environment control for heating ,cooling, lighting and ventilation systems using sophisticated technology (automated or computerized), but those applications are mostly still in industrial sectors. In the agricultural sector, especially in developing countries such as Egypt, the application of the environment

still limited, because it is costly, and some of small investors were stopped producing inside greenhouses and they were facing many problems in relation to temperature, relative humidity and lighting. In addition, one of the most serious problems in the Egyptian greenhouses is that excessively high internal temperatures, which occur during the day from early spring until the end of autumn. These conditions have negative effects on the yield and quality of almost all greenhouse crops.
Therefore, the aim of this study is to investigate the following points:

a. Effect of covering material with external shading under natural ventilation and natural lighting.
b. Reducing the environmental control problems for greenhouses to produce indoor plants under Egyptian condition

MATERIAL AND METHODS:

This study was conducted in the Agricultural Engineering Department, Faculty of Agriculture, Cairo University, Giza, Egypt, (Latitude 29.76, and Longitude 31.30) N-S oriented, and the style of the greenhouse was Quonset-style, during the period from September 2005 to March 2006.
In this experiment one plastic greenhouses was used 10×7×3 m, (L×W× H).it was divided into two equal parts by double layer of plastic and net shading sheet for 5×7×3 m, (L ×W ×H) , shape were constructed to conform to two replications, all of them were established under the same conditions: soil, irrigation, crop planted in each season, greenhouse design, greenhouse orientations, distance between plants rows (0.55 m), number of drip laterals on the ground (10 lateral), number of micro-sprinklers on the top of plants (5 sprinklers), total ground area (35 m^2), Number of plants/m^2 (1.4 plant/m^2), and the greenhouse dimensions. Variations only in type of shading cover (shaded and unshaded) were studed as independent factor to show their effects on the ideal lighting ,temperature and relative humidity inside the greenhouses for a five ornamental plants under the Egyptian conditions.
The cover materials of greenhouse was single layer of polyethylene treated against ultra violet (u.v)effect with thickness of 200 micron ,and density of 0.96 g/cm^3 .Thus it can be derived that one kilogram of this plastic covers is about 5.2m^2. The greenhouse consisted of two parts, i.e. (part I) without shading whereas the second part had single layer of

polyethylene with external net shading 75% shading (part II). The plants for both parts of the greenhouse and seasons were five types of ornamental plants were chosen for this study, i.e. "*Schefflera* (Umbrella tree), *Ficus benjamina, Dieffenbachia* (Dumb-cane), *Codiaeum* (*Croton*) and *Aglaonema* (Chinese evergreen)"

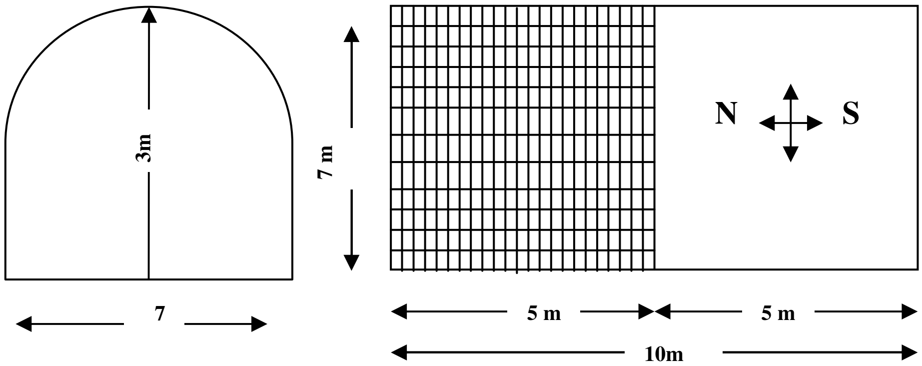

Fig.1 characteristics of the greenhouse used in the experiment (dimensions, shape and orientation)

The measurements were divided into specific measurements for plants and specific measurements for greenhouses, the whole measurements were determined under each greenhouse at the same times.

The experimental design was a completely randomized block design. The obtained data had been subjected to the analyses to variance, using two factors (plants, shaded or unshaded), and five replicates to compare the mean values.

The specific data for greenhouse conditions were, i.e. temperature, relative humidity and light intensity. The temperature readings were recorded daily many times (every 15 minuts), relative humidity twice a week ; recorded at four daily times (0.8.00 am, , 12.00 pm, 04.00 pm, 08.00pm) and light intensity measurements twice a week; recorded at four daily times (10.00 am, 12.00 pm, 02.00 pm, 04.00pm).Several sets of sensors were used inside and outside the greenhouses to determine the inside and outside air temperature and measurements were taken at 1m above the ground in four points of the greenhouses. by thermocouples (unit: c° accuracy 0.01 c°, big range, it have forty sensors).relative humidity and dry –bulb were measured by digital thermo-hygrometer (unit : °c, °f,%; range for relative humidity 2%to 98%, range for

temperature -20°c to 50°c) and light intensity measured by digital luxmeter (unit lux., range 1~150000 lux; accuracy 1 lux).
The data for the plants were collected in September 2005 and March 2006 including number of branches, Plant height, stem diameter, number of leaves per plant, and leaf area. Stem diameter was measured by vernier caliper at 10 cm above ground level (unit: mm, cm. accuracy 0.05mm) and leaf area was measured by a digital planimeter (Placom), accuracy 0.10 cm^2.

RESULTS AND DISCUSSION

The selection of the greenhouse cover material depends on many factors such as initial investment and maintenance cost, its effect on greenhouse crop productivity, local climate and technological support and developments.

3.1. Internal air temperature (T_i):

There is no difference between air temperature inside shaded and unshaded greenhouse from 8:00 pm to 8:00 am, on the other hand air temperature at 4:00am to 5:00 am was higher than air temperature in the outside by 1 c° to 1.5 c° as shown in (Fig .2).

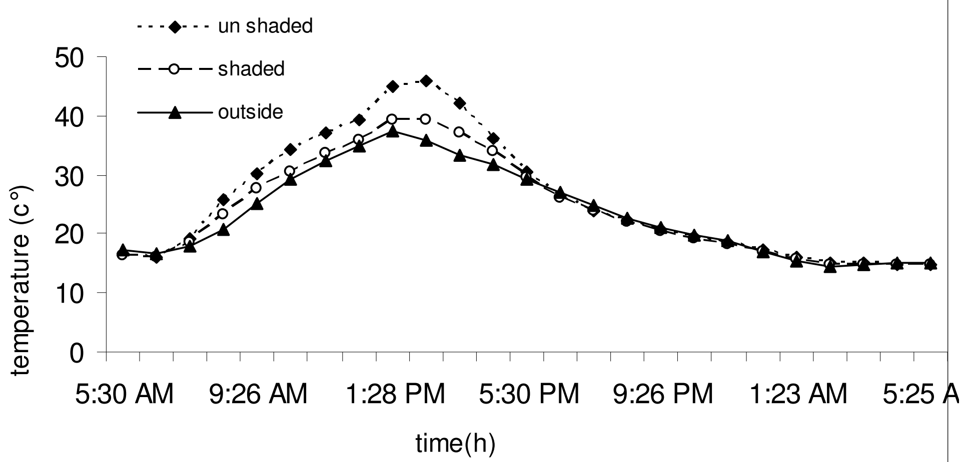

Fig.2.Average air temperature during a day (20/3/2006)

When the greenhouses side and top vents were closed, the internal temperature raised as expected. The side and top vents were 15% from the floor area of every greenhouse part as natural ventilation (5.25 m^2).

However, the average temperature increase was about 4-8°C in the unshaded greenhouses versus 2-6 °C, in the shaded greenhouse from 8:00 am to 04:00 pm (Fig.3) during September, October, and March. Therefore, with natural ventilation and covering materials it is clear that heating system is not needed under Egyptian conditions. Monthly average air temperatures in unshaded greenhouse were higher than that of shadded greenhouse. As represented in (Table.1) the highest temperatures were recorded in September (46.5 c°)while the lowest(31c°,28.1c°,26c°) were obtained in January, in the unshaded, shaded, and outside respectively when the ventilation area opened by 8% from the floor area all day, on the other hand closing all ventilation area at night raised air temperature by 3 c° to 4 c° .

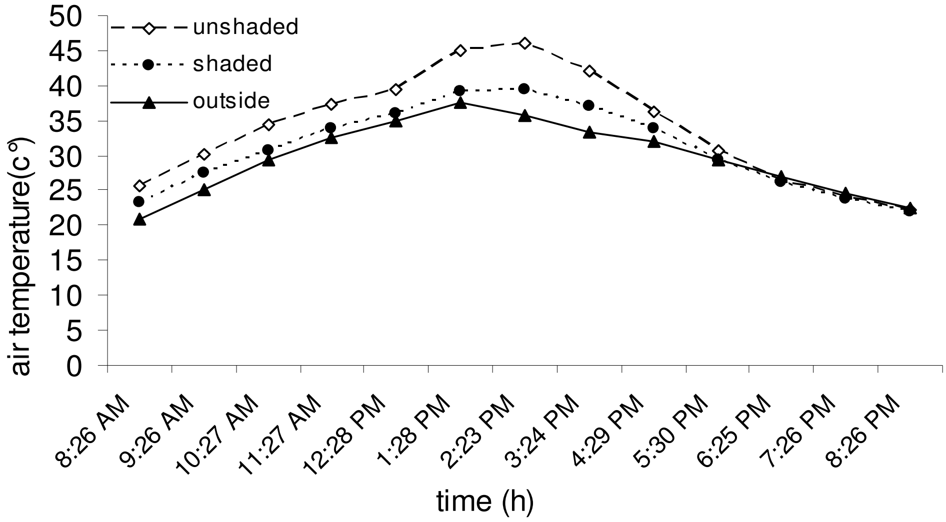

Fig.3.Relationship between air temperature and time during a critical period of day at March

Table.1. Monthly average temperature (C°) inside and outside greenhouses covered with single layer of polyethylene without shading and single layer of polyethylene with external net shading.

Month	Air temperature(c°) outside the greenhouse			Air temperature(c°)inside the greenhouse					
				unshading			shading		
	Max.	Min.	Mean	Max	Min.	Mean	Max.	Min.	Mean
September	40.0	18.2	27.8	46.8	19.3	29.5	42.8	18.2	27.8
October	35.0	11.0	20.2	41.0	10.0	22.0	37.0	13.0	20.6
November	32.0	8.3	15.7	42.0	9.6	19.7	38.0	9.5	18.3
December	30.7	9.9	17.9	34.7	11.0	18.7	31.0	11.0	17.0
January	26.0	7.4	14.7	31.0	7.6	16.2	28.1	7.6	14.0
February	31.0	15.0	17.8	42.1	10.1	20.2	36.2	9.8	18.7
March	32.5	8.3	16.0	45.6	7.6	18.6	40.3	7.8	16.5

The obtained results are in agreement with that found by Al-Helal and Al-Musalam, (2003); Kittas et al., (2003); Willits, (2003). That Shade is a very important factor in reducing leaf and air temperature because it absorbs some of the solar radiation entering the greenhouse during summer.

3.2. The inside air relative humidity (RH):

The R-square factors were deduced for the mathematical equations deduced for shaded (0.824) it was higher than unshading(0.808) ,it was 3rd degree polynomial equation obtained to develop The relation between the time and the relative humidity as shown in figs.4, and 5 . It is clear that there were large differences between temperature and relative humidity in the unshaded greenhouse during 24 hours.The highest value for relative humidity was recorded in the shaded greenhouse followed by unshaded and outside, greenhouses respectively; the highest monthly average of relative humidity (69%) was recorded in February, January while the lowest (20%) was recorded in September, October, and March. The minimum relative humidity (8%) had been recorded during the no irrigation time whereas the maximum (92%) was recorded during irrigation time.

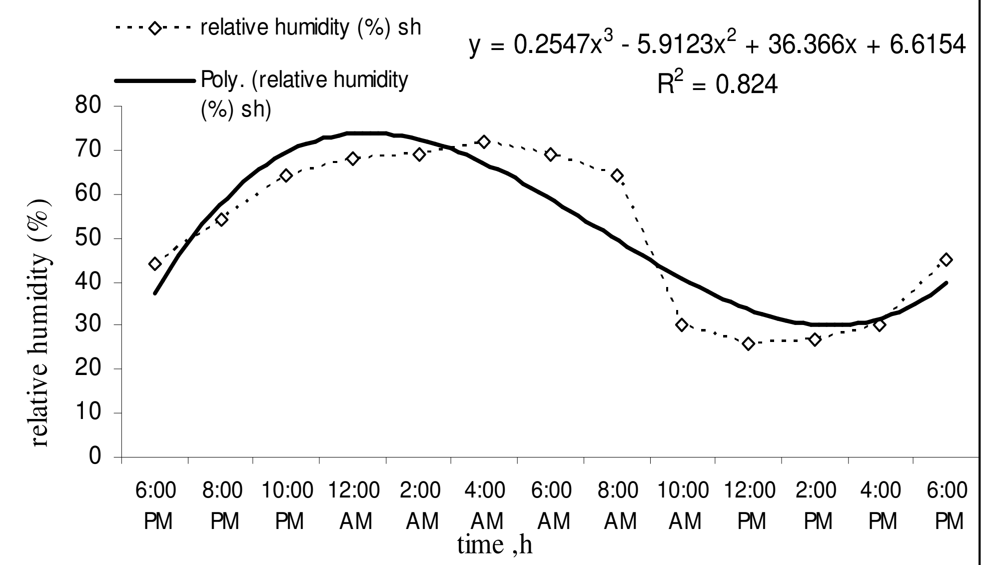

Fig.4.Relation between relative humidity and time during aday(shaded)

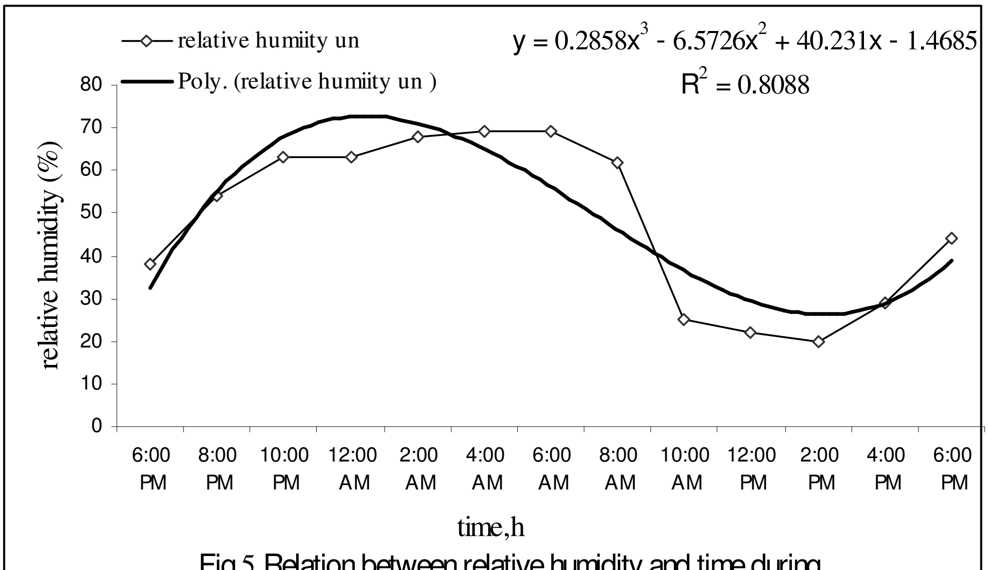

Fig.5.Relation between relative humidity and time during aday(unshaded)

These results could be attributed to the fact that level of the inside relative humidity is accompanied by the level of temperature inside the greenhouse.

Psychrometric charts were used according to ASHRAE (1993) to determine the air properties in the critical period from 8:00 am to 04:00 pm as represented in Tables.2, and 3 (dry-bulb temperature (C°), relative humidity%, humidity ratio kg/kg dry air), wet-bulb temperature, enthalpy (kJ/kg dry air), dewpoint temperature point(C°), and specific volume (m^3/kg)) in every part of experiment greenhouse

Table.2.The air properties in the shaded part of the greenhouse

Time	D.B. Temp	Rh %	HR	W.B. Temp	S.V	DP	Enthalpy
8:00 AM	18.08	64	8.40	14.00	0.836	11.50	39.90
10:00 AM	21.17	30	5.00	12.50	0.844	4.00	35.00
12:00 PM	26.55	26	5.50	14.30	0.855	5.50	40.00
2:00 PM	27.69	27	6.00	15.40	0.859	6.50	43.00
4:00 PM	26.89	30	6.60	15.80	0.858	7.80	44.00

Table.3.The air properties in the unshaded part of greenhouse

Time	D.B. Temp	Rh %	HR	W.B. Temp	S.V	DP	Enthalpy
8:00 AM	18.4	62	8.20	14.00	0.846	10.80	39.50
10:00 AM	21.7	25	4.00	11.00	0.839	1.00	31.90
12:00 PM	31.3	22	6.90	17.00	0.871	6.20	48.00
2:00 PM	31.1	20	5.60	16.50	0.870	5.20	43.50
4:00 PM	23.7	29	5.30	13.30	0.847	4.30	38.00

3.3. Light intensity:

The average of light intensity was measured under shaded and unshaded greenhouse parts. Concerning the unshaded greenhouse, the highest light intensity (68 k lux) has been measured (Fig.6) the interaction between temperatures and light showed a big impact on plant quality. Plants grown under shaded part (Moderate Light and cool temperatures) had the biggest and best quality. These conditions allow a lot of energy in the sunlight to be packed into the plant, since the leaves are developing relatively slowly. In contrast, low light and high temperatures are the worst conditions for growth of most plants. Growers must be careful not to create these conditions, by providing excess shade during the hot months.

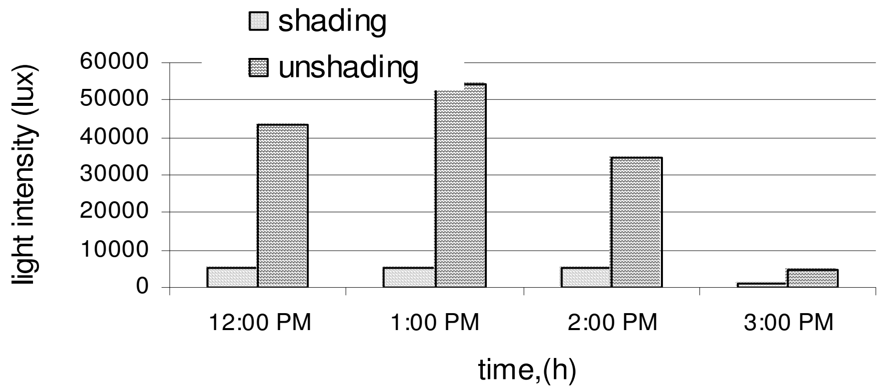

Fig.6.Average light intensity in a critical period at(March)

3.4. Growth and plant quality:

The plants varied in their growth according their types under the same conditions, the growth of plants during the period from November to March was faster than the earlier period, i.e. (first months) September and October, and this may be explained that the plants need some time for the acclimatization, the rate of growth for *Dieffenbachia* plant was decreased because of cold drafts from open windows caused discoloration, wilting, leaf curl, leaf drop and Stunted plant growth (Figs.7 and 8). In the unshaded greenhouse at January for *Dieffenbachia* plant leaf was dropped.

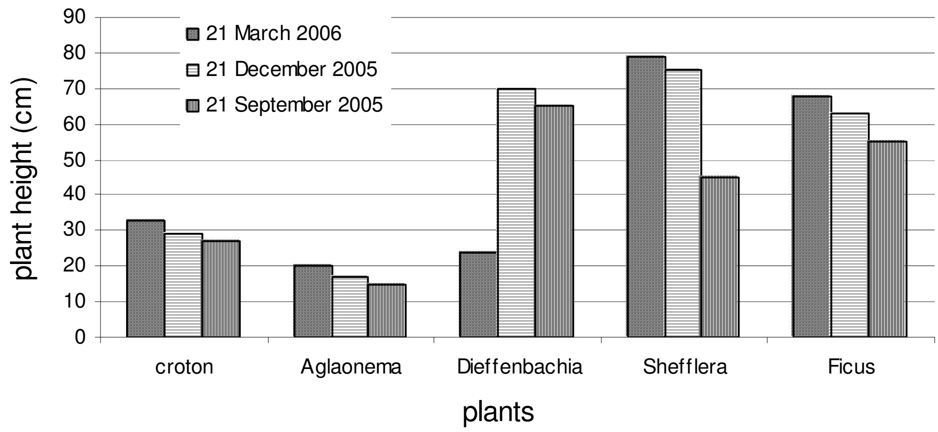

Fig.7.Average plant height in the unshaded part of the greenhouse

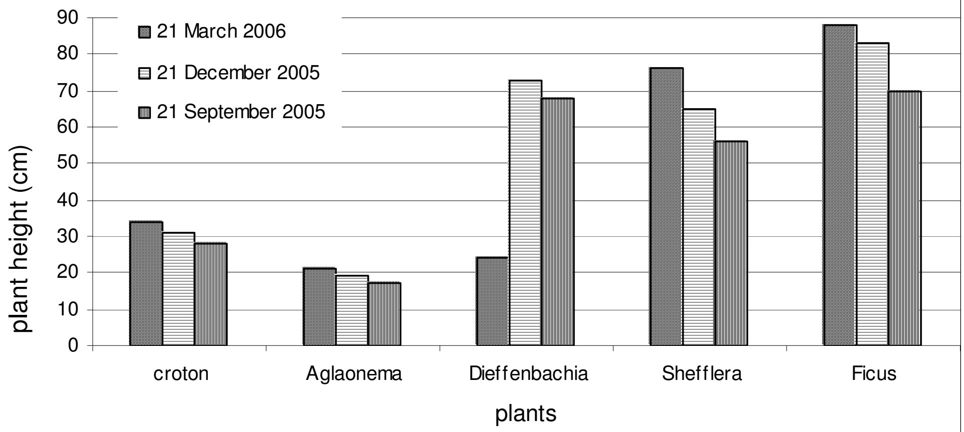

Fig.8.Average plant height in the shaded part of the greenhouse

In both greenhouse plants partition their resources to the area of greatest need under low light conditions (shaded), plants try to increase light interception. The best way to do this is by increasing the area of individual leaves. These leaves tend to be very thin and pliable (fig.9, and 10). In contrast, individual leaf size decreases and leaf thickness increases under light conditions (unshaded). These leaves are thick and have accumulated a lot of starch. However, under high conditions, plants will have more leaves. So, even though they are individually smaller

leaves, the leaf area of the entire plant increases as Daily Light Integrals (DLI) increases. For example*,* *Codiam* plant leaf area in the shaded part was larger than in the unshaded part, the total leaves area in the unshaded part was larger than the shaded part .On the other hand, root and shoot growth are proportional in shaded part. Shoot growth increases as DLI increases, so that root growth also increases as DLI increases.
These results are in agreement with that found by **Peterson et al. (1986)** that trees grown under high light intensities had smaller thicker leaves with two distinct palisade layers, while shade grown leaves had only one palisade layer.

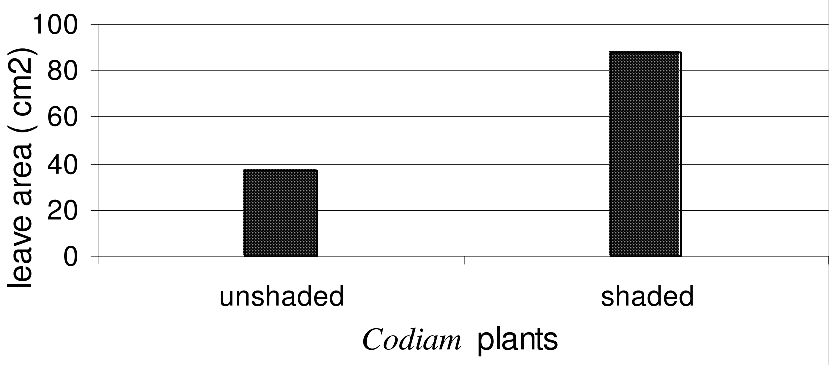

Fig.9.Average leaf area of *Codiam* plants under shaded and unshaded condations.

Aglaonema plants show yellow colourand the number of branches increased , *Schefflera* plants showed increasing in height in the shaded greenhouse part while the number of branches increased in the unshaded greenhouse part.
Many varieties of *Ficus benjamina*, *Schefflera* and *Codiam* grow best outdoors under full sun conditions; however, they require ample water. If drought stress occurs, sunburn will occur under full sunlight.

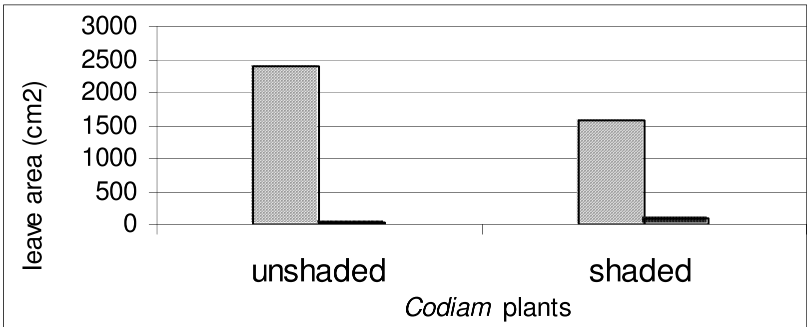

Fig.10.Average total leaf area of *Codiam* plants grew under shaded and unshaded locations

It was noticed that plant height of unshaded and shaded plants of ficus benjamina was significantly higher (79.4, 78.6 cm) compared to other plants ,while it was significantly lower (24.2,28.4 ,and 25.2 cm)in shaded of Aglaonema ,unshaded Aglaonema, and unshaded *Dieffenbachia* respectively.(table.4). it was found that branches number of unshaded and shaded plants of *Ficus benjamina* was significantly higher (34.4, 32) compared to other plants ,while it was significantly lower (1,1,1.4,1.6 and 1.8)in shaded of *Dieffenbachia* , unshaded *Dieffenbachia*, shaded Croton, shaded *Aglaonema*, and shaded *schefflera* respectively.(table.4). it was found that number of leaves unshaded and shaded plants of *Ficus benjamina* was significantly higher (211.8, 168) compared to other plants ,while it was significantly lower (6,7.8,20,21.4 and 23)in unshaded of *Dieffenbachia* , shaded *Dieffenbachia*, unshaded *Aglaonema* and shaded *Croton* respectively.(table.5). it was found that stem diameter of unshaded and shaded plants of *Dieffenbachia* was significantly higher (3.12,2.7) compared to other plants ,while it was significantly lower (0.001,0.001, and 0.75)in shaded of *Aglaonema*, , unshaded *Aglaonema*,and unshaded Croton, respectively.(table.5).

These results are in agreement with that found by ***Mortensen (2000)*** 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. Leaf area can either increase or decrease under long-term high humidity exposure.

Table.4.ffect of plant type, shaded and unshaded greenhouse on plant height and number of branches (Mar.2006).

plant	plant height (cm)			number of branches		
	shaded	unshaded	mean	shaded	unshaded	mean
aglaonema	24.2 c	28.4 c	26.3 c	1.6 c	2.4 c	2 b
dieffenbachia	29.2 c	25.2 c	27.2 c	1 c	1 c	1 b
codiam	27 c	32.8 c	29.9 c	1.4 c	2.4 c	1.9 b
schefflera	66.8 b	64.4 b	65.6 b	1.8 c	2.6 c	2.2 b
f benjamina	78.6 a	79.4 a	79 a	32 b	34.4 a	33.2 a
mean	45.160	46.040		7.560	8.560	

- **Plants with similar letter in the same columnc and rows were not significantly different at .05**

Table.5.effect of plant type, shaded and unshaded greenhouse on number of leaves and stem diameter (Mar.2006).

Plant	number of leaves			stem diameter(cm)		
	shaded	unshaded	mean	shaded	unshaded	mean
Aglaonema	21.4 c	20 c	20.7 bc	0.001 c	0.001 c	0.001 c
Dieffenbachia	7.8 c	6 c	6.9 c	2.728 a	3.122 a	2.925 a
Codiam	23.2 c	30.6 c	26.9 bc	0.925 b	0.757 b	0.841 b
Schefflera	31.2 c	30.8 c	31 b	0.995 b	1.029 b	1.012 b
F benjamina	168 b	211.8 a	189.9 a	1.031 b	1.222 b	1.127 b
Mean	50.320	59.840		1.136	1.226	

- **Plants with similar letter in the same columns and rows were not significantly different at .05**

CONCLUSION

From the present study, it can be concluded that:

1. The light intensity was high when it decreased by 75% shading ranging from 555 lux to 22200 lux (50 to 2000 foot-candle) units, which is satisfactory for ornamental foliage plants.

2. Plants generally grow much better under 30 to 50 % humidity in hot or cold climates, the humidity in the unshaded part may be lower than the humidity in the shaded part ,so that it may need mist with a sprayer to rise relative humidity by (10% to 20%) at 12:00 pm to 4:00 pm

3.Air temperature directly affects the plants health, i.e. most of house plants prefer temperatures that are ranging between 18.3 c ^{o} to 23.8 c ^{o} (65 to 75 F ^{o})

4.The height of *Ficus benjamina*, and *Codiaeum variegatum* in (SHG) were higher than those grown in (USHG).The growth of *Diffenbachia amoena, Schefflera species* and *Aglaonema* crispum in shading greenhouse (SHG) were higher than those grown in unshaded greenhouse (USHG)

5.Quality and coloration of the plants in (SHG) are better than those in (USHG) with Moderate Light

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الملخص العربى

تأثير التظليل الخارجى للصوبه على نمووجودة بعض نباتات الزينة الداخلية

.محمد هاشم حاتم -*** .فتحى جاد الابابى
-**.السعدى محمد بدوى - **** .رضاحسانين امام*

تم استخدام نموذج مصغر لصوبة ابعادها (10 م طول× 7 م عرض×3 م ارتفاع) حيث تم تقسيمها الى جزئين متساويين كل جزء ابعاده (5 م طول×7 م عرض× 3 م ارتفاع)،وقد تم عمل التظليل الخارجى فوق الغطاء البلاستيك المصنوع من البولى ايثيلين بسمك 200 ميكرون لاحدى الجزئين باستخدام شبك الساران الاسود(75% تظليل) والجزء الاخر بدون تظليل .وتم الفصل بينهمابنفس الغطاء ومادة التظليل،كما تم تغطية ارضية الصوبة بالبلاستيك الاسود"المالش".مع عمل فتحات تهويه فى كل جزء بمساحة 15%(5.25م^2) من مساحة ارضيةهذا الجزء.

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وتم استخدام نظامين للرى.نظام الرى بالتنقيط لرى بعض نباتات الزينة الداخلية ونظام الرى بالرش الرزازى لرفع نسبة الرطوبة و خفض درجة الحرارة. وقد تم دراسة تاثير التظليل الخارجى علىشدة الاضاءة ،درجةالحرارة ،نسبةالرطوبة خلال الفترة من 21 سبتمبر2005 الى 21 مارس 2006 ودراسة افضل الظروف لنمو بعض نباتات الزينةالتى تستخدم فى التنسيق الداخلى(اجلونيما –شفليرا – فيكس بنجامينا – ديفنباخيا - كروتن) للمبانى والمنشأت تحت الظروف المناخية المصرية.

ويمكن تلخيص اهم النتائج فيما يلى :

1. درجة الحرارة تحت الجزء المظلل تنخفض بمتوسط 3-5 درجة مئوية بالمقارنة بالجزء الغير مظلل وذلك اثناء فترة النهار. اما بالنسبة للجو الخارجى فترتفع بمتوسط 4 درجة مئوية عن الجو الخارجى طوال اليوم.
2. تزيد الرطوبة النسبية تحت الجزء المظلل بمتوسط 2-5 % عن الجزء الغير مظلل فى فترة عدم تشغيل الرى. اما بالنسبة للجو الخارجى فيرجع الفرق الى وقت القياس و تشغيل الرى الرزازى من عدمه.
3. تقل شدة الاضاءة تحت الجزء الغير مظلل بمتوسط 23 كيلولكس فى الفترة من الساعة الثانية عشرة ظهرا الى الرابعه مساءأ .
4. اعطت نباتات الفيكس بنجامينا،و الكروتن، والشفليرا افضل نمومن حيث طول النبات والتفريع تحت ظروف عدم التظليل بينما اعطت نباتات الديفنباخيا،والاجلونيما افضل نمو تحت ظروف التظليل.
5. كانت كل النباتات من حيث المظهر(البرقشةوالتلوين) والجودة افضل تحت ظروف التظليل.

ونستخلص مما سبق ان استخدام التظليل مع التهوية الطبيعية ونظام الرى الحديث يساعد على خفض درجة الحرارة وزيادة نسبة الرطوبة وخفض شدة الاضاءة الى الحد المناسب لنمو بعض نباتات التنسيق الداخلى ذات العائد الجيد بما يناسب صغار المنتجين .