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The Impact of Various Shading Methods on Cucumber Growth and Production

Taleb R. Abu-Zahra* and Mazen A. Ateyyat*

ABSTRACT: *A plastic house experiment was conducted in Madaba-Jordan; Madaba city is located at the east side of Jordan (31º 23'8.22"N; 35º 23'36.17"E) and 30 km at the south of Amman, to find out the impact of four shading treatments on cucumber "CilionCultivar" growth and yield production. These treatments were; Green Shadow 1 (GS1), Whitewash (Calcium Carbonate), Mud and Control (no shading).*

Results showed that; plastic cover permeability was not affected by the types of the used treatments after washing the cover materials. Whereas, the control treatment produced the highest vegetative growth and fruit yield, so there is no need for shading the plastic houses at this area of Jordan during summer months. However, using of whitewash or mud as a shading material kept on fruit quality. Also, as the light intensity or the temperature increases, vegetative and yield measurements increases. On the other hand, it was observed that the use of the GS1 as a shading material accelerate flowering, extended production period and deceased the mite infection percentages.

Key words*: Cucumber, Green Shadow1,Plastic House,Shading,Whitewash.*

INTRODUCTION

Cucumber (*Cucumissativus* L.) is one of the most profitable vegetable crops grown under protectedcultivation systems all over the world and it belongs to the guard family Cucurbitaceae [1,2]. It is a sub-tropical vegetable crop that grows successfully under conditions of high light, high humidity, high soil moisture, temperature and fertilizers in green houses [3]. The most popular cucumber are the long, seedless varieties often referred to as European, Japanese or English [4]. Cucumber requires a stable warm temperature for good yield with 26-30 ^{o}C and plenty of light [5,6], but it grown widely through the world using not only field but also protected farmland, light is considered to be the most important environmental factor for growth and development, especially in protected farmland [7,8]. In hot climates, shade can be applied over a greenhouse to improve fruit quality, increase fruit set and yield [9]. However, in climates with more moderate temperatures, shade typically reduces yield of vegetable grown in a greenhouse [10].The use of shadings in vegetable production is connected with limitation of light that reaches plants [11]. Shade-houses favor plant growth; since plants are less stressful, direct sunlight was avoided, temperature is lower, humidity is higher and evapotranspiration is low[12].

Shading a greenhouse may have a time-dependent effect on fruit production and water and nutrient uptake in plants; after 6 weeks of shading applications, yield was reduced by 30% compare to no shade treatments [9].Also, in another study conducted by Siwek [13]; cucumber yield was the lowest under shady conditions. On the other hand, greenhouse shading improved the yield of cucumber, moreover it reduced crop transpiration and thus water uptake, and improved water use efficiency by 62 percent [14]. Cucumbers grownin shaded plots produced larger marketable yieldsand a lower percent of cull fruit than plantsgrown in the open, but total number of fruit and fruit sizeof cucumbers were not affected by shading in thespring [15]. Shaded plants had greater leaf area, although less vegetative biomass and lowers dry matter than non-shaded plants [16]. While in relation to yielding best results were obtained under whitewash [13].In another study, results showed that white net greenhouse cover

* Department of Plant Production and Protection, Faculty of Agricultural Technology, Al-Balqa Applied University, As Salt 19117 Jordan.

optimized growth and yield of cucumber, recorded the highest vegetative growth (plant height, number of leaves, total leaves area, total fresh and dry weights), and significantly increased total yield [12].

High light intensity reaching the fruit surface results in high chlorophyll content, and that high chlorophyll content at harvest is associated with long shelf life during storage. Shade density had no significant effect on marketable yield, because the marketable fraction increased with shade density [17]. In Spain, mobile shade increased marketable yield by 10 percent when used only on days with intense sunlight [18].

Growers should carefully moni-tor fertilizer salts, light, air temperature, humidity, car-bon dioxide and moisture. Inattention to these details can result in decreased production and poor-quality fruit, such as bitter-tasting cucumbers [4].

In Jordan, there is a gradual increasing acreage of cucumber cultivation under covers;farmers do shading during hot summer months primarily to limit the temperature rise in the plastic houses, in order to protect the quality of some crops from decline when temperature is excessively high. In Jordan valley shading is applied in April, while in high lands in June. This study was aimed to compare between the traditional plastic houses shading methods with the innovation Green Shadow 1 "GS1" to find out the best shading method on cucumber growth, yield, quality and insect injuries.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted at Al-Husien Al-Sutari farms at Madaba city, which is located at the east side of Jordan (31° 23'8.22"N; 35° 23'36.17"E), about 30 km south of Amman the capital of Jordan, during the 2014 season.

Treatment Applications

Twelve plastic houses (0.5 dun/plastic house) were installed over the farm area. Three plastic houses were used for each treatment. Four shading treatments were applied; Green Shadow 1 (GS1; 1L/ 10 L water), Whitewash (Calcium Carbonate; 1 kg/ 10 L water), Mud and Control (no shading). Both GS1 and Whitewash were sprayed by using a pump pressure and waterspout over the three plastic houses cover. The Mud treatment was applied by dissolving a clay soil collected from the farm area in tap water and was dispersed by hand over a three plastic houses according to the method applied farmers. Moreover, the control plastic houses were kept without any covering. Few days after shading treatments applications, cucumber cultivar "Cilion" transplanting was done during summer months of 2014 season.

Experimental Design and Statistical Analysis

Four treatments were conducted in a randomized complete block design with three replicates. All data obtained were statistically analysed according to the design used in this experiment [19].The differences between treatment means were compared by using Least Significant Difference at 5 % significant level.

MEASURED PARAMETERS

Environmental Measurements

Inside the plastic houses; temperature (using data logger), relative humidity (using humidity meter) and light intensity (using Lux meter) wererecorded during all of the experimental period, all data obtained were used to determine the correlations with other measured plant growth parameters. On the other hand,at the end of the experiment(mid-September-2014) all of the used plastic houses –even for the control treatment-covers were washed by pressurized water, then temperature (using digital thermometer), relative humidity and light intensity, were measured at mid-day "12 am", in order to determine the effect of the used shading treatments on plastic (poly-ethylene) cover permeability.

Vegetative Measurements

All measurements were taken at the end of the experiment:

Plant Length (cm): different plant samples (twenty plants) were randomly taken from all over the plastic house to measure the plant length, and then average calculations were considered.

Plant Fresh and Dry Weight (gm): The Average weight were considered for the twenty freshly harvested plants per replicate and then dried in an oven at 60 °C to a constant weight.

Leaf Area (cm^2): Fifty leaves per replicate were collected, their area was measured using a Portable Area Meter (Patent Pending, LI-3000A, SR. No. 2516. LI-COR, U. S. A.) and the average leaf area was calculated.

Number of Leaves per Plant: Fifteen cucumber plants (from the beginning, middle and end) of the plastic house were randomly selected and their leaves

counted, then total number of leaves per plant were considered.

Leaf length (cm): Fifty leavesfrom all over the plastic house were collected andused to determine the leaf length.

Flowering Measurements

When cucumber plants began blooming, counting of the blooming plants started in each replicate (plastic house) every day, until 50 percent of the plants per replicate were in bloom, then the number of days from planting until blooming was recorded according to Egea [20].

Yield Measurements

Total Yield (kg/plastic house): This parameter was measured directly in the field by weighing the total freshly harvested fruits per replicate, using a digital scale balance. At the end of the experiment, all weights for each replicate were summed.

Yield (kg) per Month: it's the summation of the harvested fruit weights in each replicatefor each month.

Yield (kg) per Plant: This parameter was calculated at the end of the experiment by dividing the total harvested yield per replicate over the number of plants in that replicate.

Average Fruit Fresh Weight (gm): This parameter was measured at the end of the experiment by dividing the total yield weight by total number of fruits.

Average Fruit Dry Weight: At the end of the experiment; a twenty freshly harvested fruits per replicate were dried in an oven at 60 ^{o}C to a constant weight, then average readings were considered.

Total Number of Fruits: It was considered at the end of the experiment by counting all of the harvested fruits per replicate.

Number of Fruits per Plant: It was considered at the end of the experiment by dividing the total number of fruits for each replicate over the number of plants in that replicate.

Length of Production Period: Measured for each replicate by counting the days from first harvest until the production of that replicate, ceased.

Fruit Quality Measurements

Good Quality Yield Percentage: It includes fruits that are uniform in shape, good complete green color and acceptable by consumers. This parameter was considered at the end of the experiment by dividing the total good quality fruit weightsover the total harvested fruit weights in that replicate.

Deformed Fruit Percentage: Fruits that are not uniform in shape and not acceptable by consumers are considered as deformed fruits, it was calculated at the end of the experiment by dividing the total deformed fruit weights over the total harvested fruit weights in that replicate.

Poor colored fruit percentage: Fruits that are not uniform in green color and not acceptable by consumers are considered as poor colored fruits, it was calculated at the end of the experiment by dividing the total poor colored fruit weights over the total harvested fruit weights in that replicate.

Average fruit length: During the growing period, different fruit samples were taken to determine the fruit length, and then at the end of the experiment period, average readings were considered.

Pests Measurements

Nine plants were chosen randomly from the beginning, middle and end of the plastic house. From each plant, nine leaves were inspected for available pests, in which 3 were chosen from the top, 3 from middle and 3 from the bottom of the plant. This processwas repeated weekly all over the experiment period.

RESULTS AND DISCUSSION

Plastic Cover Permeability

At the end of the experimental period, environmental factors (temperatures, relative humidity and light intensity) recorded; results obtainedsummarized in Table 1. Recorded temperatures do not show any significant differences between all of the used treatments, even though the highest temperature was recorded in the control treated plastic houses but without significant differences with the shaded plastic houses. On the other hand, little significant differences were observed between the relative humidity

Table 1
Results of Final readings of Temperature, Light intensity, and Relative humidity, after removing the shading treatments*

Treatments	*Temperature (°C)*	*Relative humidity (%)*	*Light intensity (Lux)*
GS1	39.3 a**	33.5 a	1168 a
Whitewash	39.1 a	32.6 ab	1156 a
Mud	40.5 a	32.3 b	1123 a
Control	40.0 a	33.2 a	1117 a
LSD 0.05	2.0	0.88	131.2

* Values are the mean of four replicates.
**: Means within each column having different letters are significantly different according to LSD at 5 % level.

percentages; the lowest recorded relative humidity was observed in the plastic houses that was covered by mud materials in compare to other treated plastic houses. Although, light intensity readings, do not show statistical differences between all of the used treatments. Since, no significant differences were recorded in the environmental factors,which means that, plastic cover permeability was not affected by the types of the used shading treatments, which do not have any harmful effect, so any type of the used shading treatments is considered save be used.

Vegetative Growth

The effect of shading methods on vegetative growth has been illustrated in table 2.Data obtained indicated that there are significant differences in vegetative parameters; the highest average number of leaves per plant, plant fresh and dry weight were obtained by the control treatment, while the tallest plant (212.7 cm) were observed in mud treated plastic houses, on the other hand whitewash treatment produced the largest leaf area and longest leaf length. So results proved that vegetative growth in most cases was improved by the control treatment, and that means shading is not required in this area during summer months. Shading caused too low light intensity, which do not satisfy the requirement of photosynthesis capacity and thus results in insufficient synthesis of photo-assimilates, which severely influenced growth, development and yield[7]. The improved vegetative growth evidenced under the control treatment may be also due to the favorable weather conditions, mainly maximum temperature and light intensity [21]. These conditions increased the plant uptake ability of water and nutrients, which ultimately accelerated the rate of vegetative growth under greenhouse conditions [22]. Nevertheless, results of the present study are not in agreement with other studies, in whichvegetative growth of the cucumber plants under shade cover was higher [18].

Flowering and Yield Measurements

Flowering

Little differences observed in the number of daysrequired for 50% of cucumber plants in bloom (Table 3), but it observed that flowering date, was accelerated by the use of GS1 as shading material, and delayed by the use of other shading materials, which coincides with that obtained by Nageib [23].

Total Yield (kg)/plastic House

Yield results were summarized in table 3. In which, the highest significant total yield per plastic house (3891.7 kg) was obtained without using any shading (control)treatments, in compare to all other shading treatments, on the other hand the lowest yield per plastic house (2524.3 kg) were obtained by GS1 shading method. These results are supported by results obtained earlier [24, 25]; whom found that

Table 2
Effect of shading methods on cucumber vegetative growth*

Treatments	*Av. No. of leaves/plant*	*Av. Plant fresh wt. (gm)*	*Av. Plant dry wt. (gm)*	*Av. plant length (cm)*	*Av. Leaf area (cm^2)*	*Av. Leaf Length (mm)*
GS1	20.33 c**	356.7 c	112.7 b	198.3 b	107.3 ab	90.7 b
Whitewash	21.00 bc	439.9 b	135.2 a	187.0 b	118.5 a	139.0 a
Mud	23.33 ab	382.4 c	103.5 b	212.7 a	115.5 ab	135.3 ab
Control	23.67 a	478.5 a	148.9 a	201.0 ab	103.4 b	89.7 b
LSD 0.05	2.6	31.8	16.2	14.2	13.4	46.9

* Values are the mean of four replicates.
**: Means within each column having different letters are significantly different according to LSD at 5 % level.

Table 3
Effect of shading methods on cucumber flowering date, total yield/rep and yield/month*

Treatments	*No. of days for 50% of plants in bloom/rep*	*Total yield (kg)/rep*	*Total yield (kg) / plant*	*Yield (kg/month)/rep*		
				July	*August*	*September*
GS1	19.0 b**	2524.3 d	1.87 d	500.3 c	1667.0 d	357.0 b
Whitewash	20.0 ab	2973.0 c	2.21 c	541.0 c	2072.7 c	359.3 b
Mud	20.3 a	3280.7 b	2.44 b	592.3 b	2327.3 b	361.0 b
Control	21.0 a	3891.7 a	2.89 a	735.7 a	2648.7 a	507.3 a
LSD 0.05	1.15	72.36	0.053	51.17	159.8	69.7

* Values are the mean of four replicates.
**: Means within each column having different letters are significantly different according to LSD at 5 % level.

using shad conditions in the spring season decreased fruit weight due to less photosynthesis associated with less radiation under shaded plants. Also yield per plant was the highest in the control treated cucumber plants, with an average of 2.89 kg/plant, in compare to plastic houses covered with GS1 that produced the lowest amount of fruits with an average of 1.87 kg/plant. Although total yield results per month followed the same trend as in total yield per plastic house and or yield per plant; in which during all of the three months, control treatment produced the highest yield, while the lowest yield were obtained by the GS1 treatment.These results indicated that, there is no need to do any shading for the cucumber plants grown under plastic houses conditions -during summer months- at the high lands in Jordan. However, in climates with more moderate temperatures, shade typically reduces yield of vegetable grown in a greenhouse [10].

Average Fruit Fresh and Dry Weight (gm)

The highest fruit fresh weight was obtained by the mud shading treatment (Table 4), but without significant difference with the control treatment that produced the highest fruit dry weight. On the other hand the lowest fruit fresh and dry weight were obtained by the GS1 shading treatment.

Number of Fruits

The highest total number of fruits per replicate and average number of fruits per plant was obtained by the control treatment (Table 4), while the lowest number was obtained by the GS1 shading treatment.Results obtained showed that there is a reduction in the number of fruits in the shaded plastic houses, in compare to non-shaded ones, which may be due to shading cause a reduction in uptake of water and nutrients, and less photosynthesis associated with less radiation under shaded plants that reflects on the number of fruits [9, 25].

Length of Production Period

Production period was extended by the GS1 and mud shading treatments (Table 4), in compare to the control treatment that decreased the production period.Which may be due to shading protect chlorophyll from degradation by the high light intensity and temperature [26].

Fruit Quality Measurements

Results of fruit quality were summarized in table 5.The highest fruit quality (98.61%) was obtained by the whitewash, but without significant difference with the mud shading treatment, while the lowest fruit quality was obtained by the control treated plastic houses (98.03) without significant difference with the GS1 treatment.Avery low deformed fruit percentages were observed; best fruit quality (lowest deformed %) were obtained by using whitewashor Mud as plastic house shading materials, while the highest deformed fruit percentages were obtained by using GS1 or no shadings (control) treatments. Otherwise, a very low poor colored fruit percentages were observed andwithout statistical differences between treatments. Also, no significant differences were observed in the average fruit length between all of the used treatments, even though, the tallest fruit (14.23 cm) was observed in the mud treated plastic houses.

These results suggest that shading is more beneficial under high sunlight intensity;the reduction in marketable yield resulting from control treatment is proportional to the increase in light intensity and temperature, which may responsible for the fruits lack quality, according to Gent [9].

Pest Measurements

No insect infestations were observed in all of the cucumber plastic houses, the only registered pest was the mite infestation (Table 6). Shading using GS1 resulted in a significant decrease in the population of

Table 4
Effect of shading methods on cucumber yield/plant, fruit fresh and dry weight, number of fruits/rep, number of fruits/plant and number of production days*

Treatments	*Av. fruit fresh wt. (gm)*	*Av. fruit dry wt. (gm)*	*Total no. of fruits/rep*	*Total no. of fruits/plant*	*Production period (days)/rep*
GS1	87.13 c**	20.56 c	29048 c	21.7 c	55.0 a
Whitewash	90.13 bc	24.92 b	33083 b	24.7 b	53.3 bc
Mud	106.46 a	33.48 a	30813 bc	23 bc	55.0 a
Control	98.94 ab	26.82 b	39370 a	29.3 a	52.7 c
LSD 0.05	8.86	2.84	3568.1	2.2	0.94

* Values are the mean of four replicates.
**: Means within each column having different letters are significantly different according to LSD at 5 % level.

Table 5
Effect of shading methods on cucumber percent of normal fruit, irregular fruit shape, incomplete fruit green color/rep, and fruit length*

Treatments	*Qualified fruit (%) /rep*	*Deformed fruit (%)/ rep*	*Poor colored fruit (%)/ rep*	*Av. Fruit length (cm)*
GS1	98.05 b**	1.69 a	0.257 a	13.77 a
Whitewash	98.61 a	1.28 b	0.115 a	13.40 a
Mud	98.44 ab	1.33 b	0.233 a	14.23 a
Control	98.03 b	1.70 a	0.265 a	13.23 a
LSD 0.05	0.467	0.33	0.15	2.15

* Values are the mean of four replicates.
**: Means within each column having different letters are significantly different according to LSD at 5 % level.

Table 6
Populations of the two-spotted spider mite, *Tetranychusurticae* on cucumber leaves planted in plastic houses with different shading treatments in Madaba*

Treatments	*Average Number of TSSM in 10 X leaf disc*
GS1	5.22 b** ± 0.32
Whitewash	6.10 ab ± 0.31
Mud	6.75 a ± 0.41
Control	6.22 a ± 0.22
LSD 0.05	0.925

* Values are the mean of four replicates.
**: Means within each column having different letters are significantly different according to LSD at 5 % level.

the two-spotted spider mite, *Tetranychusurticae* on cucumber leaves planted in plastic houses compared to other shading treatments.

Results of Correlations

Results of correlations were summarized in table 7 and 8; a positive significant correlation were observed between the light intensity and the temperature with the total yield per replicate, fruit number per replicate, plant fresh and dry weight, which means that as the light intensity or the temperature increases, these parameters will significantly increase. On the other hand, no significant positive nor negative correlations were observed between the relative humidity and the measured growth parameters.

CONCLUSIONS

In conclusion, the results of the present study demonstrate that,the types of the used shading treatments did not affect plastic cover permeability, after washing the cover materials.Best results were obtained by the control treatment; since it produced the highest vegetative growth and fruit yield, so there is no need for shading plastic houses at the high lands in Jordan during summer months. But using of whitewash or mud as a shading materialskept on fruit quality. Also, as the light intensity or the temperature increases, vegetative and yield measurements increases. On the other hand, it was observed that the use of the GS1 as a shading material accelerate flowering, extended production period and deceased the mite infection percentages.

Table 7
Results of correlation coefficient of shading methods on cucumber total yield, fruit fresh and dry weight, fruit number, fruit length, blooming and plant length:

Corr.	*Total yield/rep*	*Fruit fresh wt.*	*Fruit dry wt.*	*Fruit no./rep*	*Fruit length*	*Blooming*	*Plant length*
Light intensity	0.819	0.213	0.021	0.873	-0.276	0.484	0.060
Temp.	0.814	0.281	0.131	0.828	-0.252	0.412	-0.004
RH	-0.130	-0.298	-0.510	0.024	-0.148	-0.455	-0.438

Tabulated Corr. At 0.05 = 0.553, above it significant, below it not significant [27].

Table 8
Results of correlation coefficient of shading methods on cucumber plant fresh and dry weight, leaf area, number of leaves, good quality fruit, deformed fruit and poor colored fruit

Corr.	*Plant fresh wt.*	*Plant dry wt.*	*Leaf area*	*No. of leaves*	*Good quality fruit*	*Deformed fruit*	*Poor colored fruit*
Light intensity	0.723	0.677	-0.522	0.506	-0.489	0.519	0.340
Temp.	0.703	0.647	-0.611	0.523	-0.441	0.457	0.336
RH	0.238	0.468	-0.358	-0.268	-0.453	0.520	0.206

Tabulated Corr. At 0.05 = 0.553, above it significant, below it not significant [27].

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REFERENCES

Ibeawuchi, I. I., Iheoma, O. R., Obilo, O. P. and Obiefuna, J. C. (2008), Effect of Time of Mulch Application on the Growth and Yield of Cucumber (*Cucumissativus*) in Owerri, Southeastern Nigeria. *Life Science Journal*, 5 (1): 68-71.

El-Wanis, A., Mona, M., Abdel-Baky, M. H. and Salman, S. R. (2012), Effect of grafting and salt stress on the growth, yield and quality of cucumber grown inNFT system. *Journal of Applied Sciences Research*, 8 (10): 5059-5067.

El-Aidy, F., El-Zawely, A., Hassan, N. and El-Sawy, M. (2007), Effect of Plastic Tunnel Size on Production of Cucumber in Delta of Egypt. *Appl. Ecol. Environ. Res.*, 5 (2): 11–24.

Vandre, W. (2014), Cucumber Production in Greenhouses. Cooperative Extension Service, University of Alaska Fairbanks. Available at: *www.uaf.edu/ces*

Hochmuth, R. C. (2012), Green-House Production-Florida. Green-House Vegetable Production Handbook, 3. Available at: *http//edis.ifas.ufl.edu*

Cobeil, G. and Gosselin, A. (1990), Influence of Pruning and Season on Productivity of Cucumber Plants Grown in A Sequence Cropping System. Scientia Horticulturae, 41 (3): 189-200.

Yang, X., Wang, X., Wang, L., Wei, M. (2012), Control of light environment: A key technique for high-yield and high-quality vegetable production in protected farmland. *Agricultural Sciences,* 7: 923-928.

Runkle, E. (2008), Greenhouse shading options.GPN. Available at: *www.gpnmag.com*

Gent, M. P. N. (2008), Density and Duration of Shade Affect Water and Nutrient Use in Greenhouse Tomato. *Journal of American Society for Horticultural Science*, 133 (4): 619–627.

Cockshull, K. E., Graves, C. J. and Cave, C. R. J. (1992), The influence of shading on yield of glasshouse tomatoes. *Journal of Horticultural Science*, 67: 11–24.

Siwek, P. and Lipowiecka, M. (2004), Cucumber cultivation under plastic covers economic results. *Folta Horticulturae Ann.*, 16 (2): 40-55.

Hashem, F. A., Medany, M. A., Abd El-Moniem, E. M. and Abdallah, M. M. F. (2011), Influence of Green-House Cover on Potential Evapotranspiration and Cucumber Water Requirements. *Annals of Agricultural Science,* 56: 49-55.

Siwek, P., Wojciechowska, R., Kalisz, A., Libik, A. and Gryza, I. (2010), Effect of shading with various colored films on the yield and quality of celery and butter head lettuce. *Ecological Chemistry and Engineering*, 17 (12): 1619-1627.

Lorenzo, P., Garcia, M.L., Sanchez-Guerrero, M.C., Medrano, E.,Caparros, I. andGimenez, M. (2006), Influence of Mobile Shading on Yield, Crop Transpiration and Water Use Efficiency. Acta Hort. 719: 471–478.

Valli, V. J., Bryan, H. H., Young, H. W. and Davis, D. R. (1965), The Effect of Shade on the Bio-Climate and production of Vegetable Crops. *Florida Agricultural Experiment Stations Journal eSeries* No. 2236: 95-101.

Sandri, M. A., Andriolo, J. L., Witter, M. and Ross, T. D. (2003), Effect of shading on tomato plants grown under greenhouse. *Horticultura Brasileira* 21: 642–645.

Lin, W. C., and Jolliffe, P A. (1996), Light Intensity and Spectral Quality Affect Fruit Growth and Shelf Life of Greenhouse-grown Long English Cucumber. *Journal of the American Society for Horticultural Science*. 121 (6): 1168–1173.

Lorenzo, P., Guerro, M. C. S., Medrano, E., Garcia, M. L., Caparros, I. and Giminez, M. (2003), External greenhouse mobile shading effect on microclimate water use efficiency and the yield of a tomato crop grown under different salinity levels of the nutrient solution. ActaHorticultura, 609: 181–186.

Steel, R. G. D., and Torrie, J. H. (1980), Principles and procedures of statistics, McGraw-Hill, New York. 2nd edition. ISBN: 0070610282.

Egea, J., Berenguer, T., and Byrgos, L. (1999), Dates of Bloom and Maturity of Several Apricot Selections from European Breeding Programs. Acta Horticultura, 488: 243-247.

Iglesias, I. and Alegre, S. (2006), The Effect of anti-Hail Nets on Fruit Protection, Radiation, Temperature, Quality and Profitability of'Mondial Gala' apples. *J. Appl. Hort.*, 8 (2): 91–100.

Marouelli, W. A. and Silva, W. L. (2005), Drip Irrigation Frequency for Processing Tomatoes During Vegetative Growth Stage. Pes. Agropec. Brasil., 40: 661–666.

Nageib, M. M., Malaka, A. S., Salwa, A. K., Mansour, A. E., and Nagwa S. Z. (2012), Effect of Shading at Different Dormancy Periods on Kanino Apricot Productivity. *Journal of Applied Sciences Research*, 8 (8): 4290-4295.

El-Gizawy, A.M., Abdalla, M.M.F., Gomaa, H. M. and Mohammed, S. S. (1992), Effect of Different Shading Level on Tomato Plants Yield and Fruit Quality. *Acta Hort.*, 323: 349–354.

El-Nemr, M. A. (2006), Effect of Mulch Types on Soil Environmental Conditions and Their Effect on the Growth and Yield of Cucumber Plants. *J. Appl. Sci. Res.*, 2 (2): 67–73.

Zervoudakis, G., Salahas, G., Ksapiris, G., and Kontantopoulou, E. (2012), Influence of Light Intensity on Growth and Physiological Characteristics of Common Sage (*Salvia officinalis* L.). Brazilian Archives of Biology and Technology, 55 (1): 89-95.

Bowley, S. R. (1999), A Hitchhiker's Guide to Statistics in Plant Biology. A Division of Plants *et al*., Inc., Ampersand Printing, 1st edition, Guelph, Ontario, Canada, NIG 2W1. ISBN: 0-9685500-1-0.