Effect of Shading on Organic Pepper Seedling Cultivation

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Abstract
The experiment was carried out in the temperature-controlled glass sera during July and August 2010. In order to create different light intensities for each period after seeding, material with 50 % shading property was used as 1, 2 and 3 layers also created an unshadow area for control purposes. Yalova Carliston pepper cultivar was used in the research. In the experiment, root dry weight, stem dry weight, leaf dry weight, leaf thickness and net assimilation rate were determined from seedling quality parameters. A statistically significant difference was found between all parameters in terms of the characteristics examined ($p<0.01$). Leaf thickness values decreased with shading. The highest net assimilation rate was determined in the control application in which the highest temperature values were determined.

Keywords: Seedling, quality, light, temperature, dry weight.

1. Introduction

In recent years the use of quality seedlings in terms of quality production and harmful management of disease in vegetables production has gained great importance (Sarıbaş et al., 2018). Quality seedling planting affects the production in a positive way (Kandemir et al, 2013; Tüzel et al., 2015; Yılmaz et al., 2018).

One of the important factors affecting the success of organic vegetable production is to start with healthy and high quality seedlings. When the seedlings is planting it should be careful to be free of pests and diseases. In successful vegetable cultivation, the selection of suitable varieties and the use of quality seedlings are very importance, it is of great importance to start using high quality seedlings with healthy and high quality seeds in small areas with high input or under the cover of intensive labor and cost.

Due to the increasing consumer demand for peppers with increased flavor and nutritional value, pepper production in our country is gaining great importance. According to the 2017 statistics, 2.608.172 tons of pepper was produced and 4.521,28 tons of this was produced organically in Turkey (RTMAF, 2018). Turkey comes at the beginning of the leading countries in the world pepper production with its great production quantity (FAOSTAT, 2018).

Nowadays, the fact that consumers are looking for the old taste and aroma in vegetables has opened up the effects of the wrong practices. For these reasons, it is seen that the demand for organic vegetables has started to increase in our country in recent years and it has been shown that there has been a significant increase in the demand of consumers as a result of the research and dissemination of the superior characteristics of organic products through education and media (Duman, 2015). Environmental conditions are the most significant aspects in the development of transplant production models. Environmental factors play significant roles for several physiological processes and studies have revealed close relationships between plant growth/development parameters and environmental conditions (Dennet et al., 1979; Uzun and Demir, 1996)

Light is an important factor in terms of regulating plant growth and development and temperature is another significant factor for the initiation of physiological activities in plants (Taiz and Zeiger, 2008). All the energy required for photosynthesis is obtained from the light, thus the light is the most important factor affecting net assimilation.

In summer season, when light intensity is intense, shading applications are one of the cultural processes that directly affect fruit quality and plant life (Günay, 2005; Özer and Uzun, 2013; Öztürk and Demirsoy, 2014). For this reason, during the summer period when the sunlight are upright, the green staying time of the plant is extended and plant efficiency is increased (Günay, 2005).

Shading nets are often used to protect garden products from excessive sun and solar radiation. In many cases, growers use black or green shade nets, mainly because of their market availability and not due to the quality of protection that those nets offer to the shaded crops (Rigakis et al., 2014; Fallik et al., 2009; Kong et al., 2013; Selahle et al., 2015). Also, limiting high light exposure through net shading is a well-established horticultural treatment in pepper cultivation (Kong et al., 2013; Selahle et al., 2015).

Shading applications are used to regulate the light environment so the plant light relationship is edited. Black shading nets reduce the amount of light reaching the plants but do not affect the light quality (Shahak, 2008). By using shading nets, it is aimed to prevent damage caused by extreme weather conditions (high radiation temperature) and to create the most suitable cultivation conditions for pepper (Ambrozy et al., 2016). In this experiment; it is aimed to determine the quantitative effects of different shading applications in organic pepper seedlings grown in glass greenhouse in Samsun ecological conditions.

The aim of this investigation was to observe: a) determine the quantitative effects of different shading applications in organic pepper seedlings grown in glass greenhouse b) aimed to determine the effects of applications that would benefit the development of organic pepper seedlings. In this study, dry leaf, stem and root matters, leaf thickness, leaf area, relative growth rate and net assimilation ratio were investigated and it was aimed to determine the effects of applications that would benefit the development of organic pepper seedlings.

2. Material and Method

Experiments were conducted in one room of a greenhouse (13×13 m) at Ondokuz Mayıs University Agricultural Faculty. In order to create 4 different light variations in the experiment, shading material was arranged as 1 layer (50%), 2 layers (50 + 50%), 3 layers (50% + 50 + 50) and without shading material for control treatment. Shading material was placed 1 m above the transplant production benches (4×2 m). Green shading nets with 50% shading capacity were used for shading treatments.

Untreated seeds of pepper (*Capsicum annum* L. cv Yalova Çarliston), which is a cultivar commonly produced in the Black Sea region, were used in the experiment. Peat soil was used as the sowing medium and the mixture of composted manure and garden soil (2:1, v:v) was used as the medium for transplanting the seedlings into. The peat soil and compost/soil mixture used in the study were both appropriate for use in organic production, containing no additional additive substances.

The chemical characteristics of the compost/garden soil mixture (2:1, v:v) were: pH 7.6, EC 1.09 dS m^{-1} total nitrogen 0.02%, phosphorus 0.004%, calcium 30.7 mg kg^{-1}, magnesium 8.7 mg kg^{-1}, potassium 330 mg kg^{-1}.Seeds were sown into seed trays (styrofoam viols) 345 cells (2.2 × 2.2 cm) filled with the peat soil medium on 6 July 2010.

When the seedlings were at the first true leaf growth stage, they were transplanted into plastic pots (9×8 cm) filled with the composted manure/garden soil mixture. Transplants were irrigated throughout the growing period to meet their water needs. No supplementary fertilizers were applied. All the relevant care and cultural practices were performed in a timely manner.

During maintenance, necessary maintenance and cultural practices have been fulfilled. During the production period, from sowing until the 4th true-leaf plant growth stage of the transplants, light (PAR; MJ $m^{-2}d^{-1}$) was recorded by Sunscan canopy analyzer (SS1, LI-COR, USA) and temperature (°C) values were recorded with data loggers (KT100, Kimo, France) at one-hour intervals in each of the treatments.

The transplants were regarded to root, stem and leaf parts of plant as ready for transplanting at the 4th true-leaf stage, and at this plant growth stage measurements were performed on 10 transplants of each

replication to determine seed quality. Seedlings taken from all application areas (1 layer shading, 2 layers shading, 3 layers shading and no shading) were washed with tap water so that no soil particles were left in their roots. Then, the roots, leaves and stem are separated from each other. Leaf areas of pepper seedlings were determined as cm2 with planimeter (KP-90, Placom, Japan). The leaf, stem and stem separated from the plant were placed small pouch papers and dried in an oven (Venticell 55, Ecocell, MMM group, Germany) at 48 °C for 80 hours. It was decided whether the drying process was completed by applying the weight change method in the samples that did not dry out during this period of time.
When the samples were found to be completely dry, the dry weights of the leaves, roots and stem were determined with a scale of 0.01 g. Leaf Thickness (LT), Proportional Leaf Area (PLA) and Net Assimilation Rate (NAR) values were calculated with the formulas (Uzun, 1997) given in Table 1.
Experiments were conducted in a randomized block design with three blocks and with 10 transplants in each replication. SPSS 17.0 statistical software was used for statistical analysis on experimental results using two-way ANOVA (growing period × shading). Differences between treatment means were tested with Duncan's Multiple Range test at $p<0.01$.

Table 1. Plant growth parameters and formulas used in the calculation

Parameters	Calculation models
Proportional Leaf Area (PLA)	Total Leaf Area (cm^2) / Total Plant Dry Weight (g)
Leaf Thickness (LT)	1 / Specific Leaf Area (g/cm^2)
Net Assimilation Rate (NAR)	[W2(g)- W1(g)/A2(cm^2)- A1(cm^2)]/(t2-t1) (g/cm^2/day)

W1: Dry weight of leaves in the first quantitative analysis (g) **W2:** Dry weight of leaves in the second quantitative analysis (g) **A1:** Total leaf area in the first quantitative analysis (cm^2) A2: Total leaf area in second quantitative analysis (cm^2) **T1, 2:** Time between two quantitative analyzes (day)

3. Results and Discussions

Significant effects of different shading applications (1, 2 and 3 layers) and control on the quality of pepper seedlings were determined ($p<0.01$). According to the obtained results, leaf, stem and root dry weight and leaf thickness values are in the same group from 1 layer shading and 2 layers shading applications. However, the highest leaf (0.11 g), stem (0.05 g) and root dry weight (0.05 g) and leaf thickness (0.0027 g) were obtained from the control application. The lowest obtained leaf (0.09 g), stem (0.04 g) and root dry weight (0.03 g) and leaf thickness (0.0021 g) were obtained from 3 layers shading (Table 2). In a study in which the effects of shading on the quality of cucumber seedlings were determined, it was determined that the seedling dry weight values decreased with the increase of shading practices. In another study in which similar results were determined, leaf thickness values increased with increasing light intensity (Sarıbaş et al., 2017). In another study, it has been reported that increasing in light intensity and stoma conductivity and increasing in photosynthetic rate increase the dry weight of total seedlings. In the same study, it is stated that light intensity is a threshold value for seedling cultivation and plants are adversely affected when these values are exceeded (Sarıbaş et al., 2018). In our study, leaf thickness and dry weight values increased with increasing light intensity in parallel with previous studies. According to the results, significant effect of shading applications on net assimilation rate was determined ($p<0.01$).

Table 2. The effect of shading (1 layer, 2 layers, 3 layers shaded and control) on the some seedling quality parameters

Shading (%50)	Dry leaf weight (g)	Dry stem weight (g)	Dry root weight (g)	Leaf thickness (g/cm^2)	Net assimilation rate (g cm^{-2} d^{-1})
Control	0.11±0.02 **a***	0.05±0.002 **a**	0.05±0.003 **a**	0.0027±0.0003 **a**	0.020±0.002 **a**
1 layer	0.10±0.01 **a**	0.05±0.002 **a**	0.04±0.003 **ab**	0.0025±0.0007 **a**	0.019±0.015 **b**
2 layer	0.11±0.01 **a**	0.05±0.002 **a**	0.05±0.002 **a**	0.0023±0.0004 **ab**	0.016±0.001 **c**
3 layer	0.09±0.01 **b**	0.04±0.003 **b**	0.03±0.002 **b**	0.0021±0.0003 **b**	0.016±0.002 **c**

* $p<0.01$

The highest (0.020 g $cm^{-2}d^{-1}$) net assimilation rate was determined from the control application. It has been reported that the temperature has a significant effect on the net assimilation rate. Similarly, the rate of net assimilation was high due to the rapid growth at high temperatures, while the temperature decreased (Uzun, 1997). It has been reported that the net rate of assimilation has been found to decrease linearly by the reduction of the light in every temperature conditions of pepper (Kandemir, 2005) and strawbery (Öztürk et al., 2014). It is known that this decrease is faster in high temperature conditions. Also, in our study, the highest net assimilation rate was determined in the control application in which the highest temperature values (27.07 ºC) were determined. Again in this study, the temperature (23.82 ºC) values were high, but the light (4.33 MJ $m^{-2}d^{-1}$) values were low in the 3 layers shading application, the net rate of assimilation was also rapid (Kandemir, 2005).

Table 3. Mean light intensity (PAR; MJ $m^{-2}d^{-1}$) and temperature (ºC) values in applications

	Treatments	Light (MJ m^{-2} d^{-1})	Temperature (ºC)
Shading	Control	12.03	27.07
	1 layer	9.26	26.3
	2 layer	5.77	24.63
	3 layer	4.33	23.82

4. Conclusion

Nowadays, ready-to-plant seedling sector is showing a rapid increase due to many advantages. However, due to commercial concerns, seedling quality decreases due to intensive seedling production. Growers often make some chemical applications for height control while fertilizing them frequently to improve quality. These applications have effects on seedling quality. However, it increases the growers's costs. In our study, it was determined that seedling quality could be increased by influencing the growth of seedlings by adjusting the light intensity of seedling quality. In the study, the highest values were obtained with the control application.

As a result, it was shown that seedling quality could be increased by using additional light in periods of light intensity of pepper seedling cultivation.

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