The effect of screen materials on the microclimate and growth of chili pepper plant

Sumiyati, I A G B Madrini and I W Tika*

Udayana University, Bukit Campus, Jl. Raya Kampus Unud Jimbaran, Kec. Kuta Sel., Badung Regency, Bali 80361 Indonesia
*Corresponding author: wayantika@unud.ac.id

Abstract. Climate change often causes failure in cultivation. So, microclimate modification is needed. One of which is to use the screen to ensure the cultivation of chili pepper plants. The purposes of this study were to understand the effect of several types of screen materials on the growth of the chili pepper plant and to determine the best screen material for chili pepper plant cultivation. This study consisted of four treatments; there is no screen (NO), UV plastic screen with 0.6 mm (UV) of thickness, shading net with 50% shade factor (SN), and the combination of UV and SN. The results indicated the lowest intensity of sunlight and temperature occurs in the microclimate was using a combination of UV and SN screens. The highest growth, the largest number of leaves, and the earliest flowering age was using SN treatment with 30.65 cm, 39.88 leaves, and 36 days, respectively. In Summary, the treatment of shading net showed the best material for chili pepper plant cultivation compared to UV plastic and the combination of UV plastic and shading net.

1. Introduction
Chili pepper (Capsicum frutescens L.) is a horticultural plant from the Solanaceae family which not only has high economic value but also because its fruit has a combination of color, taste, and complete nutritional value [1]. The chili pepper plant is a plant that easy to adapt to its growing environment. To grow and produce optimally, chili pepper plants must be planted in an environment that is following the growing conditions. The growth requirements include altitude, planting medium, and microclimate [2].

Climate change often causes failure in cultivation. So, microclimate modification is needed. The screen is used in chili pepper plant cultivation as a method for weather/climate modification, which was initially not suitable for the plant. Unsuitable climatic/weather conditions can be caused by climate change. The ten warmest years occurred in the period after 1990. Agriculture is one of the sectors most vulnerable to climate change [3]. Protection from hail, wind, snow, or strong rainfall in fruit-farming and ornamentals, shading nets for greenhouses, and nets moderately modifying the microenvironment for a crop are the most common applications [4]. The use of a screen is highly recommended because it can reduce the growth of pests and diseases, increase production, and plants can be planted throughout the year [5].

By using the screen, it can reduce light intensity. Environmental conditions with low light cause changes in plant physiology and morphology as a form of adaptation [6]. The screen that is usually used in plant cultivation is a screen made of plastic. The use of a screen made of shading net and a combination of plastic and shading net has not been studied. The purpose of this study was to determine how the growth of the chili pepper plant on several types of screen materials and to determine the type of screen material that is most suitable for the cultivation of the chili pepper plant.
2. Materials and methods
This research was conducted in Subak Suala, Jegu Village, Penebel District, Tabanan Regency, Bali Province, Indonesia. The materials and tools used were: chili pepper seeds of Bara variety, 0.06 mm thick UV plastic, screen net with a density of 50%, planting media, irrigation water, fertilizers, pesticides, bamboo for building hoods, tape measure/ruler, stationery, pottery, bucket, sickle, saw, big knife, hoe, and tillage. Dimensions for the frame structure of the screen are 2 m high and 1 m wide (Figure 1).

This study consisted of four treatments; there is no screen (NO), UV plastic screen with 0.6 mm (UV) of thickness, shading net with 50% shade factor (SN), and the combination of UV and SN. Each treatment was made with three replications. The research stages include the activities of collecting raw materials and preparing tools, land preparation and making beds, chili nursery, making hoods, planting, maintaining plants, and harvesting. The variables observed were plant height, number of leaves, flowering age, plant dry weight, and productivity.

![Figure 1. Dimensions for the frame structure of the screen](image)

3. Results and discussion
Climate screens and shade nets have two main uses in controlled-environment horticulture. Screens can be employed inside a greenhouse to improve climate control and save on the energy expended in heating and cooling. They are deployed automatically in greenhouses when certain environmental thresholds are surpassed (Figure 2). Shade nets can be used to cover lightweight trellis structures (shade houses), and are sometimes combined with plastic covers [7]. The higher the level of shade, the lower the light intensity received by plants. A decrease in light intensity is followed by a decrease in temperature and an increase in air humidity [6] which will affect plant growth. The results of observing plant growth indicators in this study are as follows.
3.1. Plant height

Plant height is the size of the plant most often observed as an indicator of growth. Based on Figure 3, it can be seen that at 35 days of age, chili pepper plants under the shading net (SN) screen show the highest growth with a plant height of 30.65 cm.

![Figure 2. Screen structure at each treatment.](image)

![Figure 3. Plant height at each treatment.](image)

Plants under shading net cover (SN) showed higher chili pepper plants compared to plants under the plastic screen (UV), combination screen (SN & UV), and no screen (NO). Optimal light intensity during the growing period is important for plant growth and development. In certain plants, if it receives excessive light, it will affect the formation of flowers, fruit, or tubers. Shading nets can be used to cover lightweight trellis structures (shade houses), and are sometimes combined with plastic covers [7]. The higher the level of shade, the lower the light intensity received by plants. A decrease in light intensity is followed by a decrease in temperature and an increase in air humidity [6] which will affect plant growth.

3.2. Number of leaves

The number of leaves is an indicator of plant growth. Based on Figure 4, it can be seen that the number of chili leaves under the shading net (SN) shows the highest number of leaves, namely 39.88. The use
of a shading net allows the microclimate conditions around plants such as light, temperature, and even carbon dioxide (CO₂) to be manipulated to be optimal for plants [8]. The number of leaves is measured in the vegetative phase, which is at the age of 35 days. In the vegetative phase, plants use most of the carbohydrates to form roots, stems, leaves, shoots, and plant enlargement.

Depending on the amount of light available during growth, plants possess the ability to react to the amount of available light during growth using two distinct growth responses: the strong-light growth-response as found at high light quanta and the weak-light growth-response, which is seen in shade leaves and plants growing under low-light. This ability of plants and chloroplasts to adapt to light is a fundamental growth response, which is associated with specific changes in the morphology, physiology, biochemistry, and structure of leaves and chloroplasts [9].

![Figure 4. A number of leaves at each treatment.](image)

3.3. The first flower appearing

The first flower appearing was observed in each plant that began to appear flower buds. The results of this study indicated that the chili pepper plants on the plastic screen and the combination screen had slower growth compared to the shading net screen (Figure 5). This means that the plants under the plastic screen and combination screen have a longer vegetative phase. This difference is caused by several things, including the intensity of sunlight, where the amount of light received by plants under the shading net and combination screen is lower than the plants under the plastic screen. Big or small the quality of light received affects the process of photosynthesis and reproduction in plants. The reproductive growth of plants is influenced by the intensity of solar radiation, namely the formation of flowers, fruits, and seeds [10]. In shaded conditions, the light intensity that can be accepted by the plant will be a little so that there is an increase in auxin activity and as a result, the cells grow lengthwise [11].
Figure 5. The first flower appearing at each treatment.

Shading reduced mean global radiation by more than 40%, and the screen transmissivity screen was shown to vary with solar elevation angle. Wind speed inside the screen-house was reduced by more than 50% [8]. The difference in the first flower appearing time is not only caused by the influence of irradiation but also by temperature [12]. The results of Arta et al’s research showed that the highest temperature occurred in the microclimate under the plastic screen (UV), followed by no screen (NO), then the combination UV and SN, and the smallest was the temperature in the microclimate under the shading net (SN) [2].

3.4. Dry weight

Plant dry weight measurement data for each treatment can be seen in Table 1. Figure 6 shows that the chili pepper plants that were under the shading net (SN) treatment produced the highest dry weight, namely 247.9 grams compared to other treatments. The greater the level of shade is inversely proportional to the light intensity received by plants, so it will also cause low air temperatures and higher humidity. Low humidity will inhibit plant growth and flowering. Air humidity can affect plant growth because it can affect the photosynthesis process. The rate of photosynthesis increases with increasing humidity in the air around the plant [13]. The amount of light received in the photosynthesis process shows the biomass, while the amount of biomass in plant tissue reflects the dry weight [14].

Table 1. The dry weight value of chili pepper plants in various treatments of the screen material.

| Treatment | Dry weight value (gram) |
|-----------|-------------------------|
| NO        | 92.5 a                  |
| UV        | 119.3 a                 |
| SN        | 247.9 b                 |
| UV&SN     | 148.5 a                 |

Note: the same letter in the value indicates not significantly different (p>0.05).
3.5. Plant Productivity

The average productivity of each plant in each treatment can be seen in Figure 7. The productivity of the chili pepper plant with shading net (SN) is the highest compared to other treatments. High light intensity will increase leaf temperature as a result of disrupted enzyme activity. Among other things, this can cause photosynthesis to be inhibited and the resulting photosynthate is low. Sunlight is also needed for the number of flowers and fruit sets. In the flowering process and fruit set or the percentage of flowers that successfully become fruit on the chili pepper plant, it does not require full light [11].

Table 2. The productivity of chili pepper plants in various treatments of the screen material

| Treatment | The productivity (grams) |
|-----------|--------------------------|
| NO        | 12.76^a                  |
| UV        | 20.25^b                  |
| SN        | 28.41^c                  |
| UV&SN     | 23.85^b                  |

Note: the same letter in the value indicates not significantly different (p > 0.05).

Figure 6. Dry weight at each treatment.

Figure 7. Productivity of at each treatment.
4. Conclusions and suggestions
Cultivation of chili pepper plant in shading net screen material showed better growth (the higher plant height, the higher number of leaves) and faster the first flower appearing and higher dry weight and higher productivity compared to that no screen, the type of plastic screen material and the combination shading net and plastic material.

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