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Short communication

Effect of rain shelter and shading on plantlets growth and antioxidant contents in strawberry

Lixiang Miao, Yuchao Zhang, Xiaofang Yang and Guihua Jiang*

Institute of Horticulture, Zhejiang Academy of Agricultural Sciences, Hangzhou 310021, PR China

ABSTRACT

In the present experiment, a susceptible strawberry Benihoppe was employed to note the effect of rain shelter and shading on plantlets growth and antioxidant system. In the shading treatments, the temperature (1:00 pm) inside the greenhouse was reduced compared to the control. The plastic house covered with 60 and 70% shading nets could decrease the temperature by less than 1°C compared with 80 and 90% shading nets, which could decrease it by 1.2 and 1.3°C, respectively. Even in the cloudy dawn and dusk, shading net with 80% can maintain a light intensity of more than 10,000 lux and plantlets could grow healthy. The plantlets under shading environment grew longer than the control. The plantlets under 90% shading rate had the maximum height, *i.e.* 14.35% higher than the control. The anthracnose incidence and disease index were reduced under shade nets, while the average plantlet numbers per square metre increased. The maximum numbers were under those of 80 and 90% shading rate treatments. The disease incidence was minimum under 80% shading treatment. The shading treatment, altered the content of Chl and MDA, while SOD and POD activities, significantly in order to adapt to the low light environment. The 80% shading net was the most suitable shading measure.

Key words: Anthracnose, antioxidant enzymes, rain shelter, strawberry, shade net.

Strawberry anthracnose (*Colletotrichum gloeosporioides* is a common disease in Zhejiang province of China. The fungus favours the humidity area. Hence, it is difficulty to raise strawberry plantlets during the peak rainy season under South China. However, in South China, such as Zhejiang province, strawberry plantlets are raised from late August to September. Therefore, the small plantlets must be prepared before that time. We have technology for raising strawberry plantlets under high temperature and humidity conditions in rain-shelter and shade net conditions, which can keep protect the plantlets from rain and also reduce the temperature. Light affects plant growth and development, and excessive shading will affect the normal growth of strawberry plants, hence shading must be moderate. In this study, we investigated the effect of different shading levels on strawberry physiology.

In the present experiment, susceptible strawberry cv. Benihoppe was employed to study the effect of shading and rain-shelter on plantlets growth and antioxidant system. The experiment was conducted under completely randomized design with three replications. Four sunshade nets, *i.e.* 60, 70, 80 and 90% shading rates were used in plastic houses. The control plantlets were planted in an open field. The temperature, humidity and light intensity inside and outside the plastic greenhouse were recorded with an automatic recorder during the experiment.

*Corresponding author's E-mail: jianggh@zaas.org

Strawberry plantlets were surveyed every week after appliance of the sunshade net. The disease index and incidence on strawberry plantlets were calculated (Wang *et al*., 5). Leaves were collected every 5 d after cover with sunshade net. The chlorophyll (Chl) content, soluble protein (Pr), malondialdehyde (MDA) content, the dynamic changes in activities of peroxidase (POD) and superoxide dismutase (SOD) enzymes were assayed.

One gram leaf tissue devoid of main midrib was homogenized in 10 ml 25 mm EPPS buffer (pH 7.8) containing 0.2 mm EDTA and 2% PVP. The homogenate was filtered through a nylon mesh and then centrifuged at 15,000 xg for 20 min. The supernatant was used for enzyme analysis. All operations (until analysis) were carried out at 3 to 5°C. Except SOD, all enzyme activities were measured in a final volume of 1 ml using various aliquots of the supernatants (Zhu *et al*., 6). Activity of AsA-POD was measured according to Cakmak and Marschner (1). Activity of SOD was measured according to He *et al.* (2). Concentrations of Chl (a+b) were measured as described by Lichtenthaler and Wellbum (3) after extraction with 80% acetone.

Data in Fig. 1 indicated that the temperature inside the plastic house decreased after cover with sunshade nets. The plastic house covered with 60 and 70% shading nets could decrease temperature by less than 1°C compared with the CK, while 80 and 90% shadenets decrease it by 1.2 and 1.3°C.

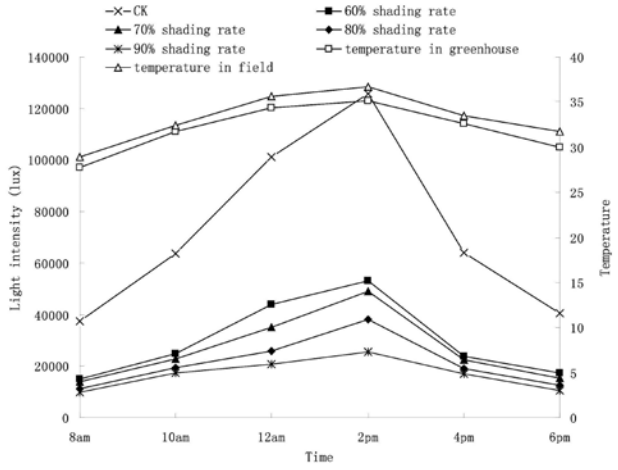

Fig. 1. Changes of temperature and light intensity in strawberry nursery.

Even in the cloudy days, shading net with 80% shade could maintain a light intensity of more than 10,000 lux. Strawberry prefers sunlight but also is a kind of shade-tolerant plant. Plant grew very slow when the light intensity was below 10,000 lux.

The chlorophyll content is an important indicator of photosynthetic performance. Higher Chl content can capture more light energy. The Chl level and speed of degradation also are significant indicators of leaf senescence. Hence, the content of Chl can reflect the quality of plant growth and development. The leaf Chl content was significantly reduced after cover with sunshade net. With the increasing shading rate, the Chl content decreased (Fig. 2). The contents of Chl with four treatments were significantly lower than those under control. This can affect the photosynthesis and delayed the plant growth. MDA is a plant cell membrane lipid peroxidation product. The rapidly increasing of MDA content is the indicator of leaf senescence. The MDA contents in sunshade net were significantly increased (Fig. 3). Then, the content of MDA has a down trend, though was still higher than control. This adjustment can adapt the plant to grow better under low light conditions.

Enzyme POD is an important protective enzyme, which can clear the reactive oxygen in plant. The higher activity of POD can make less lipid peroxidation accumulation. The process of removal of reactive oxygen can accompany the entire growth development of strawberry plant. The strawberry leaf POD activity increased during the observation period (Fig. 4). Within the 10 days after covering with sunshade, the POD activity has a slow rising trend. The POD activity has a sharp rise after 10th day. SOD activity increased rapidly when plant encountered discomfort conditions, which ensure the normal growth of plants. The SOD activity was significantly higher than the control after cover of sunshade net at the fifth day, then they decreased in the following days, but were still higher than the control. The SOD activity at 80% shading rate was higher than that of the 90% shading rate (Fig. 5). This may be one of the reasons why 80% shading rate had a fine quality plantlets compared with the other treatments.

The plantlets under shading environment grew much higher than the control. This contributes to the

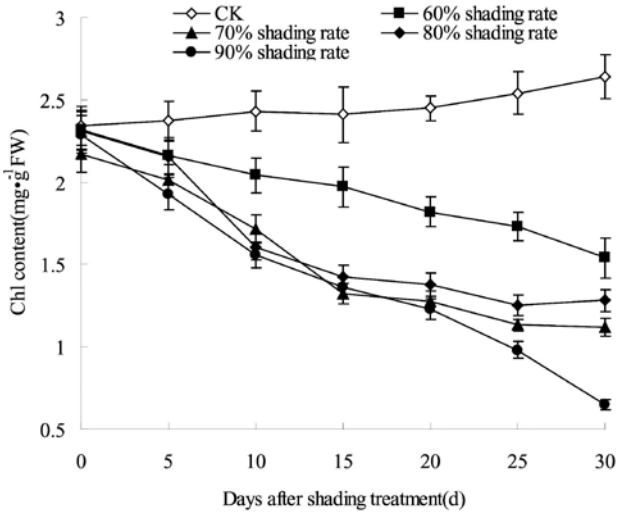

Fig. 2. Effect of different shading sunshade net on Chl content of strawberry.

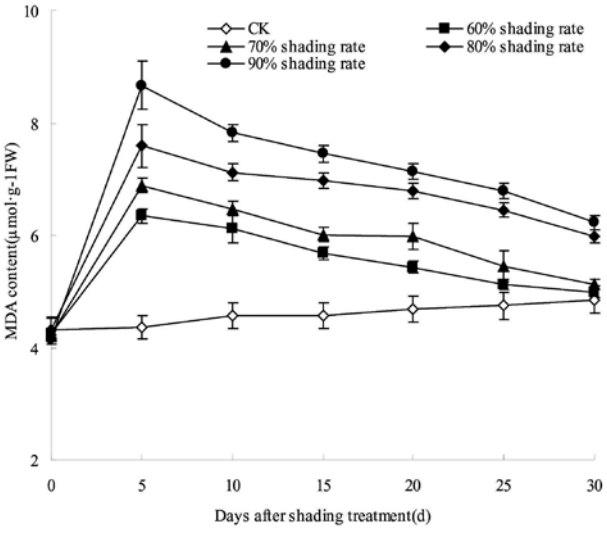

Fig. 3. Effect of different shading sunshade net on leaf MDA content.

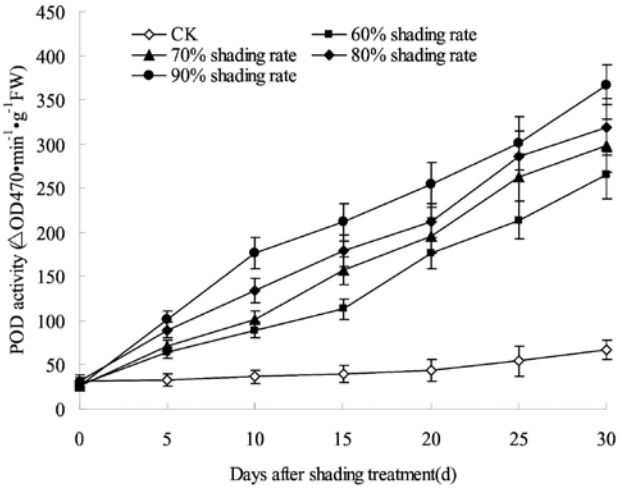

Fig. 4. Effect of different shading sunshade nets on leaf POD activity.

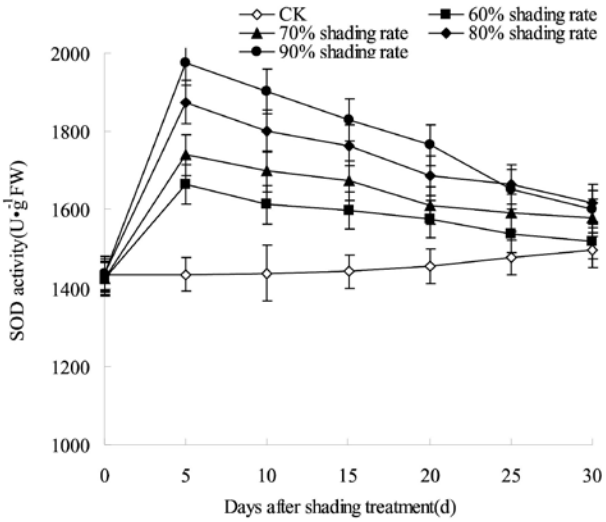

Fig. 5. Effect of different shading sunshade net on leaf SOD activity.

shortage of light. Strawberry plantlets will grow higher in order to have more leaves for photosynthesis. The plantlets under 90% shading rate has a maximum height than those of other treatments, including the control (Fig. 6). In the four shading treatments, the plantlets were significantly longer than those in the open field.

Results in Table 1 indicated that the average plantlet numbers of shading treatments were larger than those of the control. The treatment of 80 and 90% shading had the maximum numbers of plantlets, which were significantly larger than the other treatments at 5% level. However, 80% shading treatment had the minimum disease incidence of all the treatments. Furthermore, the leaf spot disease incidence reduced to 2.6%, while in the control it was 21.2%. The plantlet rates, height, main stem diameter and the stem leaf width were raised by 155.71, 21.19, 33.33 and 14.63%, respectively, compared with the control. Therefore, the most suitable shading measure is sunshade net with shading rate about 80%. Strawberry likes sufficient sunlight. The Chl content of different rate shading treatment plantlets got reduced. This may be caused due to chloroplast dysplasia, disordered, ultrastuctural destruction, and reduction in the number of chlorplasts (Shen *et al.*, 4). The capacity of photosynthesis reduced, which caused the increase in height of strawberry plants.

In the present experiment, shading rate with 80% can maintain a light intensity of more than 10,000 lux, which can maintain the plantlets growth and reduced disease incidence and disease index, was the most suitable shading levels.

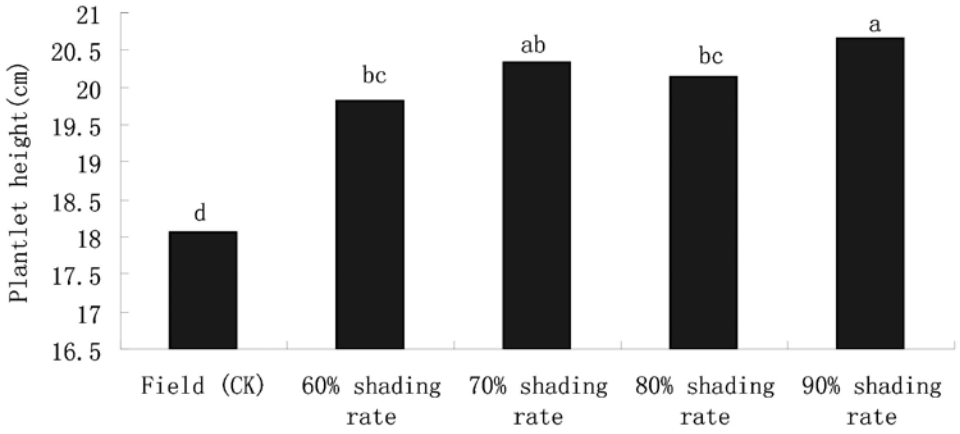

Fig. 6. Effect of different shading sunshade nets on strawberry plantlet height.

Table 1. Effect of different shading sunshade nets on reducing anthracnose incidence in strawberry plantlets.

Treatment	Survey area (m^2)	Total plantlet (No.)	Av. plantlets (plant/ m^2)	Diseased plantlets (No.)	Disease incidence (%)	Disease index (DI)
Field (CK)	42.95	514	11.97 d	269	52.33 d	55.06
60% shading rate	13.5	418	30.96 c	47	11.24 bc	37.14
70% shading rate	13.2	526	39.85 b	35	6.65 a	32.7
80% shading rate	10.5	530	50.48 a	35	6.60 a	29.52
90% shading rate	10.5	524	49.9 a	45	8.59 b	32.84

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