Effect of Duct-type Pad and Fan on Temperature Reduction and Eustoma Quality

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1. Introduction

The average temperature in Japan has increased at a rate of approximately 1.2°C per century since 1898. With the rise of the temperature, so-called “tropical nights” (nights with a lowest nighttime temperature of 25°C or higher) and extremely hot days (days with a daily highest temperature of 35°C or higher) have increased, while winter days (days with a daily lowest temperature of less than 0°C) have decreased. (From the Japan Meteorological Agency website)

There is a concern that high temperature will cause plant body temperatures to rise due to photosynthesis inhibition by intense light and heat from solar radiation, making it impossible to maintain optimum growth temperatures. Therefore, it is necessary for horticultural facilities to take measures against the heat in summer.

2. Purpose of Study

Currently, Pad and Fan (hereinafter referred to as P&F), fine mist cooling, and cooling using heat pumps have been introduced in facility horticulture as heat measures. However, the issue is that they are expensive to install. Therefore, I focused on duct-type P&Fs, which are inexpensive to produce and can be homemade, and investigated their temperature reduction effect. I also investigated the effect of duct-type P&F on the quality of Eustoma.

3. Method of Study

(1) Production of Duct-type P&F and Investigation of Temperature Reduction Effect

The duct-type P&F cools the plant population by sending outdoor air cooled by moistened pads through a fan into a duct. The production cost was 79,436 yen.

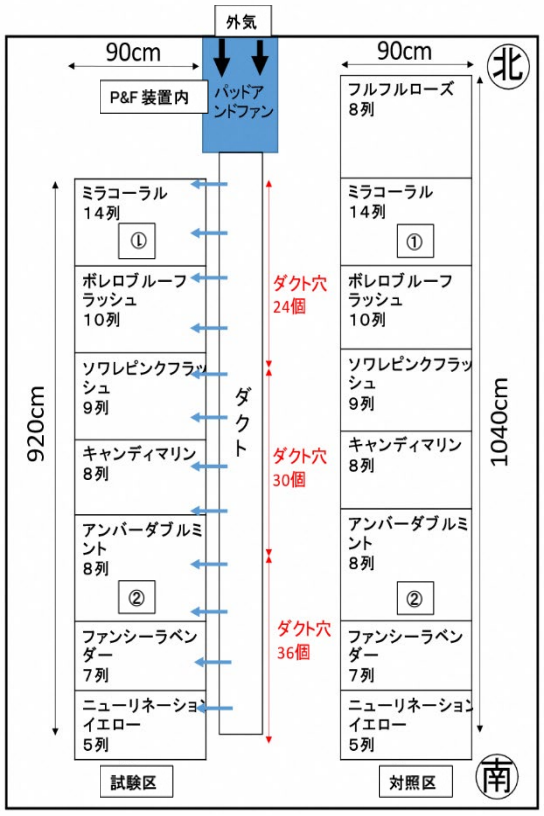

Figure-1 Outline of Test Area

For the temperature reduction effect study, as shown in Figure-1, thermometers were installed in the outdoor airspace, inside the P&F equipment, and in the test area (1), test

area (2), comparison area (1), and comparison area (2) on June 21, and temperature transitions were investigated. In addition, humidity in the outdoor air and inside the P&F equipment was investigated, the reason being how much cool pads moistened with water can raise the humidity inside the P&F equipment has a significant effect on the temperature reduction effect.

(2) Investigation of the Effect on the Quality of Eustoma

Ten plants each of Mira Coral, Bolero Blue Flash, and Amber Double Mint shown in Fig. 4 were investigated for height, weight, and number of flowers at the time of harvest in the test and comparison areas. Sown on January 27, planted on March 31, and harvested and studied from July 4, starting from the second flower blooming.

4. Results and Observations

(1) Temperature Reduction Effect of Duct-type P&F

Figure 2 shows the temperature and humidity inside the P&F equipment on a sunny, high-temperature day on July 2. At 14:50, when the outdoor temperature was at its highest, the temperature inside the P&F equipment was 32.9°C against 40.2°C in the outdoor air, and the humidity was 27% in the outdoor air and 42% inside the P&F equipment, resulting in a -7.3°C temperature and +15% humidity inside the P&F equipment.

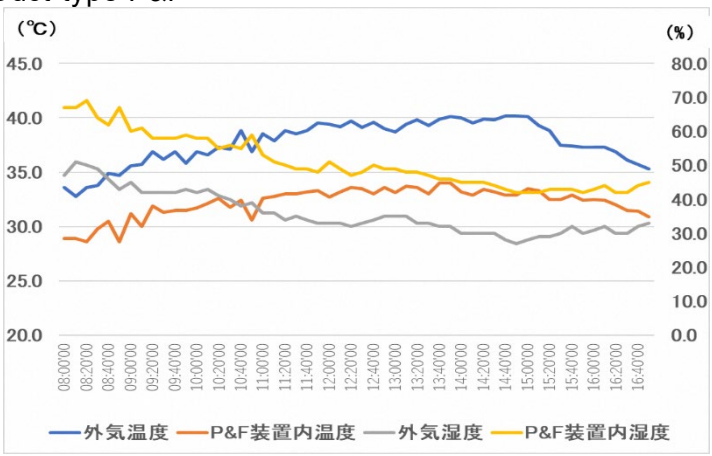

Figure 2: Transition of Temperature and Humidity inside the P&F Equipment on Sunny and Hot Days

The highest temperatures in the test and comparison areas (1) on July 2 were 40.3°C and 42.5°C, respectively, with the test area at -2.2°C. The highest temperatures in the test and comparison areas (2) on July 2 were 38.4°C and 41.2°C, respectively, with the test area at -2.8°C, demonstrating the temperature reduction effect of the duct-type P&F system.

(2) Effect on the quality of Eustoma

In the grass height harvest survey, as shown in Figure 3, the overall average was 59.6 cm in the test area and 60.6 cm in the comparison area, 1.0 cm higher in the comparison area. In the weight harvest survey, as shown in Figure 4, the overall average weight of the test area was 58.9 g in the test area and 53.4 g in the comparison area, 5.5 g heavier than that of the comparison area. In the number of flowers harvest survey, as shown in Figure

5, the overall average was 0.7 higher in the test area than in the comparison area, with an overall average of 5.2 in the test area and 4.5 in the comparison area.

The result was a 1.0 cm higher grass height in the comparison area, a 5.5 g heavier weight in the test area, and 0.7 more flowers in the test area on average. The reason for the shorter grass height in the test area may be due to the stress caused by the strong shaking of plants due to high wind in the test area during P&F operation.

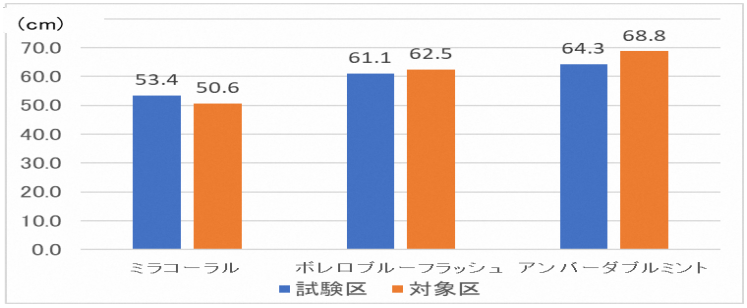

Figure-3 Harvest survey (Grass Height)

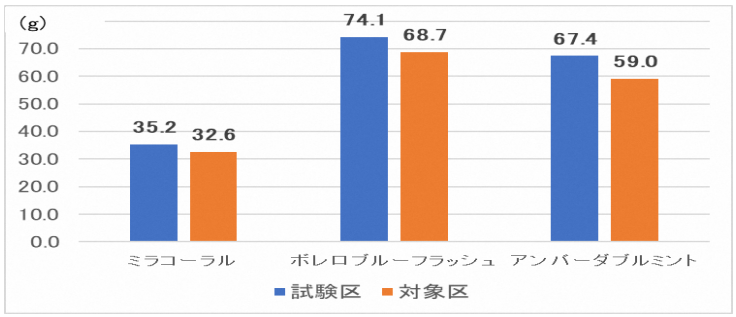

Figure-4 Harvest Survey (Weight)

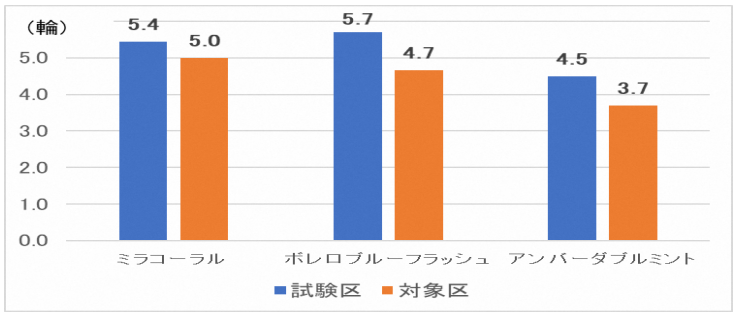

Figure-5 Harvest Survey (Number of Flowers)

(3) Future Issues

As a result of these investigations, the following three issues were identified: (1) improvement of the duct-type P&F cooling efficiency, (2) review of the installation timing, and (3) adjustment of the air volume. I would like to increase the cooling effect of duct-type P&F by improving these issues, which will lead to the enhancement of the quality of Eustoma.

*Following is a description of the figures and tables

図-１　試験区の概要＝Figure-1 Outline of Test Area

試験区＝Test Area

対照区＝Comparison Area

外気＝Outdoor Airspace

装置内＝Inside P & F Equipment

ダクト穴　24 個＝24 duct holes

ダクト穴　30 個＝30 duct holes

ダクト穴　36 個＝36 duct holes

北：north

南：south

図-2　晴天高温日のＰ＆Ｆ装置内の温度と湿度の推移＝Figure 2: Transition of Temperature and Humidity inside the P&F Equipment on Sunny and Hot Days
外気温度＝Outdoor Air Temperature
Ｐ＆Ｆ装置内温度＝Temperature inside P&F Equipment
外気湿度＝Outdoor Air Humidity
Ｐ＆Ｆ装置内湿度＝Humidity inside P&F Equipment

図-3　収穫調査（草丈）＝Figure-3 Harvest Survey (Grass Height)
図-4　収穫調査（重量）＝Figure-4 Harvest Survey (Weight)
図-5　収穫調査（輪数）＝Figure-5 Harvest Survey (Number of Flowers)
フルフルローズ　8列＝Full Full Rose 8 Rows
ミラコーラル　14列＝Mira Coral 14 Rows
ボレロブルーフラッシュ　10列＝Bolero Blue Flash 10 Rows
ソワレピンクフラッシュ　9列＝Soiree Pink Flash 9 Rows
キャンディマリン　8列＝Candy Marine 8 Rows
アンバーダブルミント　8列＝Amber Double Mint 8 Rows
ファンシーラベンダー　7列＝Fancy Lavender 7 Rows
ニューリネーションイエロー　5列＝New Lination Yellow 5 Rows