Possibility of Controlling Fruit-Cracking in Cherry Tomatoes by Light Treatment at Night

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Summary

Control of fruit cracking in cherry tomato (*Lycopersicon esculentum* Mill.) 'Sun Cherry Extra' grown in hydroponics was attempted by light treatment during the night.

The rate of fruit cracking in the untreated control was about 10%, whereas under a high light intensity ($81.1 \mu\text{mol}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$ PAR) and low light intensity ($8.1 \mu\text{mol}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$ PAR), it was 4 and 8.5%, respectively. Diffusive resistance of stomata at 4 AM was $5 \text{ g}\cdot\text{l}^{-1}$ under high light intensity, compared to $17 \text{ g}\cdot\text{l}^{-1}$ in the untreated control. The rate of solute flow into the peduncle during the high light intensity treatment decreased to negative values, whereas that into the petiole increased. This result indicates that solute flowed into the leaves when they were exposed to light, lowering the water potential to below that in the untreated control.

Based on these results we conclude that the treatment with high light intensity at night diminished the frequency of fruit cracking by decreasing the solute flow into the fruit.

Key Words: cherry tomato, fruit-cracking, hydroponics, light treatment.

Introduction

Cracking in cherry tomato fruit is a serious problem for growers (Ito et al., 1990; Murase et al., 1993). Ohta et al. (1997) demonstrated that fruit cracking occurred as a result of an increase in size caused by a rapid uptake of solute by the fruit. From this result we postulated that if the plants were stressed by hastening the transpiration rate by light treatment at night, the frequency of fruit cracking should decrease by limiting the uptake of solute into the fruit, thereby inhibiting sudden fruit enlargement.

Materials and Methods

Seeds of the cherry tomato 'Sun Cherry Extra' were sown on February 24, 1995, and the seedlings were transplanted into plastic containers ($53.4\text{cm}\times 33.4\text{cm}\times 18.8\text{cm}$) containing nutrient solution on April 15, 1995. The solution was aerated continuously at $1.25 \text{ liter}\cdot\text{min}^{-1}$ per container by air pump. The sympodial shoot was pinched leaving three leaves above the third flower truss.

The standard nutrient solution with an electrical conductivity (EC) of $1.0\text{u}, 2.4 \text{ dS}\cdot\text{m}^{-1}$ at 25°C and contained $\text{NO}_3\text{-N}$, $\text{NH}_4\text{-N}$, P, K, Ca, Mg and S at concentrations of 16, 1.3, 4, 8, 8, 4 and $4 \text{ me}\cdot\text{liter}^{-1}$, respectively. The pH of the solution was adjusted to between 5.5 and 7.0 by adding either 4N sulphuric acid or 4N potassium hydroxide. Other cultural procedures were the same as in the previous study (Ohta et al., 1994, 1997).

The light treatment was conducted during harvest between 1 AM and 5 AM using cool-white fluorescent lamps which supplied low light intensity of $8.1 \mu\text{mol}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$ PAR and high light intensity of $81.1 \mu\text{mol}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$ PAR. Six plants were used for each treatment, and the treatments were replicated three times.

Plants were checked for cracked fruit by tagging 50 fully ripe fruits on the 1st to the 3rd trusses which were observed daily at 10 AM. Diffusive resistance in stoma-

Fig. 1. Effect of light treatment at night on the rate of fruit cracking in cherry tomato cv. Sun Cherry Extra. Vertical bars indicate standard error of the mean in three replications.

Received; June 18, 1997. Accepted; July 25, 1997.

Fig. 2. Effect of light treatment at night on diffusive resistance in cherry tomato cv. Sun Cherry Extra. Vertical bars indicate standard error of the mean.

Fig. 3. Diurnal fluctuations of sap flow rate in peduncle and petiole in cherry tomato cv. Sun Cherry Extra, air temperature and relative humidity on sunny day, July, 1995.

ta of leaf at 4 AM and 1 PM was measured by a diffusive porometer (LI-COR Co. Ltd. LI-1600). During high light intensity treatments, rates of solute flow through basal portion of peduncles of the 2nd truss and basal portion of petioles just above the 2nd truss were measured by using a sap flow system (Sakuratani, 1990)

Fig. 4. Effect of light treatment on water potential of fruit and leaf in cherry tomato cv. Sun Cherry Extra. Vertical bars indicate standard error of the mean.

at 30 min intervals for 24hr during fruit harvest.

The water potential of fully ripe fruit and leaf at 11 PM, 4 AM and 7 AM was measured with a pressure chamber (Soil Moisture Equipment Corp. Model 3005) within 20 sec after sampling.

Results and Discussion

The rate of fruit cracking in the untreated control and under low light intensity was about 10%, whereas under high light intensity it was only 4% (Fig. 1). Thus, light treatment with high intensity light was significantly more effective for controlling fruit cracking.

Diffusive resistance of stomata at 4 AM decreased especially with high light intensity compared to that in

the untreated control (Fig. 2) which indicates that stomata opened and that the transpiration rate increased during the light treatment.

The rate of solute flow into peduncle during the high light intensity treatment become negative (Fig. 3) which reveals that the solute was being exported from the fruit. The rate of solute flow into the petiole during high light intensity treatment increased which means that solute flowed into the leaves. In our previous study (Ohta et al., 1997), we reported that the rate of solute uptake by the peduncle from night to early morning was about $5 \text{ g} \cdot \text{hr}^{-1}$ during which the fruit cracked. In this study, light treatment slowed the rate of solute inflow, which in turn, reduced the rate of fruit cracking. Therefore it can be considered that the rate of fruit cracking decreased due to the lower flow rate of the solute into the fruit.

The water potential in leaves during the high light intensity treatment at 4 AM decreased compared to that in the untreated control (Fig. 4) indicating that water content in the leaf decreased because of increased transpiration. At 11 PM and 7 AM there were no differences in water potential among the treatments.

Thus, treatment with high light intensity at night may control the occurrence of fruit cracking by accelerating

the transpiration rate and reducing the solute flow into fruit. These factors tend to reduce turgor pressure in the cells of the ripening fruit.

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夜間光照射によるミニトマトの裂果発生の制御の可能性

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摘 要

定植後から収穫終了時まで園試処方標準濃度液で水耕栽培したミニトマト‘サンチェリーエキストラ’において、夜間(午前1時～午前5時)光照射した場合、裂果の発生が制御可能かどうか検討した。

裂果発生率は対照区では約10%であった。強光照射区($81.1 \mu\text{mol} \cdot \text{s}^{-1} \cdot \text{m}^{-2}$ PAR)においては4%となったが、弱光照射区($8.1 \mu\text{mol} \cdot \text{s}^{-1} \cdot \text{m}^{-2}$ PAR)においては約8.5%であり、対照区とほぼ同程度であった。強光照射区では午前4時における気孔の拡散抵抗は低下した。果柄の水分移動速度は

強光照射処理時間中に低下し負の値を示したが、一方、葉柄の水分移動速度は正の値をとり、水分が流入していることを示した。午前4時における強光照射区の葉の水ポテンシャルは対照区に比べ低下した。

以上の結果より、夜間に強光を照射した場合、葉からの蒸散が生じることによって植物体内から水分が減少し、果実への水分流入が抑制された結果、裂果の発生が低減したものと考えられる。