Effects of Exogenous Melatonin on the Physiological Characteristics of Kiwifruit *Hayward* under Salt Stress

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Abstract. To explore the effect of exogenous melatonin (MT) on the physiological characteristics in kiwi under the salt stress, *Hayward* seedlings primed with 0.1μmol•L^{-1} MT solution were used as the experimental material and treated with 100 mmol• L^{-1} NaCl in hydroponic culture condition. The results showed that the effect of exogenous MT on chlorophyll content changes, cell membrane permeability increase and damage mitigation of plasma membrane of hydroponic seedlings was not obvious, but the ability to alleviate the damage was shown in the early stage of the study.

1. Introduction

Soil salinization is a global problem. Up to now, about 80% of China's salinized soil has not been developed and utilized, which has become one of the biggest constraints on China's agricultural development [1]. Studies have shown that melatonin (MT), as a stimulating compound, has the function to improve the toleration to several biotic and abiotic stresses, such as high temperature, drought and salt stress [2-5].

The *Actinidia* plant is an important fruit tree resource [6] origin from China. "Hayward" belongs to the series of *A. deliciosa*, which is the main variety cultivated in China. Its fruit has rich aroma, delicate and sweet taste, rich nutrition value and good medicinal value, and is known as the "King of Fruits".

In this study, the "Hayward" seedlings were used as the material to explore the effects of exogenous MT on plant resistance to sodium salt stress by determining the chlorophyll content of kiwifruit leaves and other physiological indexes. The results will provide a theoretical basis for the application of exogenous MT in production.

2. Material and methods

2.1. Materials

Plump *Hayward* seeds were selected in October 2016. disinfected, low temperature stratification and variable temperature germination were carried out, and the germinated seeds were sown into a hole plate containing mixed matrix (nutritive soil: vermiculite: perlite =3:1:1), placed in the artificial climate chamber (25 ± 1 ℃, 12 h / 12 h) cultivation to phase 3 true leaf, and select growth of seedlings to block (23 cm×18 cm), every pot 3 strains.

2.2. Material Treatment

When the seedlings grew to 9 true leaves, the seedlings with consistent growth were divided into 3 groups, cultured in 20×35 cm plastic box filled with 1500mL 1/2 Hoagland's nutrition. 3 boxes with 9 seedlings each first step seedlings were treated with 1/2 Hoagland's nutrition or plus 0.1μmol•L^{-1}MT (50 mL) for 5 consecutive days, then treated with plus 100 mmol• L^{-1} NaCl , and 3 treatments were set:(1) CK (1/2 Hoagland's nutrition); (2) ST (1/2 Hoagland's nutrition +100 mmol• L^{-1}, NaCl); (3) ST+MT (100 mmol• L^{-1}, NaCl +0.1μmol• L^{-1}MT), and were repeated 4 times for every 6 vessels. In the processing of salt after 0, 36, 48, 60 h respectively take roots up 3 ~ 5 true leaf, the leaf after liquid nitrogen frozen at - 80 ℃ cryogenic refrigerator preservation, the rest directly used in the determination of some physiological indexes.

2.3. Measurement Items and Methods

The content of chlorophyll was determined by the slightly improved method of Gao JF [7]. The relative electrical conductivity was determined with reference to the method of Chen JX et al. [8]. The content of soluble protein was determined by reference to Li HS et al. [9]. The content of malondialdehyde (MDA) was determined according to the method of Hodges et al. [10].

2.4. Data Analysis

SPSS 20.0 was used for significance analysis, and Excel 2010 software was used for data processing and chart drawing.

3. Results and Analysis

3.1. Effect of exogenous MT on MDA content

MDA is a product of membrane lipid peroxidation and also a landmark substance reflecting the destruction of cell membrane. Its content and change range are negatively correlated with the salt-tolerance of plants [11-12]. In this study (Figure 1), MDA content in CK (cultured in hydroponic conditions) group was relatively stable in the early stage (0-36h), but decreased in the later stage (48-60h). Seedlings in ST group had the similar changing trend as CK, except at 36h there was a slight but insignificant increase, which might indicate its suffering more or heavier stress. While the content in ST+MT group seedlings increased to the highest level at 36h, then fall down to the similar level as CK and ST during the period from 48h to 60h (Figure 1). The lowest level of MDA content in ST + MT at the 0h suggests that it might exist some degree stress before when seedlings were primed with MT. The stress forced from hydroponics during the period. And during this period, MT might play an important role in alleviating the stress to a certain degree by decreasing MDA content.

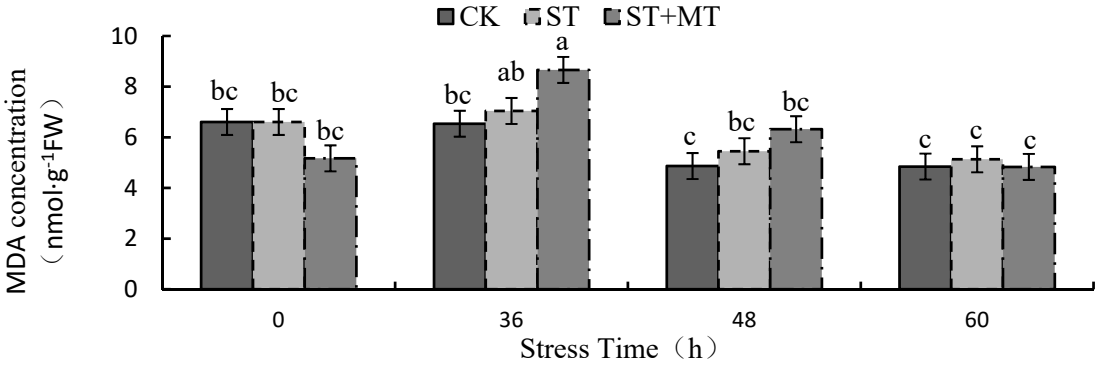

Figure 1. Changes of MDA content in leaves of hydroponic "Hayward" seedlings.

Note: Different lowercase letters in the figure indicate a significant difference at the 5% level, the same as below.

3.2. Effect of Exogenous MT on Relative Electrical Conductivity

When plants are injured under salt stress, cell membrane permeability increases, leading to an increase in electrical conductivity [13]. In this study (Figure 2), the changes in relative membrane permeability of ST group were consistent with those of CK (in hydroponic culture conditions) group, and the growth trend was slow. However, ST+MT group decreased at first, with a minimum of 36 h, significantly lower than that of ST group, and then increased. During the whole stress process, the differences between the three groups were basically insignificant, but trends in the early stage (0-36h) was different, indicating MT might help seedlings to resist salt stress to some extent, so that the permeability of cell membrane reduce.

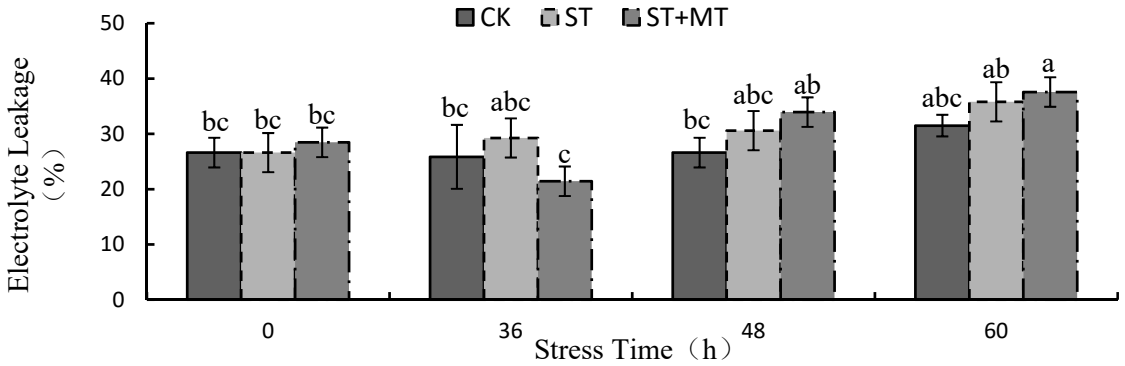

Figure 2. Changes in relative electrical conductivity of leaves of hydroponic "Hayward" seedlings.

3.3. Effect of exogenous MT on soluble protein content

Soluble protein is an important osmotic regulator in plants, which can maintain the metabolic balance in cells [14-16]. In this study (Figure 3), soluble protein content in CK (in hydroponic culture conditions) group increased in the early stage, but was relatively stable in the later stage, while that in ST group showed a trend of rise first and then reduce, which was consistent with that in ST+MT group, but the change range was smaller than that in ST group, and the overall trend was closer to CK group. During the whole stress process, there was no significant difference among the three groups except 24h. At 24h, soluble protein content in CK lower than ST and ST+MT group.

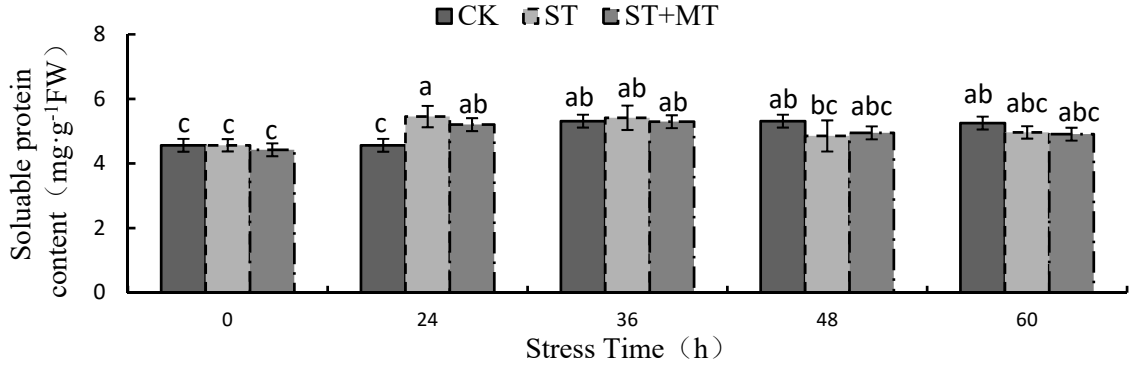

Figure 3. Changes of soluble protein content in leaves of hydroponic "Hayward" seedlings.

3.4. Effects of Exogenous MT on Chlorophyll Content

Chlorophyll is the material basis of photosynthesis. The content of chlorophyll can reflect the photosynthetic efficiency of plants. In this study, when seedlings were cultured in hydroponic box, the chlorophyll content kept relatively stable before 48 hours, but at 60h it fell down to about 60%. There was no significant difference between the three groups. The chlorophyll content in CK (in hydroponic culture conditions) group showed a slow decline trend, while that in ST group showed a trend of first rise and then decline compared with CK group. The change trend in ST+MT group was consistent

with that of ST group, but the change range was less than that of the former group and more close to that of CK group.

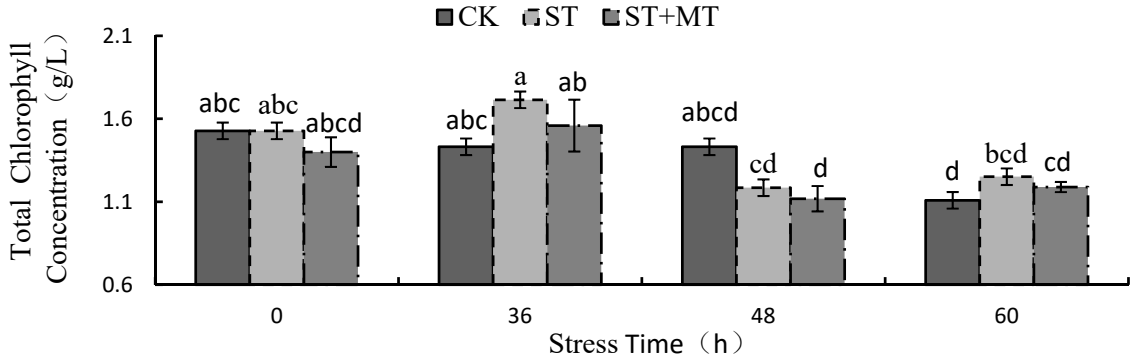

Figure 4. Chlorophyll content changes in leaves of hydroponic "Hayward" seedlings.

4. Conclusion

During the study, the changes in chlorophyll, soluble protein and other contents of plants in the early stage of ST treatment may be related to the stress response of plants themselves, which self-regulate to resist the damage caused by the increase of Na^+ concentration under salt stress to the infiltration imbalance of plants, while the damage in the later stage accumulates to a certain intensity, and the regulation effect fails. In comparison with the trend and amplitude of changes in the three treatment groups in the experiment, it is believed that melatonin might play a certain role in helping hydroponic seedlings to rebuild equilibrium conditions to resist salt stress in the early stage, but the effect was not obvious. It might be related to the kiwi seedlings which are not suitable for hydroponic culture.

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