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Effects of Exogenous Melatonin and ABA on Photosynthetic Characteristics of Naturally Aging Kiwi Seedlings

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Abstract. In this study, the annual yellow kiwi seedlings which were treated with 200μmol/L melatonin (MT), 15μmmol/L abscisic acid (ABA) and 5mmol/L sodium tungstate solution (STD) were used as experimental materials to study the changes in physiological indicators of kiwi fruit under natural aging. After comprehensive analysis, we can speculate that MT may affect the photosynthetic characteristics of aging kiwi by affecting ABA production and keeping its content at a moderate level. The experiment results provided theoretical basis and practical guidance for delaying the production and application of kiwi seedlings.

1. Introduction

Kiwifruit, belonging to *Actinidia* Lindl, is a deciduous vine [1]. Natural aging can seriously restrict the growth and development of kiwifruit seedlings and have adverse effects. Melatonin (N-acetyl-5-methoxytryptamine), whose main physiological function in the organisms is anti-aging [2]. Abscisic acid (ABA) is an important regulator of plant response to stress, which can promote plant bud dormancy, inhibit growth, and promote aging [3].At present, the study of anti-aging and anti-aging effects of kiwifruit seedlings by exogenous substance is not sufficient, and the investigation of the mechanism of aging is rarely reported. This study does make sense.

In this experiment, exogenous melatonin and abscisic acid were used to explore the mechanism of kiwifruit leaves of senescence in order to clarify the role of different exogenous substances in the aging process of kiwifruit, and provide theoretical basis and practical guidance for the effects of aging on kiwifruit seedlings and production applications.

2. Materials and methods

2.1. Cultivation of plant materials

The experiment materials were annual yellow kiwifruit seedlings. After stored at 4°C for 60 days to break dormancy, seeds were treated with variable temperature to accelerate germination. Germinated seeds were sown into a nutrient bowl containing mixed matrix (the substrate was turf: coconut shell: perlite= 2: 2: 1), placed in the artificial climate chamber (25±2 ℃, 12 h/12 h). When the seedlings fully unfolded a true leaf, we started pouring 1/2 Hoagland nutrient solution once a week, and replenished it with water in time. When the seedlings grew to 6 true leaves, the nutrient bowl was transferred to the outdoor shelter, and 3 seedlings in each nutrient bowl were routinely managed.

2.2. Experimental treatment

In early December, kiwifruit seedlings with consistent growth were selected, and the pretreatment group with MT were added 200 μmmol / L MT 100 ml to the roots in the evening every two days. The rest of the treatment group will be root irrigated with equal amount of water at the same time. After 3 times of MT pretreatment, 15 μmol / L ABA and 5 mmol / L sodium tungstate (STD, ABA inhibitor) were sprayed on the leaves, and the remaining treatment groups were sprayed with water. The experiment was divided into 6 groups, namely(1) CK (clear water); (2)ABA (15 μmmol / L ABA for foliar spray); (3)STD (5 mmol / L STD for foliar spray); (4) MT (200 μmol / L MT for root irrigation); (5)MT + ABA (200 μmmol / L MT for root irrigation, and then 15 μmol / L ABA for foliar spray); (6)MT + STD (200 μmmol / L MT for root irrigation, and then 5 mmol / L STD for foliar spray), 6 plants per treatment, repeated 3 times. Samples were taken at 0d, 15d, and 30d of the treatment, and relevant physiological indicators were determined.

2.3. Measurement items and methods

The leaf water potential meter (model WP4C) was used for the measurement. The determination of malondialdehyde (MDA) and hydrogen peroxide (H_2O_2) is based on the method of Li Hesheng [4]; the relative membrane permeability is determined by Chen Jianxun [5]; the relative water content of the leaves is determined by Barrs and Weatherley [6] method.

2.4. Data analysis

Data were expressed as mean ± standard deviation (SD), and significant analysis was performed using one-way ANOVA and Duncan methods of SPSS 20.0.

3. Results and discussions

3.1. Effects of exogenous MT and ABA on photosynthetic characteristics of kiwi seedlings

During the experiment, photosynthesis parameters of kiwi seedlings gradually decreased (Table 1). At 0 days of natural aging, melatonin pretreatment significantly increased the net photosynthetic rate (Pn), transpiration rate (Tr), and stomatal conductance (Gs) of kiwi seedlings. At 15 days, the net photosynthetic rate of kiwi seedlings in the MT + STD treatment group was significantly higher than that in the other treatment groups. At 30 days, the net photosynthetic rate of the MT + ABA treatment group was the highest, but it was not significantly different from the other treatment groups. Based on it, we can speculate that MT can promote the increase of net photosynthetic rate of leaves by affecting the production of ABA.

Table 1. Effects of MT and ABA on photosynthetic characteristics of kiwifruit seedlings.

Treaments		Pn(μmolCO_2m^{-2}s^{-1})	Tr(mmolH_2Om^{-2}s^{-1})	GS(mmolH_2Om^{-2}s^{-1})	Ci(μmolCO_2m^{-2}s^{-1})
0d	CK	10.89±0.312bc	1.91±0.498b	0.18±0.025b	281.08±5.539a
	MT	16.09±2.049a	3.50±0.279a	0.28±0.016a	271.06±14.276abc
15d	CK	9.05±0.631cd	0.80±0.141c	0.11±0.027cd	239.06±29.502de
	ABA	9.15±1.108cd	1.12±0.278c	0.12±0.035cd	249.81±18.936ab
	STD	8.58±2.820cd	0.80±0.266c	0.14±0.059bc	278.76±9.238ab
	MT	9.08±2.074cd	1.20±0.291c	0.14±0.037bc	276.21±19.099ab
	MT+ABA	9.50±1.617cd	0.99±0.095c	0.14±0.025bc	269.21±35.152abcd
	MT+STD	12.80±0.082b	0.73±0.090c	0.08±0.010d	243.52±40.134cde
30d	CK	7.26±0.983d	0.74±0.102c	0.09±0.010cd	233.68±5.364e
	ABA	8.40±0.477d	1.08±0.251c	0.11±0.008cd	234.95±11.673e
	STD	7.90±0.969d	0.84±0.085c	0.08±0.006d	244.00±7.208cde
	MT	8.06±0.525d	0.96±0.070c	0.11±0.022cd	238.12±3.662e
	MT+ABA	8.82±0.722cd	0.88±0.176c	0.11±0.014cd	240.04±9.432de
	MT+STD	8.02±0.546d	0.90±0.144c	0.10±0.018cd	236.88±8.019e

Note:The data shown are the averages± SE of three replicates. The means denoted by the same letter do not significantly

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differ at a P<0.05 (LSD test).

3.2. Effects of exogenous MT and ABA on fluorescence parameters of kiwi seedlings

During the experiment, the maximum photochemical quantum yield (Fv/Fm) and non-photochemical quenching coefficient (qN) of kiwi seedlings showed a downward trend, while the PSII photon quantum transfer efficiency (ΦPSII), photochemical quenching coefficient (qP), and apparent The electron transfer rate (ETR) is gradually increasing (Table 2). At 15 days of natural senescence, the Fv/Fm of leaves of STD treatment group and qN of leaves of ABA treatment group were significantly higher than those of other test groups, and qP of leaves of ABA treatment group was significantly lower than those of other test groups. At 30 days, the Fv/Fm of the STD group and the MT + ABA group was significantly higher than the other experimental groups. Based on it, we can speculate that MT can affect leaf fluorescence parameters by affecting the production of ABA.

Table 2. Eeffects of MT and ABA on fluorescence parameters of kiwifruit seedling leaves.

Treaments		Ev/Fm	ΦPSII	qP	qN	ETR
0d	CK	0.78±0.05a	0.54±0.024abc	0.80±0.019bcd	0.40±0.051ab	32.27±1.428e
	MT	0.77±0.010a	0.50±0.055bcd	0.79±0.042cde	0.50±0.128a	29.69±3.256e
15d	CK	0.72±0.006def	0.48±0.043cd	0.77±0.071de	0.40±0.062ab	40.31±3.603cd
	ABA	0.72±0.001cde	0.44±0.087d	0.73±0.086e	0.48±0.155a	36.78±7.301de
	STD	0.75±0.003b	0.57±0.009ab	0.84±0.021abc	0.31±0.046bc	48.02±0.786bc
	MT	0.71±0.008f	0.59±0.031ab	0.87±0.025ab	0.20±0.025c	49.14±2.635b
	MT+ABA	0.70±0.008f	0.56±0.108abc	0.89±0.039a	0.32±0.170bc	47.09±8.986bc
	MT+STD	0.71±0.004ef	0.56±0.044abc	0.84±0.056abc	0.23±0.081c	46.86±3.680bc
30d	CK	0.72±0.013def	0.57±0.016ab	0.88±0.015a	0.30±0.009bc	47.70±1.457bc
	ABA	0.72±0.016def	0.59±0.048a	0.88±0.008a	0.24±0.018c	49.42±3.994b
	STD	0.73±0.006cd	0.60±0.023a	0.88±0.018a	0.27±0.034bc	49.84±1.915b
	MT	0.71±0.009ef	0.53±0.016abc	0.84±0.022abc	0.33±0.061bc	44.38±1.362bc
	MT+ABA	0.73±0.013c	0.57±0.043ab	0.85±0.058abc	0.30±0.043bc	47.68±3.594bc
	MT+STD	0.70±0.011f	0.58±0.030ab	0.88±0.024a	0.26±0.034bc	61.06±10.604a

3.3. Effects on photosynthetic pigment content in kiwi leaves

Leaf chlorosis and yellowing are typical appearance characteristics of leaf senescence [7]. During the experiment, the chlorophyll content and carotenoid content of kiwi seedling leaves showed a downward trend (Figure 1). At 0 days of natural senescence, MT pretreatment increased leaf chlorophyll and carotenoid content by about 5%. At 15 days, the chlorophyll content and carotenoid content of the ABA treatment group were the lowest. The chlorophyll content of leaves in the STD and MT + ABA treatment groups was higher than that in the control group, but the difference was not significant. At 30 days, the chlorophyll content and carotenoid content in the leaves of the ABA and STD treatment groups were significantly higher than those in the other treatment groups, while the chlorophyll content and carotenoid content in the leaves of the MT and MT + STD treatment groups were significantly lower than those of the other treatment groups. Based on it, we can speculate that MT can affect the changes of leaf photosynthetic pigment content by affecting the production of ABA.

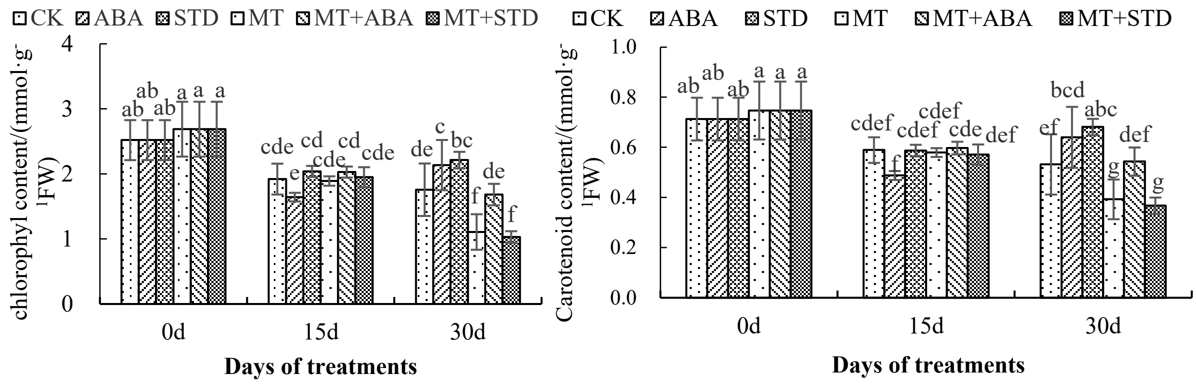

Figure 1. Effects of MT and ABA on Chlorophyll and Carotenoid contents in kiwifruit seedlings.

4. Discussion and conclusion

Aging is a progressive and irreversible state of functional decline, which is a comprehensive manifestation of various functional decline of the body [8]. During this process, chlorophyll content and photosynthetic rate will decrease [9-10]. By comprehensively considering the changes in photosynthetic characteristics of each treatment group in the experiment, we can speculate that MT may improve the photosynthesis of aging kiwi by affecting the production of ABA and keeping its content at a moderate level. However, the role of ABA in natural aging of plants and the mechanism of MT affecting ABA need to be further studied.

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