Effect of Melatonin on the Breaking Dormancy of Kiwifruit Seeds

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Abstract. In order to study the effect of exogenous melatonin (MT) on breaking the dormancy of kiwifruit seeds, in this experiment, the kiwi fruit seeds were kept at 4℃for 15 days. At the same time, we used different concentration gibberellin (GA) and MT solution to treat the seeds, and calculated germination rate (GR) and germination potential (GP) of seeds. Compared with the control treated with water with no any germination (CK), MT treatments promoted the GR to 10%-16%, and the GP increased to 4%-7%. And 50μmol/L MT treatment had the best results, with 16% GR and 7% GP respectively. GA treatments promoted the GR to 15%-30%, and the GP increased to 8%-12%. And 50μmol/L MT treatment had the best results, with 30% GR and 12% GP respectively. The results showed that MT and GA may have some effects on breaking kiwi seed dormancy, and GA had better effect.

1. Introduction

Kiwi is the deciduous vine belonging to family Actinidiaceae, genus Actinidia. The fruit of kiwi has high nutritional value, and its vitamin content is in the forefront of fruit. It also has high medicinal value and has the prevention and cure effect on hypertension, coronary heart disease and other diseases [1].

Mature kiwi seeds need to receive certain cold accumulation to break dormancy before germination. Melatonin (MT) is a kind of small molecule of indoles substance, known as n-acetyl-5-methoxytryptamine. MT plays a regulatory role in plant growth and reproduction [2]. Studies have proved that MT also plays a promoting role in seed germination [3]. In 2016, Zhang [4] discovered that the germination of cucumber seeds can be significantly promoted by external MT treatment. It can promote ABA catabolism and GA synthesis in the germination process of cucumber seeds, alleviate the inhibition of various substances on seed germination, promote the metabolism of storage substances (globulin) in seeds and the generation of cytoskeleton (microtubules and filaggrin), promote cell division and elongation, and then promote seed germination.

To date, the researches on breaking kiwi seed dormancy were mainly focused on growth regulator GA, low-temperature sand storage and variable temperature treatment [5], but the effect of exogenous MT on breaking kiwifruit seed dormancy has not been reported. This experiment studied the effect of exogenous MT treatment on the early breaking of kiwi seed dormancy in the dormant stage, and discussed the optimal concentration and physiological mechanism of MT on the early breaking of kiwi seed dormancy, providing a basis for MT to promote the early breaking of kiwi seed dormancy.
2. Materials and methods

2.1. Material preparation and treatment
Acquisition kiwifruit seeds after its order, in the middle of December. After soaking with 5% sodium hypochlorite solution for 5 min for disinfection, and washed with distilled water (CK) for several times. Kiwi seeds were placed the petri dishes in 15 cm diameter covered with two layers of filter papers and treated with 5 ml MT or GA solution during the periods kept at 4 ℃ for 15 days. GA concentrations were set at three levels: 300mg/L, 650mg/L and 1000mg/L. And the MT concentrations were set as five levels: 1μmol/L、10μmol/L、50μmol/L、100μmol/L、200μmol/L and the CK was used as control. Each treatment repeated 3 times, one petri dish was taken as one repeat with 100 seeds. During treatment, dishes were wrapped with a black cloth to avoid light, treated solution was replace every 3 days. 15 days later, seeds were placed at 25 ℃ for germination, and observed the seed GR and GP.

2.2. Seedling management
The germinated kiwi seedlings were cultivated in different soil substrates, the growth status and adverse symptoms of the seedlings were recorded, and the survival rate of the seedlings was observed. Soil matrix were treated as: C0, nutrient soil =1; C1, nutritive soil: vermiculite: perlite =3:1:1; C2, lime: vermiculite: perlite =4:1:1; C3, lime: coconut shell: perlite =2:2:1.

2.3. Physiological indexes

2.3.1. Germination rate (GR) and germination potential (GP) determination. After the germination of seeds, the germination number of each treatment seeds was recorded every day. N is a number of seeds snow, and n is the number of seeds that germinate normally, m is the number of seeds that germinate during the germination process when the number of seeds reaches its peak every day.

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GR(\%) = \frac{n}{N} \times 100\% \quad GP(\%) = \frac{m}{N} \times 100\%
\]

2.3.2. Determination of survival rate. Observe and record the growth status of seedlings after transplanting, and count the number of survived seedlings. A is the total number of transplanting plants, and a is the number of seedling plants growing normally.

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\text{Survival rate} = \frac{a}{A} \times 100\%
\]

2.3.3. Determination of pH value, air permeability and water retention of soil matrix. Random sampling of soil with different proportions was conducted to determine the physiological indexes of soil.

2.4. Data handling
Software Excel 2016 was used to calculate the experiment data and plot. Statistical analysis was performed using software Excel SPSS.

3. Results and discussion

3.1. Effects of GA on the germination
The GR and GP of kiwi seeds treated with CK were both 0. Different concentrations of GA can increase the GR and GP of kiwi seeds to 15%-30% and 8%-12%. Among them, 1000mg/L GA treatment had the best effect, and the GR and GP of kiwi seeds were 30% and 12% respectively. The results showed that GA treatment with a certain concentration may have a certain promoting effect on breaking kiwi seed dormancy and promoting seed germination.
3.2. Effects of MT on the germination

The GR and GP of the seeds treated with CK, low levels (1μmol/L) or high levels (200μmol/L) of MT were both 0. Different concentrations of MT can increase the GR and GP of kiwi seeds to 10%-16% and 4%-7%. Among them, 50μmol/L GA treatment had the best effect, and the GR and GP of kiwi seeds were 16% and 7% respectively. The results showed that MT treatment with a certain concentration may have a certain promoting effect on breaking kiwi seed dormancy and promoting seed germination.

3.3. Effects of soil substrates on the seedling growth

Kiwi seedlings are sensitive to soil composition and physical and chemical properties [6]. As shown in table 1, in this experiment, the survival rate of kiwi seedlings in different substrates was C3 > C1 > C2 > C0. The cultivation effect of substrates was the best while the matrix was lime: coconut shell: perlite = 2:2:1, and the survival rate of kiwi seedlings was 42.93% higher than that of nutrient-soil cultivation alone. The matrix pH 6-7, loose soil and good water retention soil matrix is the most favorable for kiwi seedling survival.
Table 1. Effects of soil substrates on the seedling growth.

| Deal | Matrix type (Volume ratio) | Soil pH | Breathability | Water retention | Survival rate (%) | Symptom |
|------|----------------------------|---------|---------------|-----------------|-------------------|---------|
| C0   | nutrient soil (100%)       | 7-7.5   | bad           | good            | 56.87             | roots become browning, leaves become yellowing |
| C1   | nutrient soil: vermiculite: perlite (3:1:1) | 8-9     | good          | good            | 69.75             | seedlings become vitrification |
| C2   | lime: vermiculite: perlite (4:1:1) | 6-7     | bad           | good            | 63.49             | soil was adhesion, plant grow slowly |
| C3   | lime: coconut shell: perlite (2:2:1) | 6-7     | good          | good            | 99.80             | growth was good |

4. Conclusions
Kiwifruit is a deciduous fruit tree, whose seeds need to accumulate a certain number of low-temperature hours to break dormancy [5]. To some extent, MT treatment can effectively improve the GR of seeds [4]. In this experiment, it was found that MT treatment on kiwi seeds collected and stored for one month at a low temperature of 4 degrees centigrade at 15 days had obvious effect on the GR. In the traditional way of sand storage, seeds need to be stored in sand from the end of December of that year to the middle of February of the next year, during which more than 20 times of soil digging should be carried out [5,7]. Although the cost is low and the environmental requirements are not high, it takes a long time and has cumbersome operation and seed GR can’t be guaranteed. The experiment showed that MT had the characteristics of breaking kiwi seed dormancy and promoting seed germination. Compared with the traditional method, the sleep breaking effect of MT treatment is not obvious, but the process is simple and time consuming. However, kiwi seeds are small in volume and large in quantity, and the GR can reach 30% to meet the needs of kiwi seedling cultivation. The overall GR and GP of this experiment are not high, which is mainly because the treatment time of MT immersion is short (15 days), and it is suggested to lengthen the soaking time of MT.

Experiments have shown that kiwifruit has strict requirements on soil alkalinity [6]. In this experiment, it was found that kiwi seedlings could grow normally in slightly acidic soil with good air permeability and water retention. While in neutral or alkaline soil with poor air permeability, the growth was relatively slow, and diseases such as yellowing and vitrification would occur. Therefore, it is suggested to regulate the acidity and alkalinity of kiwi seedlings and the air permeability of soil.

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