Effects of paclobutrazol on bud, plant height and antioxidant enzyme activities of Cymbidium hybridum

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Abstract. Cymbidium hybridum is a favourite flower of the annual flower. Its flower bud number, plant type and morphological characteristics affect its ornamental effect. This experiment explored the effects of 50mg/L, 100mg/L, 200mg/L, 300mg/L, 400mg/L paclobutrazol on the enzyme activity, flower bud number and plant height dwarfing of the antioxidant system of Cymbidium hybridum. The results showed that: 1. Each concentration treatment can promote flower bud differentiation, 300mg/L is the best. 2. Paclobutrazol has an inhibitory effect on plant height, and with the increase of concentration, the inhibition is more obvious, and the inhibition of 400mg/L is the strongest. 3. Paclobutrazol can increase the enzyme activity of the antioxidant system of Cymbidium hybridum. The activity of SOD and POD is promoted by low concentration and inhibited by high concentration. The contents of CAT and soluble protein in each concentration were higher than those in the control group.

1. Introduction

Cymbidium hybridum, also known as Simblan and Hutoulan [1], is one of the five largest potted orchids in the world [2]. The application range of Cymbidium is very wide and the ornamental value is extremely high [3]. It has become one of the most popular orchids in the world flower market [4]. The large flower bud orchid has a large order, long flowers and plants, a large number of small flowers, and rich colors. The flowering period of each inflorescence can last for about two months. The potted plants and cut flowers of Cymbidium are popular in the international market, and their flowering period coincides with the Chinese Lunar New Year. The viewing period can last up to 3 months [4], so in recent years it has become one of the important high-end potted flowers of Chinese New Year flowers [5].

The number of buds and plant type of the flower buds directly affect their ornamental value, and the resistance affects their physiological activities. Yunnan, Chengdu, and Guangdong are the main sales sites of cymbidium cultivated in Xichang City, but the plant type of cymbidium is not high. Transportation, proper dwarf plant type, improving its resistance to stress and enhancing its transport resistance are of great significance for maintaining the ornamental value of Cymbidium hybridum. The flowering orchids are warm and humid. [6], Xichang City is warm and dry throughout the year,
affecting flower bud differentiation and physiological characteristics, and reducing the value of commodities. How to improve flower bud differentiation rate and optimize physiological characteristics has important research significance for cultivating Cymbidium hybridum in Xichang City. Paclobutrazol, as a common plant hormone, can increase the rate of flower bud differentiation and dwarf plants to some extent [7]. At present, the effects of paclobutrazol on physiological characteristics such as alpine rhododendron [8] and Osmanthus sapling [9] have been studied, but paclobutrazol has rarely been reported on the physiological characteristics of Cymbidium hybridum. In this experiment, combined with the natural conditions of Xichang, the effects of different concentrations of paclobutrazol on the enzyme activity, flower bud number and dwarfing of the antioxidant system of Cymbidium hybridum were studied.

2. Materials and methods

2.1. Materials

2.1.1. Test materials. The three-year-old large-flowered Cymbidium, which is cultivated by Japan's Kono Co., is a healthy, disease-free, pest-resistant, and basically growing, "Yuanbao" tissue culture seedling.

2.1.2. Test location. Xizhou Fuhua Garden Co., Ltd. Lizhou Base.

2.1.3. Test drugs and equipment. Drug: Paclobutrazol - Sichuan Guoguang Agrochemical Co., Ltd. produces 15% WP of active ingredient. Equipment: electronic balance, centrifuge, spectrophotometer.

2.2. Experimental design

2.2.1. Test method. The trial was conducted from May to October 2016. A total of 5 treatments and 1 control were set up for the test, and each treatment was repeated 3 times. The paclobutrazol concentration gradients were: 50 mg/L (A), 100 mg/L (B), 200 mg/L (C), 300 mg/L (D), 400 mg/L (E), and the control was 0 mg/L (CK). On May 7, 2016 and May 21, 2016, the leaves and pseudobulbs of Cymbidium hybridum were evenly sprayed, and each plant was sprayed with 500 ML solution.

2.2.2. Test observation. After the end of the test treatment on May 21, 2016, the test materials were fixedly observed on Sundays. The first flower bud was observed and recorded on June 19, and then continued to observe and record. The bud differentiation period of the buds of the buds was about 2 months. After the number of flower buds was observed in mid-August, the number of flower buds did not change until mid-September. The final number of flower buds is recorded at this time.

The new leaves after the test treatment were collected, and the ice pack was stored at a low temperature to determine the enzyme activity content.

2.3. Data determination

2.3.1. Determination of morphological indicators. Plant height: The plant height was measured before the first treatment, and the plant height was measured at the end of the test.

Number of flower buds: The number of flower buds was determined after the end of flower bud differentiation.

2.3.2. Determination of enzyme activity of antioxidant system. CAT measurement: hydrogen peroxide method. POD determination: guaiacol method. SOD determination: nitroblue tetrazolium (NBT) method. Soluble protein: Coomassie Brilliant Blue G-250.
2.3.3. Data Processing. Statistical analysis of experimental data was performed using Microsoft Excel and SPSS 23.0 software [9].

3. Results and analysis

3.1. Effects of different concentrations of paclobutrazol on the number of buds of Cymbidium

The results showed that the number of flower buds in each concentration treatment was higher than that in the control group, and paclobutrazol promoted the differentiation of orchid buds. The increase rate of flower buds was the rate of change of the number of flower buds per treatment compared with the increase of the number of flower buds. The concentration is high to low, and the number of flower buds rises first and then decreases, and D is the peak value. The rate of increase of flower buds was the highest in D treatment, and the number of flower buds increased by 3.34 compared with the control. After significant analysis, CK treatment was significantly different from C and D treatments, and was significantly different from B treatment. The treatments of B, C and D significantly promoted the effect of flower bud differentiation compared with the control treatment, and the number of flower buds was the most in D treatment, which was the best concentration for promoting flower bud differentiation (see Table 1).

Table 1. Effect of different concentrations of paclobutrazol on the number of buds of Cymbidium

| Treatment (mg/L) | Average number of flower buds (pieces) | Significant level Flower bud increase rate (%) |
|-----------------|--------------------------------------|---------------------------------------------|
| D (300.00)      | 6.67±0.33 a                         | A 100.3                                     |
| C (200.00)      | 5.34±0.33 a                         | AB 60.36                                    |
| B (100.00)      | 4.67±0.33 ab                        | ABC 40.24                                   |
| E (400.00)      | 4.00±0.58 bc                        | ABC 20.12                                   |
| A (50.00)       | 3.67±0.33 bc                        | BC 10.21                                    |
| CK (0.00)       | 3.33±0.33 c                         | C -                                         |

3.2. Effects of different concentrations of paclobutrazol on plant height of Cymbidium hybridum

The results showed that the plant height growth of Cymbidium hybridum was lower than that of the control treatment at each concentration, and the average growth was 1.44 cm. The growth rate of the control plantation of Cymbidium hybridum was 6.20 cm. The higher the concentration, the lower the amount of growth, and the more obvious the dwarfing effect. The dwarfing rate is lower than the rate of change in the growth of each treated plant than the control. The E treatment dwarf rate is the highest, reaching 90.81%, which is significantly different from CK, and has significant difference with A and B. CK is significantly different from A, B, C, D, and E (see Table 2).

Table 2. Effect of different concentrations of paclobutrazol on plant height of Cymbidium hybridum

| Treatment (mg/L) | Average plant height increase (cm) | Significant level Dwarf rate (%) |
|-----------------|------------------------------------|----------------------------------|
| CK (0.00)       | 6.20±0.46 a                        | A -                              |
| A (50.00)       | 2.27±0.73 b                        | B 63.39                         |
| B (100.00)      | 2.17±0.44 b                        | B 65                             |
| C (200.00)      | 1.17±0.17 bc                       | B 81.13                         |
| D (300.00)      | 1.03±0.45 bc                       | B 83.39                         |
| E (400.00)      | 0.57±0.56 c                        | B 90.81                         |
3.3. Effects of different concentrations of paclobutrazol on SOD activity of Cymbidium hybridum

The results showed that the activity of SOD in A, B, C and D treatment was higher than that in the control group. The activity of SO in E treatment was lower than that in the control group, which showed that low concentration promoted high concentration inhibition. D treatment of SOD activity was the highest, 9.33 Fw·g-L, and there was a significant difference with CK, A, B, C, E treatment. CK has a very significant difference from C and D treatments, and is significantly different from B treatment. Treatments B, C, and D significantly enhanced SOD enzyme activity compared to control treatment (see Table 3).

Table 3. Effect of different concentrations of paclobutrazol on SOD activity of Cymbidium hybridum

| Treatment (mg/L) | Average SOD activity value (Fw·g-L) | Significant level α=0.05 | Significant level α=0.01 |
|------------------|------------------------------------|--------------------------|--------------------------|
| D (300.00)       | 9.33±0.30                          | a                        | A                        |
| C (200.00)       | 7.79±0.24                          | b                        | B                        |
| B (100.00)       | 6.42±0.69                          | bc                       | BC                       |
| A (50.00)        | 5.34±0.61                          | cd                       | CD                       |
| CK (0.00)        | 4.36±0.31                          | de                       | CD                       |
| E (400.00)       | 3.65±0.51                          | e                        | D                        |

3.4. Effects of different concentrations of paclobutrazol on POD activity of Cymbidium hybridum

The results showed that the POD activity of A, B, C and D treatment was higher than that of the control group, and the POD activity of E treatment was lower than that of the control group, which showed that the low concentration promoted the high concentration inhibition. The highest POD activity in C treatment was 213.43 u/g, which was significantly different from CK, A, B, D, and E treatments. The CK treatment was significantly different from the A, B, C, and D treatments. The POD activity was significantly higher than that of the control. The CK and E treatments were significantly different, and the POD activity was significantly lower than that of the control. (See Table 4).

Table 4. Effect of different concentrations of paclobutrazol on POD activity of Cymbidium hybridum

| Treatment (mg/L) | Average POD activity value (u/g) | Significant level α=0.05 | Significant level α=0.01 |
|------------------|---------------------------------|--------------------------|--------------------------|
| C (200.00)       | 213.43±4.24                     | a                        | A                        |
| D (300.00)       | 189.20±5.09                     | b                        | B                        |
| B (100.00)       | 180.96±2.49                     | b                        | BC                       |
| A (50.00)        | 166.00±3.01                     | c                        | C                        |
| CK (0.00)        | 146.51±2.81                     | d                        | D                        |
| E (400.00)       | 132.77±4.13                     | e                        | D                        |

3.5. Effects of different concentrations of paclobutrazol on CAT activity of Cymbidium hybridum

The results showed that the CAT activity of each concentration was higher than that of the control group, and the concentration of CAT activity increased first and then decreased. C treatment CAT activity was the highest, 51.05u / g, and there was a significant difference with CK, A, B, E treatment. There was a significant difference between CK and A, B, C, D, and E treatments, and CAT treatment was significantly higher than the control (see Table 5).
Table 5. Effect of different concentrations of paclobutrazol on CAT activity of Cymbidium hybridum

| Treatment (mg/L) | Average CAT activity value (u/g) | Significant level α=0.05 | α=0.01 |
|-----------------|-------------------------------|--------------------------|--------|
| C (200.00)      | 51.05±1.52                   | a                        | A      |
| D (300.00)      | 48.91±1.27                   | a                        | A      |
| B (100.00)      | 42.14±2.13                   | b                        | B      |
| A (50.00)       | 36.83±1.43                   | c                        | C      |
| E (400.00)      | 33.18±0.21                   | c                        | C      |
| CK (0.00)       | 27.63±0.56                   | d                        | D      |

3.6. Effects of different concentrations of paclobutrazol on soluble protein content of Cymbidium hybridum

The results showed that the soluble protein content of each concentration was higher than that of the control group. The concentration of soluble protein increased from high to low. E treatment had the highest soluble protein content of 0.1290 mg/g, which was significantly different from CK and A treatment. CK was significantly different from D and E treatments, and the soluble protein content was significantly higher than the control (see Table 6).

Table 6. Effect of different concentrations of paclobutrazol on soluble protein content of Cymbidium hybridum

| Treatment (mg/L) | Soluble protein content (mg/g) | Significant level α=0.05 | α=0.01 |
|-----------------|-------------------------------|--------------------------|--------|
| E (400.00)      | 0.1290±0.0083                 | a                        | A      |
| D (300.00)      | 0.1275±0.0050                 | a                        | A      |
| C (200.00)      | 0.1183±0.0073                 | ab                       | A      |
| B (100.00)      | 0.1100±0.0123                 | ab                       | A      |
| A (50.00)       | 0.1007±0.0020                 | b                        | A      |
| CK (0.00)       | 0.1005±0.0016                 | b                        | A      |

Note: Due to the small difference in the soluble protein content of Cymbidium hybridum, the two decimals cannot be compared, so four decimal places are reserved to reflect the difference.

4. Conclusions and discussion

4.1. Conclusion

Paclobutrazol is a common plant growth regulator that inhibits the synthesis of gibberellin in plants [11] and plant vegetative growth [12], and plays a role in the height of dwarf plants. It promotes tailoring, promotes the formation of flower bud differentiation, enhances resistance, delays aging and other effects [13-14]. According to the test results and data analysis, the following conclusions can be drawn: 1 after spraying paclobutrazol, the number of flower buds in each treatment of Cymbidium hybridum was higher than that in the control group, and the highest number of flower buds was the highest in 300mg/L treatment. 2 Paclobutrazol had obvious stunting effect on Cymbidium hybridum. The increase of plant height in each concentration treatment was lower than that of the control treatment, and the increase of 400mg/L treatment plant height was the lowest, 0.57cm. The variety “Yuanbao” used in this experiment has the characteristics of tall plant type and short arrowhead. The reduction of plant height enhances its ornamental value and is conducive to transportation. 3SOD, POD and CAT are the main enzymes of the enzyme system of active oxygen scavenging mechanism in plants. SOD and POD can scavenge reactive oxygen free radicals in plant cells, and CAT can eliminate H2O2 damage to cells [15]. The results showed that the activities of SOD and POD showed low concentration promotion and high concentration inhibition, while the CAT activity and soluble
protein content of each concentration were higher than the control treatment. Considering the number of flower buds, plant height and antioxidant system, 300mg/L is the best concentration obtained in this experiment.

4.2. Discussion
Paclobutrazol promotes the differentiation of buds and the height of the dwarf plant height, and enhances the antioxidant capacity and enhances its resistance to stress, which is conducive to the production and transportation of Cymbidium hybrid, further improving the commerciality and increasing economic benefits. The test basically got the best concentration, but there are still many concentrations to be solved. The concentration of CAT could promote the differentiation of flower buds, and the activity of CAT was higher than that of the control. It showed no inhibition. The concentration should be increased at the highest concentration of 400mg/L, and whether the high concentration is different for flower bud differentiation and antioxidant Systemic enzyme activity has an inhibitory effect.

The content of soluble protein was not significant at the level of $\alpha=0.01$. The difference between the concentrations should be further expanded to increase the highest concentration. The difference of the existing concentration is 50mg/L and 100mg, which can expand the difference in concentration and explore different concentrations. Whether there is a significant difference between the dissolved protein contents and the optimal concentration is obtained.

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