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Impact of Different Cultivation Substrates on the Growth of *Cymbidium goeringii*

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Abstract [**Objectives**] The paper was to explore the impact of different cultivation substrates on the growth of *Cymbidium goeringii*. [**Methods**] The impact of 13 distinct cultivation substrates on the growth of *C. goeringii* was examined using *C. goeringii* as the test material. [**Results**] The combination of burning red clay particles (15%), No.4 pine bark (15%), No.3 pine bark (60%), and perlite (10%), as well as the mixture of burning red clay particles (20%), No.4 pine bark (15%), No.3 pine bark (55%), and perlite (10%), yielded superior results. These formulations resulted in an increased number of new roots in *C. goeringii*, a reduction in the incidence of decayed roots, and enhancements in the number of tillers, new leaves, and flowers. [**Conclusions**] The selection of substrates may serve as a valuable reference for the cultivation of *C. goeringii*.

Key words *Cymbidium goeringii*; Substrate; Growth

1 Introduction

Chinese Cymbidium pertains to the terrestrial species within the *Cymbidium* genus of the Orchidaceae family. This group primarily encompasses seven major categories: *Cymbidium goeringii*, *C. faberi*, *C. ensifolium*, *C. sinense*, *C. longibracteatum*, *C. lianpan*, and *C. kanran*[1]. Chinese Cymbidium is recognized as one of the top ten traditional flowers in China. It has undergone significant transformations over time and has been shaped by historical developments, resulting in a rich cultural heritage. Additionally, this flower possesses considerable ornamental and economic value, attributed to its distinctive fragrance, aesthetic form, and overall beauty[2-3]. The global annual trade volume of flowers reaches approximately 20 billion dollars, with orchids representing 10% of this total. Orchids serve as a significant local specialty flower and constitute a major export product for Fujian Province. Zhangzhou, located in Fujian Province, is recognized as the "hometown of Chinese orchids". Nanjing County alone is home to over 2 000 professionals engaged in orchid cultivation, covering an area of 450 hm^2. In recent years, the annual output value of this industry has reached 1.5 billion yuan, with sales exceeding 800 million yuan. Consequently, Zhangzhou has established itself as one of the six major centers for flower production and distribution in China. Chinese Cymbidium is a distinctive flower that plays a crucial role in supporting and promoting the industrialization of the flower industry, as outlined in the *Flower Industry Development Plan of Fujian Province (2011 – 2020)* issued by the Fujian Provincial Government. *C. goeringii*, recognized as one of the earliest cultivated varieties of Chinese Cymbidium, is distinguished by its striking morphology and fragrant flower. This species is highly regarded for its delicate fragrance and aesthetically pleasing floral arrangement. From the current perspective, the cultivation technology of *C. goeringii* remains insufficiently developed, and the level of commercialization is relatively low. It is of considerable importance to expedite the industrialization of *C. goeringii* by enhancing research on cultivation techniques and improving the quality of the final products derived from *C. goeringii*. The cultivation substrate plays a critical role in the growth of *C. goeringii*[4-5], as it significantly influences the root system and survival rate of the species. Conducting a systematic screening and proportioning of the cultivation substrate for *C. goeringii* is beneficial for enhancing its reproduction rate during production. Furthermore, optimizing the substrate can improve the quality of *C. goeringii* pots and flowers, thereby increasing market competitiveness. This, in turn, can lead to greater benefits and income for plantation households or enterprises, while also promoting the large-scale and industrialized development of *C. goeringii*.

2 Materials and methods

2.1 Materials The test materials consisted of *C. goeringii* seedlings characterized by healthy and intact root systems, with plant heights ranging from approximately 12 to 18 cm.

2.2 Methods The experimental site was established within the greenhouse of Zhangzhou Baiguan Guolan Co., Ltd., where a standardized approach to water and fertilizer management was implemented for the *C. goeringii* specimens under investigation. The *C. goeringii* was separated into individual plants. Following the removal of decayed and dead roots, the plants were immersed in a 40% solution of thiophanate-methyl or an 800-fold dilution of chlorothalonil for a duration of 1 h. Subsequently, they were washed and dried until the roots appeared white and soft. The roots of *C. goeringii* were then buried in the substrate to a depth of approximately 5 cm. The root substrate was subsequently compacted and irrigated. Pests and diseases were managed through the application of prochloraz, diluted at a ratio of 1 : 1 500, administered biweekly, and abamectin · acetamiprid, diluted at a ratio of 1 : 2 000, applied monthly. A comparative exploration was con-

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ducted using various types and ratios of cultivation substrates, as presented in Table 1. The pore sizes of No. 3 pine bark and No. 4 pine bark were found to be different, with No. 3 pine bark exhibiting a pore size range of 0.6 – 0.8 cm, while No. 4 pine bark demonstrated a pore size range of 0.8 – 1.2 cm. The substrate must be thoroughly decomposed and homogenized, while the stones should be cleaned and sterilized prior to utilization. We quantified the number of roots, tillers, leaves, and the first onset of flowering, and conducted a comparative analysis of the effects of various substrate ratios on the growth of *C. goeringii*. The analysis aimed to identify the most suitable substrate types and ratios for the cultivation of *C. goeringii*, thereby establishing a robust foundation for the efficient and high-quality facility cultivation of this species.

Table 1 Different substrate ratios %

No. of substrate	Peanut shell	Crushed granite	Common pine bark	Perlite	Burning red clay particles	No. 4 pine bark	No. 3 pine bark
1	60	40	0	0	0	0	0
2	70	30	0	0	0	0	0
3	30	40	30	0	0	0	0
4	0	40	40	20	0	0	0
5	0	0	0	10	15	15	60
6	0	0	0	10	20	15	55
7	0	0	0	10	30	10	50
8	0	0	0	10	40	10	40
9	0	0	0	10	50	0	40
10	0	0	0	10	60	0	30
11	0	0	0	10	70	0	20
12	0	0	0	10	80	0	10
13	0	0	0	10	90	0	0

2.3 Data processing The data were analyzed utilizing statistical software, including Excel 2003 and SPSS.

3 Results and analysis

3.1 Impact of different cultivation substrates on the growth of *C. goeringii* roots As illustrated in Table 2, treatment 5 exhibited the highest number of new roots, averaging 4.6 roots/pot, followed closely by treatment 6, which recorded an average of 4.2 roots/pot. A highly significant difference in the number of new roots was observed between treatment 5 and the other treatments. Conversely, treatment 13 demonstrated the lowest number of new roots, with an average of only 2.3 roots/pot. The highest incidence of new root formation was observed in treatment 6, followed closely by treatment 8, with no statistically significant difference between these two treatments. Additionally, treatment 7 exhibited a similar trend, showing no significant difference when compared to treatment 5. The highest number of decayed roots was observed in treatment 13, which exhibited an average of 2.2 roots/pot. In contrast, the lowest number was recorded in treatments 5 and 4, with averages of 0.8 and 0.9 roots/pot, respectively. The highest incidence of decayed roots was observed in treatment 13, while the lowest incidence was recorded in treatment 5. This difference was found to be highly significant when compared to all other treatments. The analysis of the four indicators indicated that treatment 5 and treatment 6 exhibited superior performance regarding the number of new roots, the incidence of new root formation, the number of decayed roots, and the incidence of decayed roots. Specifically, the combination of burning red clay particles (15%), No. 4 pine bark (15%), No. 3 pine bark (60%), and perlite (10%), as well as the mixture of burning red clay particles (20%), No. 4 pine bark (15%), No. 3 pine bark (55%), and perlite (10%), produced more favorable outcomes.

Table 2 Impact of different cultivation substrates on the growth of *Cymbidium goeringii* roots

No. of substrate	Number of new roots roots/pot	Incidence of new root formation	Number of decayed roots roots/pot	Incidence of decayed roots
1	2.70 eE	0.17 iG	1.80 bcBC	0.18 cdBCD
2	2.80 eE	0.26 fgF	1.50 defCDE	0.17 deCDE
3	3.30 dD	0.39 eE	1.60 cdeCDE	0.15 efDEF
4	4.10 bB	0.42 dDE	0.90 hiH	0.19 bcdBC
5	4.60 aA	0.45 cCD	0.80 iH	0.05 iH
6	4.20 bB	0.51 aA	1.00 hiGH	0.09 hG
7	3.90 bBC	0.47 bcBC	1.10 ghFGH	0.13 fgF
8	3.60 cCD	0.49 abAB	1.30 fgEFG	0.12 gFG
9	3.50 cdD	0.25 gF	1.40 efDEF	0.14 fgEF
10	3.30 dD	0.28 fF	1.60 cdeCDE	0.17 deCDE
11	2.80 eE	0.26 fgF	1.70 cdBCD	0.21 bB
12	2.60 eEF	0.20 hG	2.00 abAB	0.20 bcBC
13	2.30 fF	0.19 hiG	2.20 aA	0.25 aA

NOTE Different letters in the same column signify a statistically significant difference. The same below.

3.2 Impact of different cultivation substrates on tillering and leaf growth of *C. goeringii* As presented in Table 3, treatment 5 exhibited the highest number of tillers, followed by treatments 6, 7, and 8, which recorded 4 and 3.6 tillers/pot, respectively. Conversely, treatments 1, 2, and 13 demonstrated the lowest number of tillers, with an average of 3 tillers/pot. A highly significant difference was observed between treatment 5 and the other treatments. However, no significant differences were noted among treatments 4, 6, 7, 8, 9, 10, and 11. Therefore, the impact of various substrates on the number of tillers in *C. goeringii* exhibited minimal variation, with the exception of treatment 5, which demonstrated superior results. Treatment 6 yielded the highest number of new leaves, followed closely by treatment 5, which produced 17.3 and 17 leaves/pot, respectively. These results indicated highly significant differences when compared to the other treatments.

3.3 Impact of different cultivation substrates on the flowering of *C. goeringii* As illustrated in Table 4, various substrates influenced the flowering frequency of *C. goeringii*. Treatment 5 yielded the highest number of flowers, with an average of 2.8 flowers/pot. Treatments 6 and 7 exhibited the second highest number of flowers, averaging 2.7 flowers/pot. There were no statistically significant differences observed between treatments 6, 7, and 8. Similarly, treatments 8, 9, 10, and 11 did not demonstrate

Table 3 Impact of different cultivation substrates on tillering and leaf growth of *Cymbidium goeringii*

No. of substrate	Number of tillers tillers/pot	Number of new leaves leaves/pot
1	3.00 eD	5.80 gG
2	3.00 eD	6.20 gG
3	3.20 deCD	8.30 fF
4	3.40 bcdBC	15.00 bBC
5	4.00 aA	17.00 aA
6	3.60 bB	17.30 aA
7	3.60 bB	13.80 cdCD
8	3.60 bB	13.20 dD
9	3.40 bcdBC	15.50 bB
10	3.50 bcBC	14.80 bcBC
11	3.50 bcBC	14.80 bcBC
12	3.30 cdBCD	10.40 eE
13	3.00 eD	6.40 gG

significant differences among one another. Conversely, treatment 1 exhibited the lowest number of flowers, with an average of 1.9 flowers/pot. This result did not demonstrate a statistically significant difference when compared to treatments 2, 3, and 13. Under uniform management conditions, *C. goeringii* exhibited a consistent flowering period, indicating that the substrate has a minimal effect on the flowering period of this species.

Table 4 Impact of different cultivation substrates on the flowering of *Cymbidium goeringii*

No. of substrate	Number of flowers flowers/pot	First onset of flowering
1	1.90 hG	January 11
2	2.00 ghFG	January 12
3	2.10 fghEFG	January 10
4	2.60 abcABC	January 11
5	2.80 aA	January 9
6	2.70 abAB	January 10
7	2.70 abAB	January 11
8	2.50 bcdABCD	January 11
9	2.40 cdeBCDE	January 10
10	2.30 defCDEF	January 11
11	2.20 defCDEF	January 11
12	2.20 efgDEFG	January 12
13	2.10 fghEFG	January 13

4 Discussion

Currently, the substrates utilized for the cultivation of *C. goeringii* primarily consist of peanut shell, pine bark, and crushed granite. The project team observed during the preliminary testing phase that the incorporation of burned red clay particles yielded superior results. Additionally, perlite demonstrated effective heat retention properties, capable of increasing temperatures by 1 – 2 ℃ during the winter months, thereby facilitating the emergence of *C. goeringii* from its dormant state. The substrate is composed of pine bark, which is rich in essential nutrients such as hydrogen (H), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg). It exhibits a stable pH and low salt content, making it an effective cultivation substrate that has demonstrated superior results in various studies[6-7]. The cultivation process of *C. goeringii* can be enhanced through the utilization of specific substrate compositions. Two effective mixtures include: (i) 15% burning red clay particles, 15% No.4 pine bark, 60% No.3 pine bark, and 10% perlite; and (ii) 20% burning red clay particles, 15% No.4 pine bark, 55% No.3 pine bark, and 10% perlite. When combined with appropriate humidity management, these substrate formulations significantly improve the survival rate of *C. goeringii*, enhance the quality of the plants, and increase the neatness of the seedlings. Additionally, these mixtures contribute to a reduced incidence of decayed root, while maintaining lower cost, good air permeability, and effective fertilizer retention capacity, thereby demonstrating superiority over alternative treatments. The physicochemical properties of these substrates may be conducive to the development of *C. goeringii* root system, thereby facilitating the growth of the species. However, the impact of various cultivation substrates on the root vigor of *C. goeringii* plants requires further investigation.

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