Green Prevention and Control of *Dendrobium Officinale* Diseases Based on Green Irrigation

Jinxia Yang[1], Yaoyao Zhou[1], Paras Shah[1], Jiaxin Wang[2], Baozhu Du[1,3], Yuyin Tan[1], Yuanqi Wang[4] and Lei Wang[1,3,*]

[1] College of Information and Communication Engineering, State Key Lab of Marine Resource Utilisation in South China Sea, Hainan University, Haikou 570228, China
[2] Hainan Shengrong Biotechnology Co., Ltd, Shishan Town, Xiuying District, Haikou 570300, China
[3] Sanya Research Institute of Hainan University, No. 7, Daxue Road, Yazhou District, Sanya 572024, China
[4] ShiShangShanShui (Hainan) Eco-agriculture Co., Ltd., No. 7, Daxue Road, Yazhou District, Sanya 572024, China

Abstract. Dendrobium, a medicinal and food plant of high medicinal and economic value, is being cultivated in various regions across China. Based on years of cultivation experience, we explored effective cultivation measures for Dendrobium and analyzed the role of green prevention and control technologies in its cultivation. The experiment demonstrated that the green prevention and control system effectively manages Dendrobium diseases. This provides foundational data for the future application of biopesticides in Dendrobium cultivation and facilitates the integration of green irrigation technology with biopesticide practices. Ultimately, this approach aims to reduce the use of chemical pesticides and minimize environmental pollution in Dendrobium cultivation, particularly in volcanic regions.

1. Preface

Dendrobium belongs to the orchid family and is known for its rich medicinal properties as well as its great ornamental value[1]. Wild Dendrobium typically grows on the trunks of forest plants, in shaded understory areas, and on rocky surfaces in valleys[2]. This habitat is ideal because its characteristic aerial roots can absorb moisture from the air, help anchor the plant to its supports, and contribute to photosynthesis and respiration[3]. Due to its high value, Dendrobium has long suffered from over-collection, leading to a significant scarcity of wild resources. To reduce reliance on wild stocks and meet the growing market demand for Dendrobium, artificial cultivation technology has been developed. This approach enables the efficient production of Dendrobium through scientific planting and management practices.

As the scale of industrialized production of Dendrobium expands, the incidence of diseases is increasingly exacerbated. These diseases are primarily caused by three types of pathogens: fungi, bacteria, and viruses[4]. Traditional pest control methods have relied heavily on chemical pesticides, which address the problem to some extent but also lead to issues such as pesticide residues, drug resistance, and potential environmental pollution.

With the growing emphasis on green agriculture and sustainable development, traditional prevention and control methods are proving inadequate to meet the demands of modern agriculture. Consequently, exploring new pest prevention and control technologies has become a focal point in current agricultural research.

In this project, we utilize green irrigation technology based on biological microwave water treatment to enhance water quality. This method alters the molecular structure and biological activity of water, promoting the growth of beneficial organisms and reducing the occurrence of diseases. The integration of bio-microwave water treatment technology into Dendrobium cultivation aims to address the challenges posed by conventional prevention and control methods while improving both the quality and yield of Dendrobium. By enhancing irrigation water quality through this innovative technology, we can effectively reduce pests and diseases at their source.

2. Dendrobium disease types

The main diseases of Dendrobium are soft rot, black spot, anthracnose, sheath rot, root rot, leaf rust, leaf blight and so on.

1) Soft rot: mainly caused by Dickeya fangzhongdai [5]. This disease is likely to occur in high-temperature and high-humidity environments. Initially, water-soaked spots, similar in size to green beans, appear on the leaves. These spots are initially yellow and characterized by water stains. As the disease progresses, these spots gradually become black and sunken. Eventually, the entire leaf rots and falls off, resulting in the death of the plant.

2) Black spot disease: caused by fungi of the genus Phyllosticta [6]. It usually occurs in late spring and early summer (March to May). Small light brown spots appear on the new leaves, surrounded by a yellow halo that spreads into larger round spots. In severe cases, the spots

* Corresponding author: wanglei@hainanu.edu.cn

will merge together on the leaves. Eventually, the entire leaf blade will turn yellow and fall off.

3) Anthracnose: Caused by Colletotrichum karstii[7]. January to May is the main period of incidence, while June to September is the peak period. Plants infested with mealybugs are more susceptible to the disease. The disease is primarily characterized by the appearance of greenish dots on the leaves, which gradually expand to form dark brown or black spots surrounded by black rings that spread from the inside to the outside. In severe cases, stems and new plants can also be infected.

4) Root rot: caused by Fusarium spp. fungi [8]. The pathogen survives the winter in diseased plant tissue or cultivation substrate, waiting for the right conditions to reactivate. If circular or elongated brown spots are found on rhizomes, root tips, or other parts of the plant, and these spots show significant signs of tissue edema and decay, along with the presence of light brown material, it is certain that the plant has been infected with root rot.

5) Physiological diseases: Diseases caused by abiotic agents include high temperatures, cold damage, leaf burn, chemical damage, nutritional disorders, and other factors that may lead to physiological diseases in Dendrobium. These diseases usually manifest as leaf rust, leaf blight, and other symptoms. They are characterized by leaf spotting, wilting, yellowing, and sunburn.

The current green prevention and control technologies for Dendrobium primarily focus on biological and physical control methods. Biological control of Dendrobium diseases mainly involves the use of biopesticides and timely intervention strategies. Some cultivation bases have introduced microorganisms such as Streptomyces and Mycobacterium to inhibit the growth of pathogenic bacteria. These beneficial microorganisms suppress pathogens by producing antibiotics, lysozymes, and other antimicrobial substances.

In Dendrobium growing regions, isolation measures such as insect nets and shade nets are utilized to reduce the incidence of pests and diseases. Additionally, high-temperature sterilization and low-temperature treatments for seeds and planting materials help minimize the spread of pathogens. Beyond traditional physical control methods, some growers have adopted innovative techniques such as electrostatic spraying and ultraviolet lamps, which effectively control pests and pathogens while minimizing environmental impact[9].

3. Material and Methods

3.1. Experimental materials

Dendrobium (domesticated seedlings) provided by Hainan Zhongliheng Li Pharmaceutical Science and Technology Co., Ltd, in line with the normal leaf color, no contamination, no mechanical damage, each plant has more than 3 roots, each root length of more than 3cm, the seedling height was 5-6cm having approximately 0.3cm diameter and had vigorous growth. The irrigation water source was designed to sterilize and disinfect water for the Dendrobium officinale on behalf of the disease prevention method.

Using sterilized bark as the culture substrate for Dendrobium, due to the unique porous structure of the bark, it not only ensures the supply of oxygen needed by the roots, effectively preventing root rot, but also retains just the right amount of moisture, avoiding over-wetting or over-drying. The nutrients released during its slow decomposition process provide a continuous supply of nutrients for Dendrobium, while naturally regulating the pH balance, creating a growing environment that is both economical and environmentally friendly. It lays a solid foundation for Dendrobium to thrive.

Rather than the use of traditional methods like harmful chemical drug disinfection and treatment for disease prevention, the project is directly to the biological microwave sterilizer out of the sterilized water used for irrigation, this method is safe and effective and can improve the Dendrobium officinale immunity, which in turn improves the quality of quality and yield. In addition, the shed is ventilated, breathable, and insulated with sunshade nets, insect nets are installed around the perimeter, and the shed is equipped with seedbeds, fans, and a certain heating and spraying system to promote the growth of Dendrobium officinale in a higher quality.

3.2. Biological microwave water treatment

Bioelectromagnetic wave (bio-microwave) is a kind of electromagnetic wave that exists in living organisms with very small power. Similar to natural electromagnetic waves, they have specific wavelengths and frequencies that can trigger resonance phenomena. If the externally applied bio-microwave matches the frequency of the electromagnetic wave emitted by the plant cell itself, resonance occurs, which in turn transmits energy and information. Water is the most abundant molecule in living organisms and has strong polarity, which can effectively absorb microwave energy. So we use water as the carrier of biological microwave. Bio-microwave energy water machine converts ordinary agricultural water into small molecule group water with specific energy and biological activity. Using a specific frequency and energy field to treat the water, these treated water can resonate with the bioelectric field of plant cells, which improves plant metabolism, enhances plant cell vitality and accelerates plant growth. Bio-microwave energy water machine also uses ultraviolet sterilization technology. UV sterilization technology refers to the use of specific wavelengths of ultraviolet light to destroy the DNA or RNA of microorganisms, thus achieving the effect of sterilization. This technology can effectively kill bacteria, viruses and other microorganisms, and does not produce chemical residues, which is a physical sterilization method.

Bio-microwave water treatment technology, the deep integration of electromagnetic biology and water treatment science, not only significantly improves the biological activity of water and promotes the healthy growth of plants, but also ensures the purity of water through ultraviolet sterilization technology, which provides a brand-new perspective and possibilities for the agricultural field and ecological research. The innovative application of this technology not only promotes the green revolution in the field of agriculture and ecology, but also opens up a new path for the sustainable development of agriculture in the future, which has important academic value and application prospects in the fields of plant physiology, water resource management and ecological environmental protection.

The application of this technology not only provides a green and efficient solution for modern agriculture, but also opens up new horizons for ecological research, water resource management and ecological environmental protection. The combination of biological microwave and ultraviolet sterilization technology not only optimizes the plant growth environment and improves crop yield and quality, but also provides innovative ideas for the purification and recycling of water resources and promotes the development of ecological balance and sustainable agriculture. The in-depth research and application of this technology will have a profound impact on agricultural modernization, ecological environmental protection and global food security, reflecting the important role of science and technology in promoting the sustainable development of the agricultural and ecological fields.

3.3. Experimental design

The technology used in this project is biological microwave water treatment technology, guided by the theory of bioelectromagnetism. First, the water solution formed by a specific magnetic field is mixed with ozone for irrigation disinfection and air disinfection, effectively sterilizing and inhibiting bacteria. Then, through intelligent control technology and the integration of compound probiotics, it can regulate the soil pH value, maintain a beneficial soil flora to inhibit bacteria, promote plant growth, and restore the soil ecology. This technology and program will be widely used in the planting and breeding industry to achieve a combination of planting and breeding, as well as waste resource utilization and environmental purification, thereby realizing the goal of ecological recycling agriculture.

The biological microwave water treatment process is shown in Fig 1 A high-efficiency filtration system is employed to remove suspended particles and other impurities from the water, followed by a magnetization device that enhances the energy between water molecules and improves their activity. Ultrasonic molecular oscillation technology is used to disperse the water molecules, forming smaller water molecules that enhance permeability and plant absorbability. On this basis, the water samples are further treated with ozone ionization to generate water rich in negative ions, which is conducive to plant growth and development. Finally, high-frequency oscillation treatment is applied to achieve uniform spraying of the treated ionized water.

The selected two acres of experimental field were divided into two blocks, A and B. The layout of the experimental field was meticulously planned. Group A was the experimental group, consisting of 18 groups with 4 columns in each group, where approximately 40 frames of Dendrobiums were placed in each column. Group B was the control group, containing 16 groups of Dendrobiums, also with 4 columns in each group, and approximately 42 frames of Dendrobiums were placed in each column. Each basket was 43 cm long and43 cm wide, ensuring that the two fields were similar in terms of type, fertility, light, and other conditions.

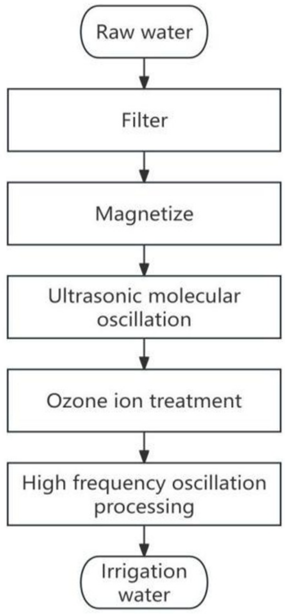

Fig 1. Water Treatment Steps.

To prepare bark as a substrate for Dendrobium planting, bark of the same type and thickness was selected, torn into 5-10 cm pieces, and sterilized. In the experimental field, the bark was spread evenly on the planting frame, and the Dendrobium seedlings were planted uniformly to ensure that the planting density and growth conditions of each acre of land were as consistent as possible. The Dendrobium seedlings were not exposed to air during the planting process, and the seedlings in Group A were irrigated with biomicrowave water, while Group B was irrigated with ordinary agricultural water and fertilizers used in standard dosages.

3.4. Data recording and analysis

In this experiment, about 2880 frames of Dendrobium in group A and 2688 frames of Dendrobium in group B. There was a slight difference in the number of frames of Dendrobium in group A and group B. The results of the experiment were evaluated using the incidence rate (Eq. (1))

$$D = \left(\frac{n}{N}\right) \times 100\% \tag{1}$$

Here, parameter D represents the incidence rate, parameter n represents the number of infected

Dendrobium frames, and N represents the total number of *Dendrobium* frames.

Root rot, warp rot, and soft rot are common pests and diseases in *Dendrobium officinale* cultivation, which often affect the growth of *Dendrobium officinale*, causing official death of *Dendrobium officinale* plants in severe cases and significantly reducing the yield of *Dendrobium* V Green control system and chemical pesticide spraying can improve the effectiveness of *Dendrobium officinale* disease control and reduce the incidence of *Dendrobium officinale* diseases. However, the effectiveness of the combination of biological control and low-toxicity chemical pesticide control in controlling maize pests and diseases is still worth exploring. In this experiment,efficacy of different treatments against Dendrobium diseases, as detailed in Table 1 below. All the experimental treatments of *Dendrobium officinale* were comparable with the control group, in which the rate of diseased plants (root rot, soft rot, warp rot) of *Dendrobium officinale* in the treatment group of green control + low-toxicity chemical pesticide control was reduced by 0.049%, 0.005%, and 0.256% in July compared with that of the control group, respectively, and the rate of root rot and soft rot was increased by 0.550%, and 0.252% in August compared with that of the control group, which was significantly higher than that of the control group, and warp rot was reduced by 0.037%. rot decreased by 0.037%, which was lower than the control group, and the preventive effect was good.

Table 1. Efficacy of different treatments against *Dendrobium* diseases.

Group		Disease Rate		
		Root Rot (%)	Soft Rot (%)	Sheath ROT (%)
Jul	A	**0.397**	**0.036**	**1.157**
	B	0.446	0.041	1.413
Aug	A	1.256	1.078	**0.558**
	B	**0.706**	**0.826**	0.595

4. Summary and Discussion

The results of this experiment show that Dendrobium officinale was subjected to different treatments with different effects on disease control, and performed better in the July green control + low-toxicity chemical pesticide control treatment group; and better in the August low-toxicity chemical pesticide treatment group. Although the overall effect is comparable, in the test group of chemical pesticides to reduce 60%, green control has a good value of popularisation and application. Only by doing a good job in the efficient and high-quality cultivation management and disease control of Dendrobium officinale, can we ensure the rapid growth of Dendrobium officinale, improve its yield, and guarantee its good growth status. Dendrobium green prevention and control should be implemented by the principle of prevention as the mainstay, the integrated use of physical, biological, and chemical ways to strengthen the regulation of diseases and to create an ecological environment conducive to the growth of Dendrobium. At the same time, we should also adhere to the requirements of scientific rigor, the rational use of low-toxicity and low-residue chemical pesticides, focusing on the protection of natural enemies, to ensure the safety of planting Dendrobium officinale. In addition, the time of drug application in this experiment is in the pre-growth period of Dendrobium officinale, the occurrence of disease in Dendrobium officinale different growth period law may have some differences, can be further experimental research, for the above green control system to promote the use of providing a richer theoretical basis.

The application of bio-microwave water treatment technology significantly reduces the incidence of disease in Dendrobium. By applying bio-microwave treatment to the irrigation water, it can not only effectively prevent the occurrence of diseases, but also improve the immunity of Dendrobium, thus reducing the possibility of subsequent diseases. In addition, the bio-microwave treatment can improve the quality of the water, making it easier to be absorbed by the plants and helping to promote the healthy growth of Dendrobium. From the perspective of sustainable development, bio-microwave water treatment technology not only reduces the use of chemical pesticides and the risk of environmental pollution, but also improves the yield and quality of Dendrobium.

In this experiment, the strategy of combining biological control with low-toxicity chemical pesticides shows great promise for managing pests and diseases in Dendrobium officinale. Through ongoing research and practice, it is anticipated that this approach will deliver an efficient, environmentally friendly, and sustainable pest control technology system for the Dendrobium officinale industry in China.

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