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Screening of biocontrol microorganisms in tea garden soil and their inhibition mechanism against root rot of tea tree

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Abstract Root rot of tea tree is one of the major diseases affecting tea production and poses a serious threat to tea yield and quality. In order to investigate the screening of biocontrol microorganisms in tea plantation soil and their inhibitory effects on tea root rot, this study was conducted to isolate and characterize biocontrol microorganisms from tea plantation soil, and to screen Z-1 strain and evaluate its inhibitory effects on tea root rot. The study examined the inhibitory ability of Z-1 strain against the pathogenic fungi of tea tree root rot using plate standoff assay and found that its inhibition rate was as high as 42.9%. Further field trials showed that the Z-1 strain had a positive effect on tea tree growth, with root length, plant height and fresh weight showing significant improvement. Compared with traditional chemical control methods, Z-1 strain showed comparable control effects and lower toxicity. The study suggests that Z-1 strain has strong potential for disease resistance and can provide new ideas and methods for green control of root rot of tea tree.

Index Terms root rot of tea tree, biocontrol microorganisms, Z-1 strain, inhibition, green control, plate standoff experiment

I. Introduction

As one of the important economic crops, the yield and quality of tea tree are directly related to the economic income of local farmers and the development of tea industry. However, the frequent occurrence of tea tree diseases is a serious threat to the safety of tea production [1]. Although the traditional chemical pesticide control methods are effective in the short term, the long-term use of large quantities will lead to pesticide residues and environmental pollution and other problems [2], [3]. Therefore, exploring new green prevention and control technologies, especially the application of biocontrol microorganisms, is of great significance to guarantee the quality of tea and promote the sustainable development of tea plantations [4].

Tea root rot is the most common and serious disease in tea areas, and it is often not easy to be detected in the early stage of its infestation due to the hidden site of tea root rot [5]. With the development of the disease, the root system of the tea tree rots and blackens, and some of the fibrous roots fall off and become necrotic, which can lead to the death of large areas of tea plantations in severe cases [6], [7]. In production practice, chemical control of tea root rot is easy to kill non-target organisms, leading to the reduction of microorganisms in the tea garden, which in turn disrupts the balance of the ecosystem in the tea garden [8]-[10]. Compared with chemical control, biological control measures that utilize biological agents, including living organisms or their metabolites, to kill harmful organisms are less harmful to the environment and have the advantages of being sustainable and environmentally friendly [11], [12]. Therefore, it is important to screen and identify the microorganisms in the inter-root soil of diseased plants that have the best antagonistic effect on the pathogen, and to analyze their growth characteristics as well as the inhibition mechanism of root rot of tea tree, with a view to providing a basis for the biological control of root rot of tea tree.

In this study, we first isolated and screened birth control microorganisms from the soil of tea plantations, and evaluated their inhibitory effects on the root rot pathogens of tea trees through plate standoff experiments. After screening the strains with significant disease resistance, their control effects were verified through field trials and analyzed in comparison with traditional chemical control methods. In addition, the mechanism of biocontrol microorganisms in improving the growth of tea tree and enhancing disease resistance was explored to provide scientific basis for the green control of root rot of tea tree.

II. Discussion on the trend and suppression mechanism of tea tree diseases

II. A. Root rot of tea tree and its control

II. A. 1) Tea tree root rot and means of control

Root diseases refer to the root diseases of tea tree caused by pathogens. There are more than 10 kinds of tea root diseases occurring in China, among which the common ones are red root rot, brown root rot, purple feather disease, as well as tea seedling white silk disease and tea seedling root-knot nematode disease occurring in young tea trees [13].

Tea red root rot stretches of spores have a long incubation period, up to 10 years, in the environment when the temperature and humidity conditions are suitable, the germination of mycelium through the wound infection of tea tree roots, can be transmitted through root contact or wind and rain transmission. Winter mycelium or mycelium in the tea garden soil or tea tree root system overwintering. In the high water table and sloppy management of the old tea plantations are prone to disease, infected plant leaves sparse, part of the withering and dying; root necks have flat ambrosia. Roots have red or white leathery branching mycelium, and later become dark red or purple. Prevention and control methods: (1) dig out the diseased plants, spray 75% thirteen morpholine emulsion to disinfect the soil, (2) dig a 15-20cm deep circular ditch around the base of the diseased plant, spray 75% thirteen morpholine emulsion into the ditch, mulch, repeat the treatment once after half a year, (3) for the plots with a high water table, open a ditch and drain the water to reduce the soil moisture.

Tea brown root rot generally occurs in poor drainage or high water table in wet plots. The surface of the diseased root has a brown and thin, brittle mycelium, and rust-colored fluffy mycelium; xylem dry rot, white or brown mycelium between the phloem and xylem of the root section. The upper leaves of the diseased plant turn yellow. Control methods can be referred to tea red root rot control.

Tea purple feather disease occurs in the high temperature and rainy spring and summer or summer and fall, in the soil moisture is high or passing through the dry soil is easy to develop. The disease can survive in the soil for many years and spread with the movement of groundwater or underground pest activities. The surface of the diseased root has purplish-red mycelium, and later the root becomes blackish-brown or yellowish-brown, with a layer of purplish-red velvet forming on the root neck, and the cortex rotting and turning black and peeling off. The above ground branches and leaves of the diseased plant are yellow and even die. Prevention and control methods: (1) tea seedling treatment: found tea seedlings with disease, available 50% carbendazim wettable powder 1000 times water solution soaked for 30 minutes after transplanting, (2) with 70% quintozene wettable powder to disinfect the soil (2.5kg / mu), or formalin 30 times solution to disinfect the soil, (3) for the adult onset of the disease of the tea plantation with 50% carbendazim wettable powder 1000 times solution watering the root and neck. Roots and necks.

Tea seedlings white silk disease germ in dry soil incubation period of up to 5-6 years, at the turn of spring and summer temperature and humidity when the nucleus sprout mycelium, spread along the soil gap or with the groundwater or rainwater transmission, June-August for the peak of the incidence of the disease; low-lying, sticky soil, poor drainage conditions of the plots of the onset of serious; early in the root and neck of the brown spot, the surface has a white silky material, the root and neck of the root and neck of the root. The surface has white sericeous material, followed by the formation of a circle of white sericeous fungal film around the rhizome; later in the root to form granular nuclei, like rapeseed; root cortex rot, affecting water and nutrient absorption and transportation, ultimately leading to the bitter taste of the leaves off, until the death of the whole plant. Prevention and control methods: (1) open ditch drainage, reduce soil moisture, enhance soil permeability, (2) cuttings before using 70% quintozene wettable powder to disinfect the nursery soil (2-2.5kg/mu), (3) with 50% carbendazim wettable powder 500 times water solution or 50% metribuzin wettable powder 500 times water solution watering.

Tea seedling root-knot nematode disease is a disease caused by the parasitization of southern root-knot nematode or peanut root-knot nematode. Eggs and female adults in the root tumor or larvae in the soil overwintering; overwintering eggs in the following year when the temperature rises to 10 ℃ above the hatching out of the larvae, the second instar larvae with the spread of water infestation of the root cortex into the roots, secretion of irritants caused by the root cells to expand to become a root knot. Diseased roots have yellow-brown rhizomes, a number of achenes gathered together, the root tissue is lax and easy to break; above ground leaves yellow, severe leaf loss or even plant death. Prevention and control methods: (1) deep turning and solarization of nursery land in summer high temperature, when possible, the surface can be covered with mulch, so that the soil temperature rises, killing nematodes, (2) open a ditch of about 20 cm, with 10% graminephos granules, or 3% of the methyl isothionophos granules, or 98%-100% of cotton ron granules spreading or ditching.

II. A. 2) Principles of tea tree root rot control

Tea tree diseases are not easy to be recognized in the early stage of the disease, and can be popular under the right conditions. Therefore, the prevention and control of tea tree diseases should follow the "prevention-oriented, comprehensive prevention and control" approach to plant protection, and follow the following three principles.

(1) Green and coordinated principle

Tea products of high quality and safety is based on the establishment of a green tea industry, in order to effectively solve the problem of excessive application of chemical fertilizers and pesticides in China, China launched a national key research and development program "chemical fertilizers and pesticides to reduce the application of efficiency of integrated technology research and development" key special. Tea belongs to the beverage plant, to pick fresh leaves after processing and drinking mainly, drinking tea with water for many times, equivalent to continuous extraction, so it should be more cautious and reduce the application of chemical pesticides in the tea plantation. In addition, in the prevention and control of tea tree diseases, we should maximize the role of agricultural control, physical control, biological control and other technologies to implement the principle of green and coordination.

(2) Health and safety principles

Tea is a traditional drink that can enhance human health. Therefore, the green prevention and control of tea tree diseases must be based on the principle of health and safety to develop control technology measures. Tea quality and safety issues mainly from two aspects: one is the irrational use of chemical pesticides, so that the pesticide residues in the tea exceeds the standard, and the second is the environment in the deposition of harmful pollutants in the tea. At present, all countries in the world have formulated standards for the permissible residues of pesticides and pollutants in tea, of which 480 are in the European Union, 36 are in the United States, and 236 are in Japan. China has enacted 106 kinds in 2021, which is an important regulation to ensure the quality and safety of tea, and a safety red line that must be observed for tea production in China. Some pesticides have off-flavors that can affect the quality and safety of tea products. Such as lime and sulfur combination of autumn and winter garden closure control of mealybugs, mites pests and tea tree diseases with good results, but because it has a strong sulfur odor, and lasts a long time, so in the growing season of the tea tree should not be applied, but in the end of the fall can be used for over-wintering control of pests and diseases, after an interval of 3 to 4 months, both to play the efficacy of the medicine, but also will not affect the quality of spring tea.

(3) High efficiency and low toxicity principle

In the tea tree disease control should be selected high-efficiency, low-toxicity pesticides, such as fungicides and nematicides should be pathogenic bacteria and nematodes with high efficiency, while the human body and beneficial organisms of low toxicity, is safe for the environment. In addition, recent research results show that water-soluble pesticides have a significant impact on the safety of tea drinking. Tea is different from other crops in that tea leaves are processed directly into dry tea after harvesting, and the tea broth is consumed directly after brewing with boiling water. Research has proved that the higher the solubility of pesticides in water, the more the amount of pesticides that enter the tea broth when brewing tea, the greater the safety hazard to human beings. Therefore, in the prevention and control of tea tree disease selection of chemical pesticides should not only consider the prevention and control effect, but also pay attention to the water solubility of pesticides and the leaching rate in the tea broth, should not be selected water-soluble pesticides to ensure that the health of the drinker. A large number of studies have shown that the water solubility of a pesticide if higher than 150 mg / L, it is not recommended to apply in tea production.

II. B. Screening experiment of biocontrol microorganisms in tea plantation soil

II. B. 1) Soil suspension preparation

Weigh 5g of soil sample and add it to the triangular bottle containing 100mL of sterile water and oscillate for about 25min, so that the soil sample and water are mixed well to obtain 10^{-1} dilution, use a sterile pipette to suck up 0.5mL of soil suspension and add it to the test tube containing 10 mL of sterile water, and oscillate appropriately so that the soil suspension is mixed well to obtain 10^{-2} dilution, and use a sterile pipette to suck up 0.5mL of 10^{-2} dilution. Add the 10^{-3} dilution solution into a sterile test tube containing 10 mL of water to obtain the 10^{-3} dilution solution.

II. B. 2) Medium Preparation

PDA medium was prepared using 250 g of potato, 25 g of glucose, 25 g of agar, and 1 000 mL of water, and the medium was sterilized at 120°C for 30 min and set aside.

II. B. 3) Isolation and purification of microorganisms

Label 10^{-1}, 10^{-2} and 10^{-3} on the sterile plates, and repeat each concentration 3 times. Use a sterile pipette to suck up 0.5mL of 10^{-3} dilution in the corresponding labeled plate in strict accordance with the requirements of aseptic operation, and suck up 10^{-2} dilution and 10^{-1} dilution in the same way. Then use a sterilized glass rod to spread the bacterial solution evenly on the plate, and use 1 glass rod for each dilution separately. Put the connected plate into 28℃ constant temperature box inverted culture for 3~5 d, and observe and record to obtain the first isolated colonies. Pick a small number of colonies on the surface of the first isolated colonies with an inoculating ring or inoculating needle and inoculate them onto a new plate with a line for 3-5 d. After artificial culture, pick a small number of colonies again and transfer them. Repeat the operation according to the same method until pure culture of various microorganisms was obtained. The microorganisms obtained in pure culture were stored at 4℃ for spare use.

II. B. 4) Determination of indoor antagonistic effect of biocontrol bacteria

The isolated and purified microorganisms were inoculated on both sides of the same plate with the tea tree Verticillium verticillioides pathogen, and incubated in an incubator (digital water barrier type 303As-3) for about 7d. The indoor resistance of the target microorganisms was analyzed and judged by plate standoff experiments based on the antagonistic effect. According to the presence or absence of antagonistic bands or the growth status of the pathogenic bacteria, the microorganisms with more significant antagonistic effects in the plate standoff experiment were used as alternative strains, prepared into liquid bacterial agents and preserved for use in the field control test of tea tree Verticillium wilt, and the strains with poor antagonistic effects were directly eliminated [14].

II. C.Mechanisms of root rot inhibition by bioprophilic microorganisms in tea plantation soils

II. C. 1) AM fungi

Root rot is a worldwide crop disease that poses a serious threat to crop yield and quality. Root rot is caused by a variety of pathogenic bacteria and fungi alone or in combination, which leads to a certain degree of difficulty in the selection of root rot control agents. For a long time, the control of plant root rot is mainly based on chemical control, but it is easy to have pesticide residues, environmental pollution, pathogenic bacteria resistance and other problems. Therefore, how to safely, efficiently and environmentally friendly control of root rot has become an urgent problem in crop production. In the inter-root soil, there are a variety of microorganisms closely related to plants, which are called the “second genome” of plants, and some inter-root microorganisms play an important role in plant growth and development and resistance to adversity stress. In recent years, under the background of chemical fertilizer and pesticide reduction, the use of biocontrol microorganisms to promote plant nutrient metabolism and improve root rot resistance has been paid more and more attention to, such as arbuscular mycorrhizal (AM) fungi are such biocontrol microorganisms.

II. C. 2) Inhibitory effect of AM fungi on root rot of tea tree

Numerous studies have shown that most species of AM fungi can inhibit the occurrence of plant root rot and effectively reduce the damage of pathogens. Single inoculation of AM fungi such as Mossy Dipper tubular bursa, Microcystis microcarpa, Young set of ballooning molds, Multiple brooding ballooning molds, Ground surface ballooning molds, Curved filamentous ballooning molds, and Heteromorphic Rhizoctonia sp.) can reduce the damage of fungi from the genera Blighty mildew, Rotylenchus, Silk saccharomyces cerevisiae, Fusarium, Silibacterium, and Broomstalk Columnarium on host plants such as alfalfa, soybeans, navy beans, and chili peppers, and lower the incidence rate of root rots and the index of the condition as well as the root system pathogen biomass, and increase the proportion of healthy root systems.

II. D.Mechanisms of action of AM fungi to improve plant resistance to root rots

II. D. 1) Changing the morphological structure of the root system to form a mechanical protective barrier

Pathogenic bacteria infecting plant roots must enter the cell through the cell wall, while AM symbionts can induce changes in root growth, development and morphology, and thickening of the root cortex cell wall to construct a mechanical protective barrier against pathogen invasion, thereby increasing host plant disease resistance. Inoculation of Moses balloon mold significantly increased the total root length and the number of root tips of tomato root system under the treatment of the root rot pathogen, Rickettsia rickettsii.

The AM fungus induced a significant increase in the number of root branches, but the number of root necrosis was low and enhanced the resistance of strawberry to strawberry blight mold. In addition, inoculation with Mossy Balloon Mycorrhizal fungi enhanced the cell division capacity of the root tip of tomato lateral roots, increased the root tip length and diameter as well as the number and width of cortical cells, and impeded the invasion of the parasitic blight mold.

II. D. 2) Improvement of plant nutrient levels and resistance to pathogens

AM expands root uptake through a well-developed extra-root mycelial network and enhances host plant nutrient uptake and utilization, and mycorrhizalized plants with high nutrient levels will exhibit greater resistance to pathogen infestation compared to non-mycorrhizalized plants. The biomass loss and functional impairment caused by plant infestation by pathogenic fungi can be compensated by the establishment of symbiosis with AM fungi.

III. Screening of biocontrol microorganisms and their mechanism of inhibition of root rot of tea tree

III. A. Screening and identification of biocontrol bacteria

III. A. 1) Screening for biocontrol bacteria

A strain of bacteria isolated from tea tree leaf tissue formed colonies on PDA plates that did not come into contact with the pathogenic fungus D.HK, but mycelial growth of the D.HK fungus was significantly inhibited, suggesting that the strain was able to antagonize the D.HK fungus, and the tea endophyte was named Z-1.

III. A. 2) Identification of biocontrol bacteria

Morphological observation: Observe the growth of strain Z-1 on LB solid medium after 24 h. The colony morphology showed milky white, translucent, with irregular edges, which would crumple to the center to form raised folds, Gram stained, positive, and purple short rods under the microscope.

III. A. 3) Z-1 growth curve determination

The growth cycle of Z-1 strain is shown in Fig. 1, its retardation period is very short, 4-14 h is the logarithmic period, after 14 h, the growth rate of Z-1 slows down, but still maintains the ascending state, and the stabilization period is 16-30 h. After 30 h, the curve begins to decline slowly, and it starts to enter into the period of demise.

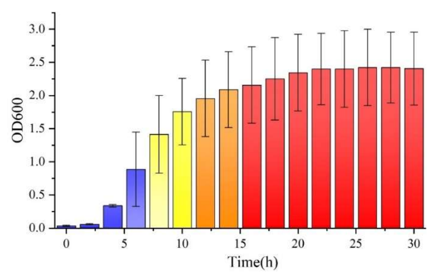


Figure 1: The growth cycle of the Z-1 strain

III. A. 4) Z-1 Bacteriostatic Capacity Assay

Figure 2 shows the bacterial inhibition ability of the sterile fermentation broth of Z-1 strain, take the fermentation broth of Z-1 strain at 24h of fermentation, centrifugation and filtration, test the bacterial inhibition ability of the sterile fermentation broth at this time and found that the sterile fermentation broth at 24h could obviously inhibit the growth of mycelium, with an inhibition rate of 42.89593%. With the extension of the fermentation time, the inhibition rate also increased gradually, so it was initially inferred that the inhibitory substances were extracellular products, and with the extension of the fermentation time, its concentration gradually became higher.

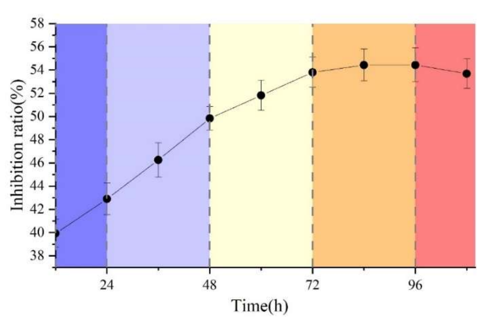


Figure 2: The bacteriostatic ability of the Z-1 strain

III. A. 5) Detection of bacteriostatic substances in fermentation broths

The results of the infrared absorption spectra of the crude extract are shown in Fig. 3. The absorption band at 3297 cm-1 is the telescopic vibration absorption of the N-H bond, and the strong absorptions at 1638 cm-1 and 1538 cm-1 are the absorption bands of the amide Ⅰ and amide Ⅱ bonds, which indicate that the peptide bond exists in the molecular structure of the crude extract.The small peaks at 3003-2845 cm-1 and 1463-1370 cm-1 are the absorption bands of the stretching vibration of the C-H bond on the aliphatic carbon chain. 1463-1370 cm-1 are the absorption bands of the stretching vibration of the C-H bond on the aliphatic carbon chain, and the small peak at 1748 cm-1 is the absorption of the stretching vibration of the lactone carbonyl structure. Combining the above results, it can be preliminarily determined that the substance is a lipopeptide.

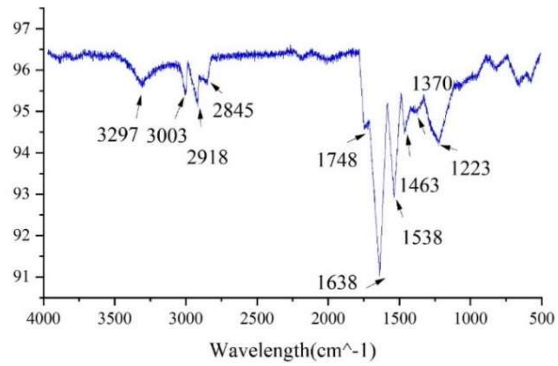


Figure 3: Infrared absorption spectrometry of crude extract

III. A. 6) Detection of the effectiveness of health protection

The soil was mixed with vermiculite by removing impurities, sterilized at 120°C for 30min, cooled and packed into seedling trays as substrate. After the seeds sprouted, they were moved into the seedling tray substrate, sprayed and watered in the morning and evening, and when the tea seedlings grew to 6 cm high, the tea seedlings with consistent growth were retained, three per pot, and they were divided into four groups to be rooted with different treatments, respectively:

PG1: 5 mL of sterile LB medium and 5 mL of sterile PDB medium.

PG2: 5 mL of sterile LB liquid medium and 5 mL of Zc-2 PDB fermentation broth, the

PG3: 5 mL sterile LB liquid medium containing 0.2% carbendazim and 5 mL Zc-2 PDB fermentation broth.

PG4: 5 mL Z-1 LB fermentation broth and 5 mL Zc-2 PDB fermentation broth.

The tea trees were sprayed and watered with sterile water every morning and evening, and the horticultural indicators were tested after 25 d of growth.

The final test effect of Z-1 on tea trees is shown in Table 1. In terms of tea tree growth (root length, plant height and total fresh weight), the tea trees of PG2, PG3 and PG4 groups, which were applied with Fusarium oxysporum solution, were significantly weaker than those of PG1 group, which were not applied with Fusarium oxysporum solution, in terms of root length, the root length of the three groups were 7.8496, 10.9248 and 10.3788, respectively. The results indicated that Fusarium fujikura had an inhibitory effect on the growth of tea seedlings in the soil, and the growth of tea plants in the PG3 and PG4 groups was basically the same, and they were significantly higher than those in the PG2 group, and the P value of root length was less than 0.05, indicating that the chemical pesticides carbendazim and Z-1 biocontrol bacteria in the soil could inhibit Fusarium fujira pathogens, and the biocontrol effect of 5 ml Z-1 solution was comparable to that of 0.2% carbendazim.

Table 1: Effects of Tea tree biocontrol test

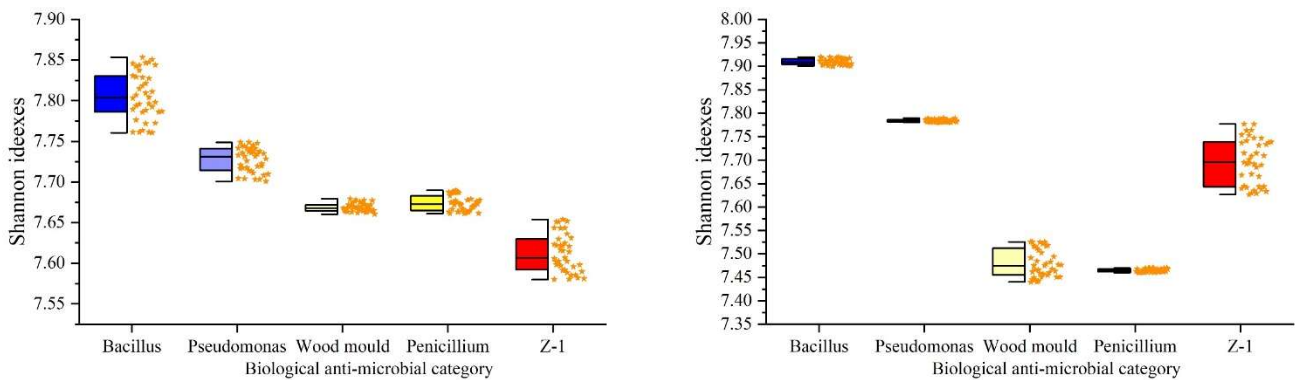
/	Root length /cm	Plant height /cm	Total fresh weight /g	Fresh weight of the upper part/g	Upper dry weight /g
PG1	11.2564*	22.7555*	0.1548*	0.1654*	0.0263*
	(0.6158)	(0.6163)	(0.0036)	(0.0769)	(0.0024)
PG2	7.8496	16.3889	0.0856	0.0569	0.0148
	(0.4789)	(1.6426)	(0.0038)	(0.0069)	(0.0004)
PG3	10.9248*	21.6358*	0.1858*	0.1248**	0.0248**
	(0.3648)	(0.2048)	(0.0269)	(0.0058)	(0.0008)
PG4	10.3788*	22.1399*	0.1687*	0.1536*	0.0248**
	(0.9966)	(0.7596)	(0.0199)	(0.0195)	(0.0164)

Note: The standard deviation is indicated in parentheses for each data. In the same column, *, **, and *** indicate that the differences have reached significant ($P<0.05$), very significant ($P<0.01$), and extremely significant ($P<0.001$) levels respectively.

III. B. Analysis of the inhibition effect of root rot of tea tree

Alpha-diversity is the analysis of species diversity in a single sample, i.e., the diversity of the microbial community within the sample is analyzed. The analysis of diversity in a single sample (alpha-diversity) can reflect the richness and diversity of the microbial community within the sample. Shannon is used to estimate one of the diversity indices of microorganisms in the samples, the larger the Shannon value, the higher the community diversity. Four kinds of biocontrol microorganisms, combined with the Z-1 flora extracted in this paper, were selected to jointly analyze the effect of root rot inhibition in tea tree, and the biocontrol microorganisms of the experimental samples were Bacillus sp., Pseudomonas sp., Xylococcus sp., Penicillium sp., and Z-1, respectively.

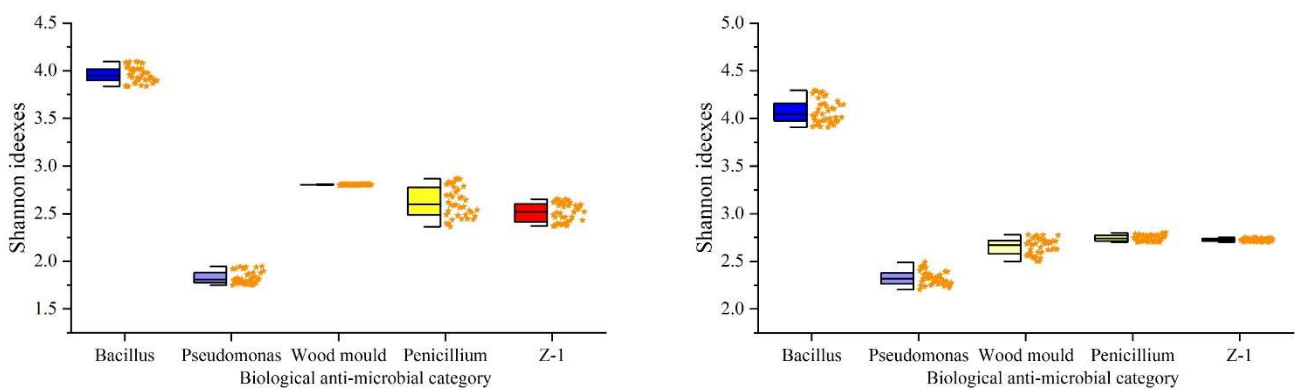
The results of bacterial Shannon index analysis of ND15 and C106 inter-root soil samples are shown in Fig. 4, Fig. (a) for ND15 and Fig. (b) for C106. The results of bacterial community diversity analysis of the inter-root soil showed that the bacterial community diversity was significantly reduced after susceptibility to the disease, and that after the foliar application of the biocontrol microorganisms, the bacterial community diversity of the Shannon index did not significantly change or significantly reduced compared with that of Pseudomonas sp. The Shannon index of bacterial community diversity of Z-1 proposed in this paper was the lowest in ND15 soil, which was only 7.61221.



(a) ND15 (b) C106

Figure 4: The shannon index of the ND15 and C106 interinternational soil samples

Figure 5 shows the fungal Shannon index analysis of the inter-root soil samples of ND15 and C106 Disease susceptibility also led to a significant decrease in the diversity of the inter-root soil fungal community, whereas foliar application of different biocontrol microorganisms resulted in a significant increase in the Shannon index of the diversity of the fungal community in comparison to that of Pseudomonas aeruginosa, which suggests that foliar application of the colonies were able to recover the diversity of the inter-root soil fungal community in the disease-susceptible tea tree plants. Also taking the Z-1 flora extracted in this paper as an example, the Shannon indices of the inter-root fungal communities of ND15 and C106 were 2.51555 and 2.72535, respectively.



(a) ND15 (b) C106

Figure 5: The D15and C106 the fungal shannon index of the international soil sample

IV. Conclusion

This study showed that Z-1 strain exhibited significant effects in controlling root rot of tea tree. In the field experiment, the root length, plant height and fresh weight of tea trees treated with Z-1 strain were significantly higher than those of the control group, in which the root length reached 10.37 cm, the plant height was 22.14 cm, and the total fresh weight was 0.169 g. Compared with the treatment with the chemical carbendazim, Z-1 strain showed comparable efficacy in controlling the disease, and possessed lower environmental toxicity. The strain showed strong potential for biological control by altering the morphological structure of the root system, promoting root growth, and increasing the resistance of tea trees to pathogens. Taken together, strain Z-1, as a highly effective biocontrol microorganism, has a better application prospect in the control of tea root rot and provides a new solution for green prevention and control in tea gardens.

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References

[1] Hu, H., Cao, A., Chen, S., & Li, H. (2022). Effects of risk perception of pests and diseases on tea famers' green control techniques adoption. International Journal of Environmental Research and Public Health, 19(14), 8465.

[2] Wei, Y., Pang, Y., Ma, P., Miao, S., Xu, J., Wei, K., ... & Wei, X. (2024). Green preparation, safety control and intelligent processing of high-quality tea extract. Critical reviews in food science and nutrition, 64(31), 11468-11492.

[3] Gao, F., Xu, J., Li, D., & Chen, F. (2024). The Impact of Adopting Green Control Technologies on Farmers' Income: Based on Research Data from Tea Farmers in 16 Provinces of China. Polish Journal of Environmental Studies, 33(3).

[4] Xiangyang, L. I., Linhong, J. I. N., Zhuo, C. H. E. N., & Baoan, S. O. N. G. (2022). APPLICATION AND DEVELOPMENT OF'GREEN'PREVENTIVE AND CONTROL TECHNOLOGIES IN GUIZHOU TEA PLANTATIONS. Frontiers of Agricultural Science & Engineering, 9(1).

[5] Bodah, E. T. (2017). Root rot diseases in plants: a review of common causal agents and management strategies. Agric. Res. Technol. Open Access J, 5(555661), 10-19080.

[6] Pandey, A. K., Sinniah, G. D., Babu, A., & Tanti, A. (2021). How the global tea industry copes with fungal diseases–challenges and opportunities. Plant Disease, 105(7), 1868-1879.

[7] Elango, V., Manjukarunambika, K., Ponmurugan, P., & Marimuthu, S. (2015). Evaluation of Streptomyces spp. for effective management of Poria hypolateritia causing red root-rot disease in tea plants. Biological Control, 89, 75-83.

[8] Manjukarunambika, K., Ponmurugan, P., & Marimuthu, S. (2013). Efficacy of various fungicides and indigenous biocontrol agents against red root rot disease of tea plants. European journal of plant pathology, 137, 67-78.

[9] Islam, M. S., Ahmad, I., & Ali, M. (2018). Biocontrol studies on rizpspheric microorganisms against black rot disease of tea caused by Corticium theae Bernard. Bangladesh Journal of Botany, 47(4), 985-991.

[10] Xie, Y., Cao, C., Huang, D., Gong, Y., & Wang, B. (2025). Effects of microbial biocontrol agents on tea plantation microecology and tea plant metabolism: a review. Frontiers in Plant Science, 15, 1492424.

[11] Dhar Purkayastha, G., Mangar, P., Saha, A., & Saha, D. (2018). Evaluation of the biocontrol efficacy of a Serratia marcescens strain indigenous to tea rhizosphere for the management of root rot disease in tea. PloS one, 13(2), e0191761.

[12] Zhao, Z., Yan, W., Xiao, M., Xiao, T., & Lei, F. (2021). Molecular identification of pathogens causing root rot of Camellia Oleifera in tropical. Molecular Pathogens, 12.

[13] Yang Yishuai,Yang Xueyu,Zhang Yudan,Ren Zuohua,Zhong Jie,Hu Qiulong & Tan Lin. (2023). First report of Fusarium cugenangense causing root rot of tea plants (Camellia sinensis) in China. Plant disease,

[14] Puspita Sari Gracela Nanda,Pustika Arlyna B.,Solichah Chimayatus,Wicaksono Danar,Widyayanti Setyorini,Sudarmaji& Yolanda Kiki. (2023). The effect of antagonistic microbial and seed bulb-size on fusarium wilt and yield of shallot. E3S Web of Conferences,467,01006-01006.