Analysis on Effects of Different Pesticides on Termite Control in Four Villages of Zhejiang Province

Wei LIN，Yubai SHI * **，Xiao NI，Xudong WANG，Chengtao LUO**

School of Medical Technology，Ningbo College of Health Science，Ningbo 315100，China

Abstract ［**Objectives**］To explore the effects of different pesticides on termite control in four villages of Zhejiang Province. ［**Methods**］ Based on the investigation of termite damage to trees in Lijiakeng Village，Longmen Ancient Town，Luobu Ancient Town and Huanglin Village in Zhejiang Province，the indoor toxicity test of powder and bait was conducted to analyze the termite control effect of different agents. ［**Results**］The experiment showed that 5% Fipronil powder was relatively better than 4.8% Imidacloprid powder，and 1.3% Fipronil was better than 2.5% Hexaflumuron. ［**Conclusions**］It was found that the termite bait station combined with powder spraying and baiting has high social value for termite control in rural areas.

Key words Termite control，Vector control，Ant killing agent，Ant killing method

1　Introduction

Termites are highly destructive and have a wide range of hazards. They can damage rural house foundations，reservoir dams，mountain orchards，leading to house collapse，ground collapse，agricultural production reduction and other consequences. Their economic losses range from loss of life，and they are one of the five internationally recognized pests[1]. As a precious heritage left by nature and predecessors，ancient and famous trees are not only one of the main symbols of ancient villages，but also irreplaceable natural resources of a tourist village[2]. At present，the ancient and famous trees in rural areas are generally damaged by termites，and some damages are very serious[3]. Timely termite control is conducive to the protection of ancient cultural trees in rural areas，and is of great significance to reduce rural economic losses and protect the safety of people's lives and property[4]. In order to better protect the ancient and famous tree resources in Zhejiang Province，we conducted an investigation on termite damage to ancient trees in Lijiakeng Village in Ningbo City，Longmen Ancient Town in Hangzhou City，Luobu Ancient Town in Jinhua City，and Huanglin Village in Wenzhou City. Combined with the practice of termite control in Zhejiang Province，termite control agents were screened indoors，so as to provide a scientific basis for the control of ancient wood termites in ancient buildings.

In order to better protect the resources of ancient and famous trees in rural areas of Zhejiang Province，we investigated the termite damage of ancient trees in Lijiakeng Village in Ningbo City，Longmen Ancient Town in Hangzhou City，Luobu Ancient Town in Jinhua City，and Huanglin Village in Wenzhou City. Combined

with the practice of termite control in Zhejiang Province，termite control agents were screened indoors，providing a scientific basis for the control of ancient wood termites in ancient buildings.

2　Materials and methods

2.1　Survey sample　A total of 486 ancient trees were collected from four ancient villages，including Lijiakeng Village in Ningbo，Longmen Ancient Town in Hangzhou，Luobu Ancient Town in Jinhua，and Huanglin Village in Wenzhou. There are 158 ancient trees in Lijiakeng Village，115 ancient trees in Longmen Ancient Town，92 ancient trees in Luobu Ancient Town and 121 ancient trees in Huanglin Village.

2.2　Survey tools　Survey tools mainly include screwdriver，flashlight，multi-function shovel，insect collector，specimen bottle，record book，pen，*etc.* ；the auxiliary investigation tools include termite detector，electronic endoscope，climbing ladder，*etc.*

2.3　Investigation method　According to the living habits of termites，during the period of high activity of termites，an all-round investigation was conducted through the signs of termite activity，such as ant path，damage traces，*etc.* The activity of termites was high during the separation period. At this time，it is easy to collect both soldiers，workers and winged adults[5]. Record various indicators of the surrounding environment during collection，and conduct preliminary identification of termites under the condition of ensuring individual integrity as much as possible，then further classify them，and determine the termite species after microscopic observation and comparison. Each registered ancient and famous tree shall be inspected in detail one by one，and the specific inspection contents are as follows[6]：（ⅰ）check whether there are any signs of termite activity such as mud quilt，mud line and fly hole on the surface of tree trunk and exposed root on the ground；（ⅱ）observe whether there is any sign of termite harm or living body；（ⅲ）check whether all parts of the tree have holes，

dents, rottenness, *etc.*; (ⅳ) taking the tree base as the center, check whether there is any sign of termite damage or living body in the surrounding environment; (ⅴ) if live termites are found during the investigation, collect samples on site and take them back to the laboratory for termite species identification; (ⅵ) take photos and record the growth momentum, growth environment, listing information of ancient and famous trees and the termite damage status of each termite hazard point; (ⅷ) record the geographic information data of each ancient and famous tree in detail, and fill in the *Investigation Record Form of Termite Damage to Ancient and Famous Trees*.

3 Investigation results in four villages of Zhejiang Province

3.1 Hazard overview   Through the investigation on the termite damage of 486 ancient and famous trees in four places (Table 1), the results show that the rate of termite damage to ancient trees in Lijiakeng Village, Longmen Ancient Town and Luobu Ancient Town is high, and the ancient and famous trees are seriously damaged by termites, while the rate of termite damage to Huanglin Village is relatively low. The rate of termite damage to ancient and famous trees in the area under investigation is 12.14%.

Table 1   Overview of termite damage to famous trees in Zhejiang Province

Region	Survey data	Trees with ants	Termite damage rate // %
Lijiakeng Village	158	21	13.29
Longmen Ancient Town	115	18	15.65
Luobu Ancient Town	92	14	15.21
Huanglin Village	121	6	4.96
Total	486	59	12.14

3.2 Occurrence types of termites   It can be seen from the damage of different types of termites that there are mainly three types of termites that harm ancient and famous trees in the four villages, namely, subterranean termites, Scattered termites and Taiwan milk termites (Table 2). Among the three kinds of termites, the Soil termite is the most harmful to ancient and famous trees, followed by scattered termite, and Taiwan milk termites is the least harmful to ancient and famous trees.

Table 2   Harm of different kinds of termites in four villages of Zhejiang Province

Category	Number of damaged trees	Percentage // %
Subterranean termites	37	38.54
Scattered termite	31	32.29
Taiwan milk termites	28	29.17

4 Laboratory bioassay test

4.1 Reagents   The reagents adopted included 5% Fipronil powder, 4.8% Imidacloprid powder, 1.3% Fipronil bait, and 2.5% Hexaflumuron bait.

4.2 The test termites   Selected the subterranean termites with strong destructive capacity among the main types of termites in

Zhejiang Province as the test objects.

4.3 Test conditions   Put it in a glass tank, with pine sawdust and sand wet with water as food and water source. Feeding temperature is (29 ± 1) ℃, humidity is $90\% - 95\%$, and it will be kept for two weeks.

4.4 Test method

4.4.1   Determination of indoor toxicity of powder. For the indoor toxicity test of the powder, the food that termites like to eat is used as bait. After the termites are trapped, 5% Fipronil powder and 4.8% Imidacloprid powder are sprayed. Test method: put filter paper at the bottom of 4 Petri dishes with a diameter of 10 cm, then move 55, 50, 45 and 40 healthy workers of soil dwelling scattered termites into the Petri dishes respectively, evenly spread appropriate amount of 5% Fipronil powder or 4.8% Imidacloprid powder in the other 4 Petri dishes with a diameter of 7 cm, put 8, 16, 32 and 64 healthy workers into each dish, and after all termites are coated with powder, Then carefully move the workers with sticky powder into the pre prepared culture dish with a diameter of 10 cm covered with filter paper, so that the number of termites in each dish is 100. Even if the gradient of the number of pollinated termites in the test is set to 8%, 16%, 32% and 64%, each treatment is repeated for three times, and the blank control uses talcum powder to replace the termite powder. Add a few drops of water to the filter paper with a rubber tip dropper, and add a mass of wet absorbent cotton at the edge of the petri dish to ensure proper air humidity and moisture in the petri dish. After application, the dead number of termites shall be observed and counted every day, and the dead bodies shall be removed. Water shall be added to the filter paper and absorbent cotton, and the test shall be ended on the 10th day after application.

    The test analysis is shown in Fig. 1. It can be seen that, with the increase of the proportion of termite pollination, the number of days required for the death of termites in the Petri dish decreases first and then increases. When the proportion of pollination is 16%, 5% Fipronil powder only lasts for 5 d, which is relatively better than 4.8% Imidacloprid powder for 9 d.
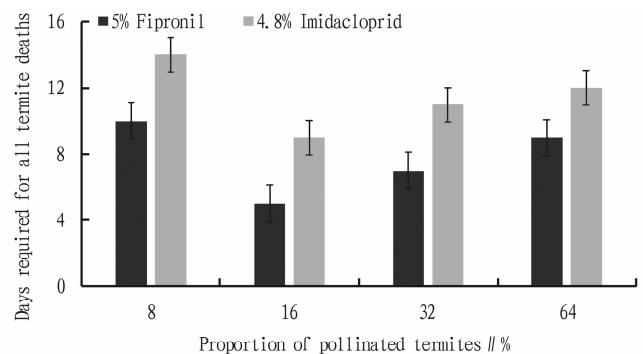
Fig. 1   Days required for all termites to die in the culture dish under different gradient of termite pollination ratio

4.4.2   Indoor toxicity test of baits. In the indoor toxicity test of baits, the baits containing 1.3% Fipronil and 2.5% Hexaflumuron, the effective ingredients of termite control, were directly put into the termite activity area to let the termites eat freely. Take 6 Petri dishes and divide them into three groups. Weigh 20 g of

1.3% Fipronil and 2.5% Hexaflumuron bait respectively in each group, and wet them with 15 mL of tap water. Put 90 termite workers and 10 soldiers in each Petri dish, cover them, and put them in a dark room at about 28 ℃ with relative humidity (RH) of 82%. Take another Petri dish and set a blank control with pine sawdust. Check it once a day to record the death of termites.

The test analysis is shown in Fig. 2. The average time required for the death of all terrestrial scattered termites is 16.3 days, and the average time required for the death of all termites in the Petri dish after workers take bait is 20.3 d. The natural mortality of the blank control group was 6% and 5%, respectively. Therefore, it can be concluded that 1.3% Fipronil has a strong killing effect on terrestrial termites, and 2.5% Hexaflumuron has a toxic effect on terrestrial termites. And from the test results, it can be seen that 1.3% Fipronil is better than 2.5% Hexaflumuron in killing subterranean termites.
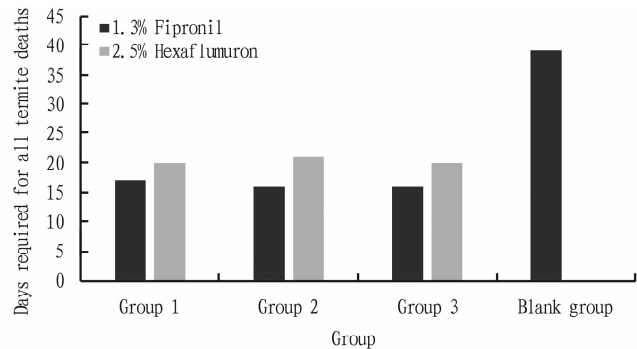

Fig. 2   Days required for all termites to die in the laboratory test 1.3% Fipronil bait and 2.5% Hexaflumuron bait

5   Conclusions

Powder spraying method and bait method have played a great role in agricultural termite control. Among them, Fipronil has significant effects on termite trapping. An appropriate amount of bait can increase agricultural production value, but it is worth noting that excessive bait will also have certain side effects on agricultural products. In view of the fact that the control effect of different chemicals on termites is slightly lower in this study, it may be due to errors caused by humidity, temperature and other factors. Therefore, it is speculated that the dosage of chemicals required in different regions should be controlled according to various local factors.

Termites can damage the root system of crops, causing seedling shortage and ridge breakage. Early detection, early treatment and early prevention should be achieved. Local governments should actively respond to the rural rejuvenation strategy, and use high-tech to monitor and protect ants and take monitoring control technology to monitor termite activities of ancient and famous trees and their surrounding environment for a long time to reduce the risk of termite invasion[8]. At the same time, we should also strengthen policy guidance and implement management measures. Implement the policy of prevention first, combination of prevention and control, and comprehensive treatment, closely combine termite control with rural development, improve the rural landscape, increase the rural economic development index, and take the road of sustainable development.

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