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Application and Popularization of New Green Prevention and Control Technology for Greenhouse Vegetables in Shouguang City, Shandong Province

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Abstract In recent years, through financial subsidies, Shouguang City has promoted the application of electrostatic sprayer, dual-purpose fog and mist sprinkler machine, *Bacillus cereus*, flame disinfection service based on fine rotary tillage and multi-functional plant protection machine and other new green prevention and control products and technologies for the greenhouse vegetable in the city. As a result, the utilization rate of pesticides was increased by more than 5%, and the application rate was reduced by more than 10%.

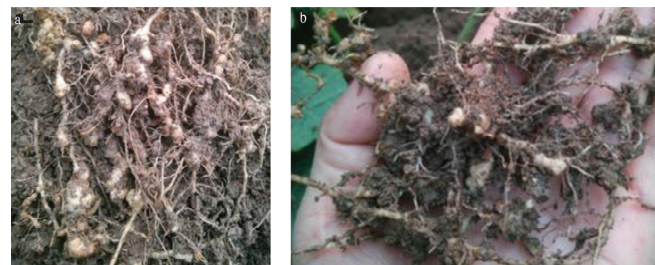
Key words Greenhouse vegetables, Green prevention and control, Shouguang City

1 Introduction

Pesticide, as an important means of agricultural production, is very important for disease prevention and pest control and promoting vegetable production. In recent years, due to the extensive use of pesticides and the lack of scientific application methods, it has brought about problems such as increased production costs, excessive pesticide residues, crop drug damage, and environmental pollution^[1-2]. In order to promote the transformation of the mode of agricultural development, effectively control the use of pesticides, ensure the safety of agricultural production, the quality and safety of agricultural products and the safety of the ecological environment, and promote the sustainable development of agriculture, Shouguang City has been committed to the promotion and application of green prevention and control technology since 2014, with remarkable results.

At present, relying on the implementation of *Shouguang Cultivated Land Quality Improvement Plan—Pesticide Residue Control Project, Integrated Control Project of Root-Knot Nematode Disease for Greenhouse Vegetables*, it has employed the way of financial subsidy, to popularize and apply 4 100 sets of pesticide reduction and damage control instruments in the whole city, such as electrostatic sprayer and dual-purpose fog and mist sprinkler machine, 25 000 glue traps, 150 000 m² of insect control net, 22.57 t of *Bacillus cereus* and other biological pesticides. The promotion area covers 12 key towns and streets of greenhouse vegetables in the city, and the promotion area is above 667 ha. Through the implementation of the project, the utilization rate of pesticides in the city has been increased by more than 5%, and the amount of pesticides used has been reduced by more than 10%. In particular, in the luffa producing areas on the streets of Luocheng, the harm

of root-knot nematode was significantly reduced after the treatment with *Bacillus cereus* (Fig. 1). The original injured roots also gradually returned to growth, and the roots became sturdy and healthy.



Note: a. before use; b. after use.

Fig. 1 Comparison of *Bacillus cereus* before and after use

2 Green prevention and control technology

According to the characteristics of pests and diseases in greenhouse vegetables, Shouguang City mainly popularizes the following green prevention and control techniques.

Biological pesticides include *Bacillus cereus*, wuyiencin, *Bacillus thuringiensis* and other biological pesticides, to replace or reduce the use of chemical pesticides^[3].

Physical prevention and control technologies include flame disinfection, high temperature treatment of solar greenhouse and other agricultural physical control technologies. At the same time, mature physical control technologies such as anti-insect net, glue traps, germicidal lamp and insecticidal lamp have been promoted.

New plant protection instruments include electrostatic sprayer, fog and mist sprinkler dual-purpose machine and other cost-saving and efficient instruments, instead of "dripping, leaking" backward machinery. On the one hand, it reduces the spraying amount of pesticides, on the other hand, it reduces the environmental pollution caused by the loss of pesticides.

It also includes cost-saving and synergistic pesticide auxilia-

ries, such as organosilicon and other pesticide auxiliaries, to improve the control effect and reduce the use of pesticides.

3 New green prevention and control products

It is mainly planted with greenhouse vegetables in Shouguang City. Under the environment of high temperature and high humidity, diseases and pests are easy to occur and there are many kinds of diseases and pests. Root-knot nematode disease is one of the most difficult diseases and pests to control^[4]. At present, most of the diseases and pests are mainly chemically controlled, supplemented by glue traps, pest control net and other physical control means. The application of traditional sprayer is time-consuming and labor-consuming, and the phenomenon of "dripping and leakage" is serious. Large area foliar spraying of pesticides is easy to cause pesticide waste and soil environmental pollution. In order to solve the problems of difficult control of root-knot nematodes, low utilization rate of pesticides, excessive use of chemical pesticides, serious agricultural residue pollution and so on, Shouguang City focuses on the promotion of the following several new green prevention and control products.

3.1 Electrostatic sprayer Wuxing 3WJB-16 electrostatic sprayer can make use of high voltage static electricity to establish electrostatic field, and the adsorption rate on the back of the leaf can reach more than 30%. The phenomenon of droplet drop on the back of the leaf is reduced and the utilization rate of pesticide is greatly improved. The atomization effect is good, saving about 60% of pesticide and water. Even in winter rainy days, pesticide application will not increase the humidity of the greenhouse, reducing the occurrence of diseases and pests.

Technical points: 12V fully sealed lithium battery is used as power source to drive high-speed water pump, high-speed centrifugal atomization disk and high-voltage electrostatic generator at the same time. The liquid is pressurized through the diaphragm pump and extruded directly from the small nozzle hole. Under the action of electrostatic force, the tiny fog droplets thrown (sprayed) run directly to the front and back of the crop. It is firmly adsorbed by the stems and leaves of crops, so as to achieve the purpose of disinfection, disinfection and sterilization.

Matters needing attention: (i) The sprayer is not suitable for powder spraying. (ii) After use, the sprayer must be cleaned with clean water. (iii) After use, it is necessary to touch the sprayer head with an iron sheet to release static electricity.

According to the villagers of Cuijia Village, Luocheng Street, the amount of pesticides used after the use of the device was on average 40% less than before, and the number of times of pesticide application was reduced by an average of one. On the premise of ensuring the efficacy, it obviously reduces the use of pesticides and the frequency of pesticide application, and solves the problems of crop drug damage and agricultural residual pollution.

3.2 Dual-purpose fog and mist sprinkler machine Jiayu DWY120 dual-purpose fog and mist sprinkler machine saves time and effort, and it can be used to spray for 100 m greenhouse within 10 min. Due to the huge energy produced by the pulse field, the fine particles produced during spraying can directly pass

through the plant canopy to kill insects and bacteria, leaving no dead angle, and the control effect is obviously improved. It has a double-pipe independent cold water system, to save pesticide and water.

Technical points: The pulse engine is used as the power. When the pesticide machine is working, the high-temperature and high-pressure air produced by the pulse jet engine is ejected at high speed through the fuming tube. After opening the liquid valve, the drug supply system sends the liquid into the nozzle according to a certain amount and is mixed with high-temperature and high-speed air flow. At the moment of meeting, the liquid is broken and evaporated, and synthetic fog is ejected from the end of the tube and spreads quickly. When objects such as diseases and pests are exposed to the fog, they can be killed quickly.

Matters needing attention: (i) Be sure to add pure gasoline of national standard 9 or above, off-color gasoline can not be used. (ii) Do not press the oil bubbles many times when there is gasoline in the oil pipes and oil bubbles. (iii) Be sure to close the water valve before flameout and shutting down. (iv) For every 4 to 5 barrels of pesticide sprayed, it is necessary to clean up the carbon deposits on the front end of the spray cylinder. When the electricity is insufficient, it should be charged in time to prevent it from being unable to charge due to excessive discharge. (v) When the machine is not in use for a long time, be sure to exhaust the gasoline in the machine and recharge once every 2 to 3 months.

The villagers of Jiangji Village in Sunji Street reported that the amount of pesticide used after the use of the insecticide-spreading instrument was reduced by an average of 10%, and the average application time was reduced by about 83%. In addition, it can also save planting costs, improve control efficiency and reduce pesticide residues.

3.3 *Bacillus cereus* The suspension of *Bacillus cereus* containing 1 billion spores per g was used to control root-knot nematode in cucumber, towel gourd, tomato and other vegetables with good control effect. It enhances the disease resistance of crops and promotes the growth of new roots to resist root-knot nematodes^[5].

Technical points: The activator was added to dormant *B. cereus*. After 1:50 dilution, it can quickly break dormancy, activate activity and accelerate reproduction. The number of *B. cereus* and actinomycetes in soil can be increased by more than 100 times within 5 d. This makes the root-knot nematode lose its living space, thus improving the effect of killing the nematode, and killing the nematode more thoroughly.

Matters needing attention: (i) Do not use soil fungicides within 10 d before using this product. (ii) Soil fungicides and highly toxic pesticides can no longer be used after the use of this product, otherwise the effect will be affected. (iii) The container for dilution must be cleaned thoroughly before use, so as not to affect the biological activity of the product. *B. cereus* can activate soil, automatically adjust soil pH and destroy the living environment of root-knot nematodes. At the same time, it alleviates the soil salt damage caused by excessive or unreasonable use of chemical fertilizer, and has a good control effect on all kinds of soil-borne diseases while controlling root-knot nematode. Villagers in

Yangjiyaohe Village, Luocheng Street, said that the pesticide had an obvious and a long lasting control effect on loofah root-knot nematode disease in the greenhouse, improved soil quality, promoted the healthy growth of plants, and enhanced resistance to diseases and pests.

3.4 Flame disinfection service based on fine rotary tillage

Flame disinfection service based on fine rotary tillage is to carry out flame disinfection of soil on the basis of fine rotary tillage. At the same time of killing root-knot nematode larvae, it also has obvious killing effect on fungi and bacteria in soil. Soil disinfection service is carried out by physical method, which is green, environmentally friendly and pollution-free.

Technical points: (i) Fine deep ploughing. The deep tiller is used to plough the soil to 35–40 cm (tilled soil) so that the soil particles are smaller than 2 cm. At the same time, it breaks the original tillage pan, eliminates soil compaction, increases soil water permeability and air permeability, and reduces the occurrence of soil acidification, secondary salinization and so on. (ii) High temperature flame disinfection. The high temperature flame disinfection and insecticidal machine is used to disinfect and kill insects. The deep soil of 30–40 cm is dried by soil plate and fly-wheel and spreads into the oven. When the soil plate falls, burning is carried out, so that the effective killing rate of root-knot nematodes in the soil is up to 92.00%–98.89%. At the same time, it also has obvious killing effect on pathogenic fungi and bacteria in soil and weed seeds. (iii) Combined with high temperature treatment of solar greenhouse. After high temperature flame disinfection, the soil temperature within 30 cm reaches the lethal temperature of nematodes. At this time, combined with high temperature treatment of solar greenhouse, the soil can maintain a high temperature for a long time, and the killing effect is more obvious. (iv) Combined with microbial prevention and control. In order to make the disinfection effect more lasting and effective, after crop planting, microbial agents such as *B. cereus* and *Bacillus firmus* are applied or drip-irrigated to control root-knot nematodes. It is necessary to increase the application of *Bacillus subtilis*, *Bacillus polymyxus* and *Bacillus megaterium* to control soil-borne diseases so as to maximize the control effect.

Advantages: This technology does not use pesticides, and it can use high temperature for the decomposition of some pesticide residues in the soil, and has a single operation for multiple effects. First, the method of sterilization and pest control is simple and thorough. The second is fine deep ploughing with a depth of 30–40 cm, which can loosen the soil, break the tillage pan and solve the problems of soil secondary salinization caused by excessive use of chemical fertilizer. Third, there is no pollution, no residue, and it is green and environmentally friendly, and will not cause harm to vegetables. Fourth, it is flexible, it can plant vegetables after the drop of soil temperature, and it can be used in open fields all the year round. This is a green, environmentally friendly and efficient soil disinfection technology worth popularizing.

Matters needing attention: Due to the use of liquefied gas as the power source, it is necessary to follow the operating rules to ensure safety. Daotian Town villagers said after use that the insecticide-spreading instrument is easy to operate, and can save time

and effort. Without the use of pesticides in the whole process, we can achieve the goal of sterilizing and killing eggs. At the same time, it can also reduce all kinds of soil problems, and it is green, environmentally friendly and pollution-free.

3.5 Multi-function plant protection machine The insecticide-spreading instrument is independently developed by the National Agricultural Intelligent Equipment Engineering and Technology Research Center. It is mainly used for greenhouse agriculture, and its main functions are sterilization, deworming, heating, deodorization, epidemic prevention and so on.

Technical points: The ozone produced by the plant protection machine can be quickly and evenly spread to the whole space of the greenhouse through high-speed and high-flow fans and special air passage. When ozone reaches a certain concentration, it can decompose the cell walls of bacteria and fungi, destroy DNA, destroy their metabolism and reproduction, and achieve the purpose of killing bacteria. According to the features of pests moving in response to yellow and blue, the plant protection machines are equipped with blue and yellow trapping lights, and can also kill adults of aphids, whitefly, thrips and other pests. At the same time, the plant protection machine is also equipped with 1 000 W heating pipe, which can temporarily heat up and prevent frost injury in extreme low temperature weather, prolong the growth period and increase the yield.

Matters needing attention: When using plant protection machines, we cannot use bumblebees for pollination at the same time, nor can we use natural enemies to control pests at the same time.

Application examples: It is used in the Demonstration Park of Modern Agricultural Innovation and Entrepreneurship in Tianliu Town, Shouguang City. Without the use of pesticides, tomatoes are growing well and there are no diseases and pests.

4 Mode of popularization and application

The promotion of new green prevention and control technology and new products is an important task to benefit the people, determined by the Shouguang Municipal Party Committee and the Municipal Government. The municipal government office issued an implementation plan, which combines enterprise self-sale with promotion at the city, town and village levels, and the municipal government invests in subsidies for bid-winning products. Among them, dual-purpose fog and mist sprinkler machines and electrostatic sprayers are subsidized by 50%, biological agents by 60%, and flame disinfection service based on fine rotary tillage by 70%. Apart from the financial subsidies, the remaining funds shall be handed over to the village committee by the growers, parks, cooperatives, etc., who procure pesticides and products. A village-level staff member is responsible for the supervision and recording of the purchase. It is necessary to leave the purchase image data and fill in *Promotion and Management Account of Insecticide-spreading Instrument Purchase* at the same time. After confirmation, the village committee shall affix its official seal on it and publicize it in the open column of the village committee, and hand it over to the town (street) without objection. The town (street) transfers

the money to the bid-winning enterprise account through the bank in time, and checks and summarizes the *Promotion and Management Account of Insecticide-spreading Instrument Purchase* in each village. After confirming that it is correct, it shall be reported to the Agricultural and Rural Bureau together with the bank bills, the video materials of the pesticide purchase site and the public photos with the official seal. It is strictly forbidden to sell the bid-winning products through the sales outlets of the bid-winning enterprises.

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(From page 77)

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