Comprehensive Prevention and Control Technology of Vegetable Diseases and Pests in Shandong Province

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Abstract An in-depth research and practice has been conducted on vegetable diseases and pests in Shandong Province, and the principles of comprehensive and ecological control of diseases and pests are put forward, including agricultural control measures such as crop rotation, field cleaning, fertilizer and water management, physical control measures such as catching and killing, trapping, blocking, photoelectric energy treatment, biological control measures such as the use of natural enemies, pathogenic microorganisms, other beneficial organisms and metabolites, and scientific and rational chemical control measures. Comprehensive prevention and control not only controls vegetable diseases and pests effectively, but also protects the ecological environment.

Key words Vegetable; Diseases and pests; Comprehensive prevention and control

1 Introduction

Shandong Province, located in the east of China, the lower reaches of the Yellow River, has superior climatic conditions, with an average annual temperature of 11 - 14 ℃, the average annual precipitation of 550 - 950 mm, and the average annual sunlight of 2 290 - 2 890 h, which are suitable for the development of high-quality vegetable production. The vegetable planting area in Shandong Province reaches 1 524 700 hm^2, and the total output is 88 million t, accounting for 6.9% and 11.4% of the national level, respectively. In recent years, the prevention and control of vegetable diseases and pests has become an important issue of concern to the whole society, which is related to the high quality and high yield of vegetables and the sustainable development of agriculture, and is associated with the protection of agricultural ecological environment and the health of the masses.

Comprehensive prevention and control of vegetable diseases and pests is a kind of management system for diseases and pests that controls diseases and pests under the economic injury level by natural enemies and appropriate technologies and methods according to the population dynamics of diseases and pests and the relevant environmental relationship. To systematically control vegetable diseases and pests, promote agricultural efficiency and farmers' income, and promote rural revitalization, Shandong Agriculture and Engineering University has explored a systematic vegetable disease and pest control technology through years of research and practice.

2 Prevention and control principle

The negative impact on the agricultural environment caused by prevention and control should be considered from the whole agricultural ecosystem. In the process of comprehensive treatment, all kinds of treatment measures should be integrated to make them coordinate with each other and exert the maximum effect, thus controlling the harm of diseases and pests within the economic threshold level.

2.1 Comprehensive principle In the implementation of comprehensive management, it is necessary to coordinate the use of agricultural, physical, biological, and chemical controls, in order to control the harm of diseases and pests effectively.

2.2 Ecological principle Based on the relationship between the environment and diseases and pests, comprehensive management can comprehensively solve the problem of diseases and pests by analyzing the relationship between various ecological factors from the vegetable field ecosystem.

2.3 Control principle In the process of comprehensive management, it is necessary to give full play to the role of natural control factors (such as climate, natural enemies, *etc.*), prevent the occurrence of diseases and pests, and control the damage of diseases and pests below the economic injury level rather than completely eliminate diseases and pests.

3 Agricultural control

Some factors can be changed purposely following the relationship between the environment of vegetable field and diseases and pests, so as to achieve the purpose of protecting vegetables and preventing diseases and pests.

3.1 Rotation Crop rotation is an important measure to combine the cultivation and use of land and ensure the increase and stable yield of vegetables. It can balance the use of soil nutrients, improve soil physical and chemical properties and fertility, and achieve the purpose of controlling diseases and pests. Water and drought rotation receives certain effects, especially for some soil-borne diseases such as wilt of Solanaceae and Cucurbitaceae vegetables, and underground pests such as cutworms, scarabs, mole

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crickets, *etc.* Root knot nematodes of vegetables can be controlled by crop rotation with non-host vegetables.

3.2 Garden cleaning Some pathogens and pests have a wide range of hosts, and field weeds, especially perennial weeds, are often the primary sources of infection of some vegetable pathogens and the overwintering sites or shelters of pests. Therefore, eradicating weeds in the field is of great significance for the prevention and control of diseases and pests. Removing residues in vegetable fields and destroying habitats where pests breed and overwinter is another important technique for disease and pest control. For example, *Peronospora parasitica* of Chinese cabbage survives the winter as oospores in diseased leaves; *Plasmodiophora brassicae* of Chinese cabbage overwinters in the daetylorhiza with dormant spores; *Colletotrichum capsici* goes through the winter in diseased fruits.

3.3 Fertilizer and water management Reasonable fertilization and irrigation are closely related to the growth of vegetables and the occurrence of diseases and pests. The type, amount and application method of fertilizer are associated with the occurrence of diseases and pests. Various fertilizer elements have different performance on vegetable growth. Generally, increased application of phosphorus and potassium fertilizer is beneficial to the mechanical tissue formation of vegetables, and enhances disease and pest resistance. Organic fertilizers, especially municipal waste, contain a large number of pathogens and insect eggs, which must be fully decomposed before application. Timely drainage and irrigation is a particularly important technical measure in vegetable production, which can quickly change the environmental conditions of vegetable fields, playing a significant role in the prevention and control of many pests.

4 Physical control

Physical control refers to the method of applying equipment and various physical factors, such as light, electricity, color, temperature and humidity, *etc.*, to prevent and control diseases and pests. Physical control is featured by labor saving, low cost, simplicity and high efficiency.

4.1 Catching and killing Wormy fruits, wormy leaves and worm cysts can be removed purposefully by using the living habits or biological characteristics of pests, such as clustering, deth feigning and latency, or simple instruments can be used to vibrate and kill scarabs, dig and capture cutworms, and hook and kill longicorn larvae and other pests.

4.2 Trapping Pests can be trapped and killed intensively by using taxis and other habits. Black light can be used to trap *Hellula undalis*, *Plutella xylostella*, *Prodenia litura*, *Argyrogramma agnate*, *Mamestra brassicae*, *Spodoptera exigua*, and tiger moth adults; yellow basin containing washing powder can be settled according to the positive taxis of aphids to yellow, or yellow sticky trap can be hung; sex attractants such as live pests, crude extracts of pest sex hormones and sex attractant products can be used to kill or trap pests.

4.3 Blocking According to the characteristics of the occurrence of diseases and pests, obstacles can be set up to prevent the invasion of diseases and pests. For example, fruit bagging can prevent direct invasion of diseases and pests, and insect nets can defend the invasion of pests.

4.4 Photoelectric energy processing The radiation energy of infrared radiation, flash radiation and rays can cause sterility of pests, and a large number of male sterile pests can be released regularly in the isolation area, to achieve the purpose of killing pests. The use of appropriate laser wavelengths can kill pests selectively.

5 Biological control

According to the types of natural enemies, biological control can be divided into predation and the use of parasitic natural enemies (treating insects with insects), the use of pathogenic microorganisms (treating insects with bacteria, treating diseases with bacteria), the use of other beneficial organisms and the use of biological metabolites.

5.1 Natural enemy Predatory natural enemies mainly refer to the predators which generally capture individual smaller pests, bite insects or suck their body fluids. Adult and larvae generally share the same living habits and can live freely, such as ladybirds, hoverflies, ground beetles, ants, asilids, wasps, *Cassida piperata*, as well as spiders and predatory mites. Parasitic natural enemies generally parasitize large pests, and absorb nutrients in or outside the host by larvae, resulting in the death of the host. Adults can live freely, such as ichneumons, braconids, chalcidoids and tachinids. In production, *Encarsia formosa* presents a control effect of 97% against *Trialeurodes vaporariorum*.

5.2 Pathogenic microorganisms The use of pathogenic microorganisms to prevent and control diseases and pests is also known as "treating insects with bacteria" and "treating diseases with bacteria". In the past 30 years, countries around the world have actively carried out research on the prevention and control of diseases and insects by microorganisms. Due to large reproduction of microorganisms, the products can be manufactured in factories and used in the same way as chemical pesticides. Therefore, a variety of microbial insecticides and fungicides have been developed and gradually commercialized.

5.3 Other beneficial organisms and metabolites It mainly involves the use of genetically sterile insects, agricultural antibiotics, hormones and beneficial animals and plants.

6 Chemical control

Chemical control is an important part in the comprehensive management of diseases and pests, which achieve the purpose of protecting plants by killing and controlling diseases and pests through chemical pesticides and means. Chemical control usually receives fast and outstanding effect, and has the advantages that can not be

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replaced by other measures. However, there are chemical residues of products and environmental pollution and other problems in chemical control, so it is necessary to follow the guidelines for pesticide use and the relevant production technical regulations of vegetables, select high-efficiency, low-toxicity, low-residue pesticide varieties and use rationally, to reduce pesticide residues in vegetables.

6.1 Application method of pesticides There are three main application methods of pesticides: vegetable treatment, seedling treatment and soil treatment.

6.1.1 Vegetable treatment. Vegetable treatment methods include mist spray, powder spray and fumigation. Mist spray is a method of diluting the pesticide with water to a certain concentration and spraying it with a sprayer, featured by less pesticide consumption and good efficacy. Powder spray is the application method of powder pesticide by a duster, suitable for the areas lacking water. The method is characterized by high efficacy and no consumption of water, but has the disadvantages of large dosage, severe drift loss and serious environment pollution. Fumigation is a method of controlling diseases and pests by using chemical volatilization, suitable for disease and pest control in greenhouse, seedling bed and soil. The method is featured by high efficacy, fast action and no water consumption, but has high requirements for application technique and safety protection.

6.1.2 Seedling treatment. Seedling treatment methods mainly include soaking, mixing, smothering, spraying, fumigation and so on. The treatment concentration, time and method mainly depend on the control object.

6.1.3 Soil treatment. Soil treatment methods mainly include spraying, watering, soil poisoning and injection, *etc.*, which are used for soil disease and pest control in seedbeds, root circumference, *etc.*

6.2 Rational use of pesticides Rational use of pesticides is the key to solve the 3R (resistance, resurgence and residue) problem in chemical control. Rational use of pesticides mainly includes rational selection of pesticides, mixing and rotation of pesticides and safe use of pesticides. (i) Rational selection of pesticides. Diseases and pests or individuals at different developmental stages have varying toxicity reactions to the agent because of their biological characteristics and living habits, so appropriate pesticide varieties should be selected according to the control objects and development stages in production. (ii) Mixing and rotation of pesticides. The combination or rotation of two or more pesticides can delay the development of disease and pest resistance while playing the role of quick effect and increasing efficiency. (iii) Safe use of pesticides. The use of pesticides must be targeted at different vegetable varieties, and appropriate pesticide types, concentrations and periods should be selected rationally. Highly toxic and high-residue pesticides are strictly prohibited in production, and the amount of pesticide residues and safety intervals are strictly controlled to avoid human and animal poisoning.

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