Prevention and Control of Main Vegetables Diseases and Insect Pests

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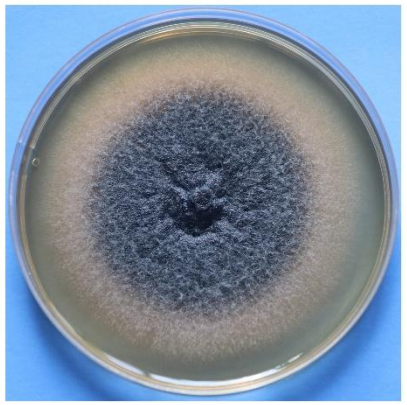


1. Basic biological and physical prevention and control measures for diseases and insect pests of main vegetables

1. Basic biological and physical prevention and control measure

- **Section 1: Resistant varieties**
- The selection of vegetable varieties should not only be based on local market demand, consumption trend and rotation time, but also the main epidemic diseases of the local vegetables we planting.
- Using resistant variety is the best measure for disease control.

soft rot and the difference among Chinese cabbage varieties

1. Basic biological and physical prevention and control measure

- **Section 2 Planting plot selection**
- Vegetable planting plots should be flat terrain with loose and deep soil and well nourished, and Water is readily available.
- Besides, having ditch around planting area can discharge in time the heavy rain or irrigation water, reduce soil moisture and the humidity in the field, thus reduce the disease occurs greatly.

1. Basic biological and physical prevention and control measure

Section 3 Scientific and reasonable rotation

- 1) The occurrence of many diseases or insect pests has obvious seasonal, for some it is hard to control by biological or chemical pesticide. Planting earlier or later, avoiding the peak period of the diseases or insect pests can reduce pesticide, and ensure the safety of vegetable products

2) In order to avoid continuous cropping obstacles, rotation between crops phylogenetic relationship the far the better. pepper rotates with corn or pepper rotates with watermelon are successful.

1. Basic biological and physical prevention and control measure

Section 4 Seed treatment

Many diseases can be spread by seeds. if the seedling infected, the lose of the yield is great. So seed treatment is very important for disease control.

1) Soaking seeds in 55℃ warm water for 15-40 minutes can deal with most of pathogens on the seeds, depending on seed size and tolerance, and the seeds must be dry.

2) While Some seeds, such as celery, are not suitable for treating in 55 ℃ water, because it need low temperature to germinate. Thus treat seeds with 2% Sodium hypochlorite（NaClO ）for 10-20 minutes or other chemical reagent can remove almost all the pathogens except for virus.

3) As for virus infected seeds should be soaked with 10% trisodium phosphate for 30 minutes or 1% potassium permanganate for 10 minutes.

Garlic seeds treated with 27% Culasi (thiamethoxam 22.6% + fludioxonil 2.2%+ difenoconazole 2.2%) for garlic maggots control

Cucurbitaceae seeds treated

Green Chinese onion seeds

Green Chinese onion seeds pelleted uniformly for sowing by machine

Seeds treated with reagent in different bright colour so as to distinguish from untreated

1. Basic biological and physical prevention and control measure

Section 5: Soil or facilities disinfection

Specific measures are: mixed microbial agents, decomposing straw or other crop residues, high temperature in summer and the heat from decomposing organic matter can be used for soil or facilities disinfection. For continues planting soil or long-term facilities, pathogen and insect pests will continue to grow. High temperature in summer and the heat from decomposing organic matter can be used for soil or facilities disinfection. 4-8m3/667 m2. keep soil moisture 65-75%. By the heat from decomposing organic matter and the high intensity of solar radiation in summer, the temperature in the facility reach more than 60 ℃ and the soil temperature of the plough layer reached above 45 ℃, and the pathogen and some underground pests were eliminated. This process lasts for 15 ~ 20 days, and at least 15 days in sunny.

facilities disinfection with dazomet in summer, the process in details will be showed later

Soil disinfection with chloropicrin in open land in late autumn or early spring in north China

1. Basic biological and physical prevention and control measure

Section 6: Water and fertilizer management

Water and fertilizer directly affect field moisture and soil electric conductivity(EC value), and also affect root development and plant growth. Suitable water and nutrients make plant strong, even pathogen coming, few or slight symptom occur. On the contrary, the plant is abnormal without resistance to pathogen.

Each vegetable at different growth period has its own nutrient absorption rule, the fertilizer we supplying should be based on the rule. Basically, the demand for fertilizer and water increases along with the increase of seedling growth.

As for water supply , drip irrigation is mostly used to save water, and reduce moisture in fields, and reduce the occurrence of diseases.

Laying drip irrigation pipes for onion in open field

drip irrigation very common in facilities

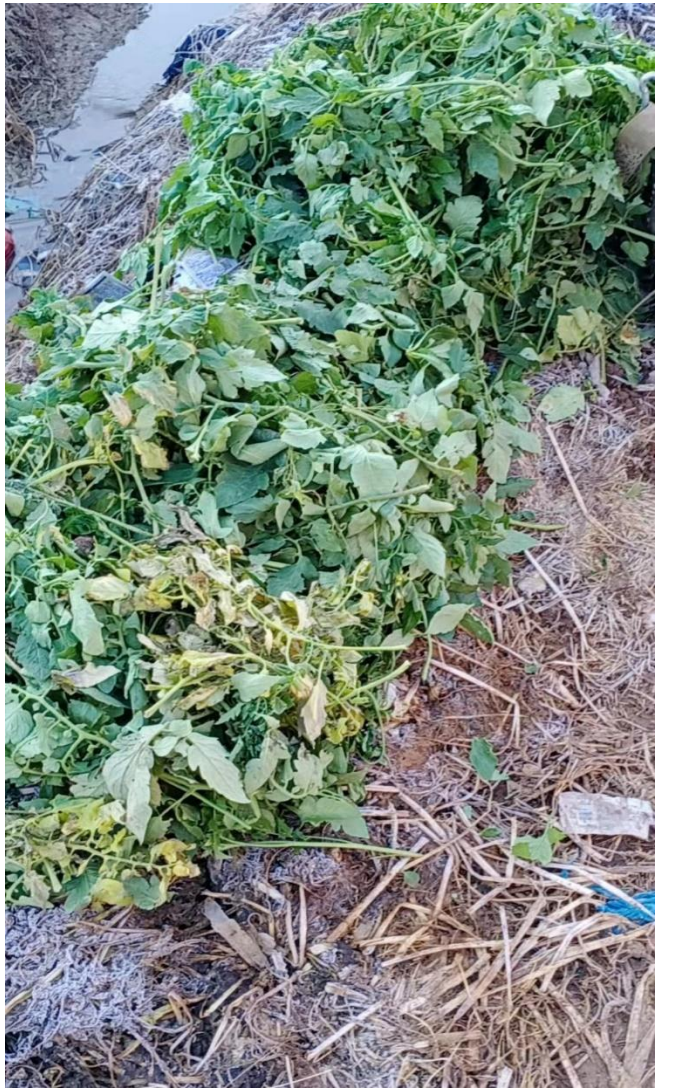
1. Basic biological and physical prevention and control measure

Section 7: Treatment of remnants after harvest

After harvest, the field has lots of plant remnants with pathogens and eggs of pests. Spraying mixed microbial reagent to the remnants can decompose them into organic fertilizer, returning some nutrient to the soil without worrying about the pathogens on the remnants. For the mixed microbial reagent can inhibit or kill the pathogen, and keep the soil microbes in balance.

However plant roots infected with root-knot nematodes or clubroot of crucifers need to be dug out with their rhizosphere soil and treated separately with chemical reagent in a sealed environment/plastic bags, such chemicals as lime nitrogen, chloropicrin and dazomet. Pay attention that the infected roots can not directly returned to the soil.





The remnants threw away as garbage before the returning soil technique comes out, polluting the environment

Spongy soil and long root of cucumber after the remnant returning soil for 3 year

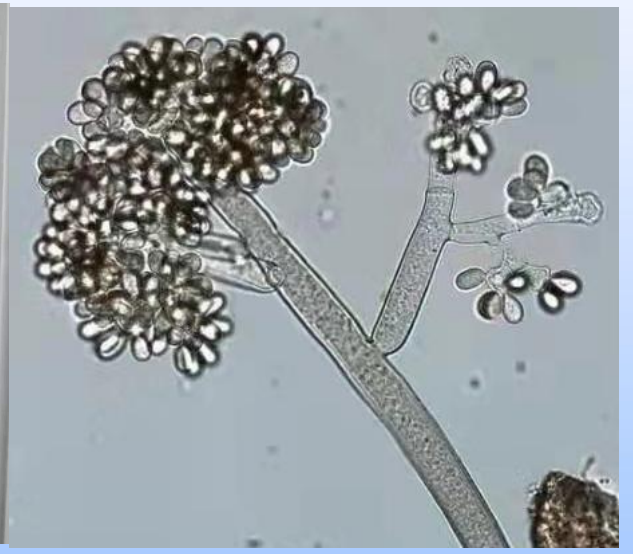
mixed microbial reagent

spray microbial reagent to the remnants

Fresh cucumber remnants return to soil

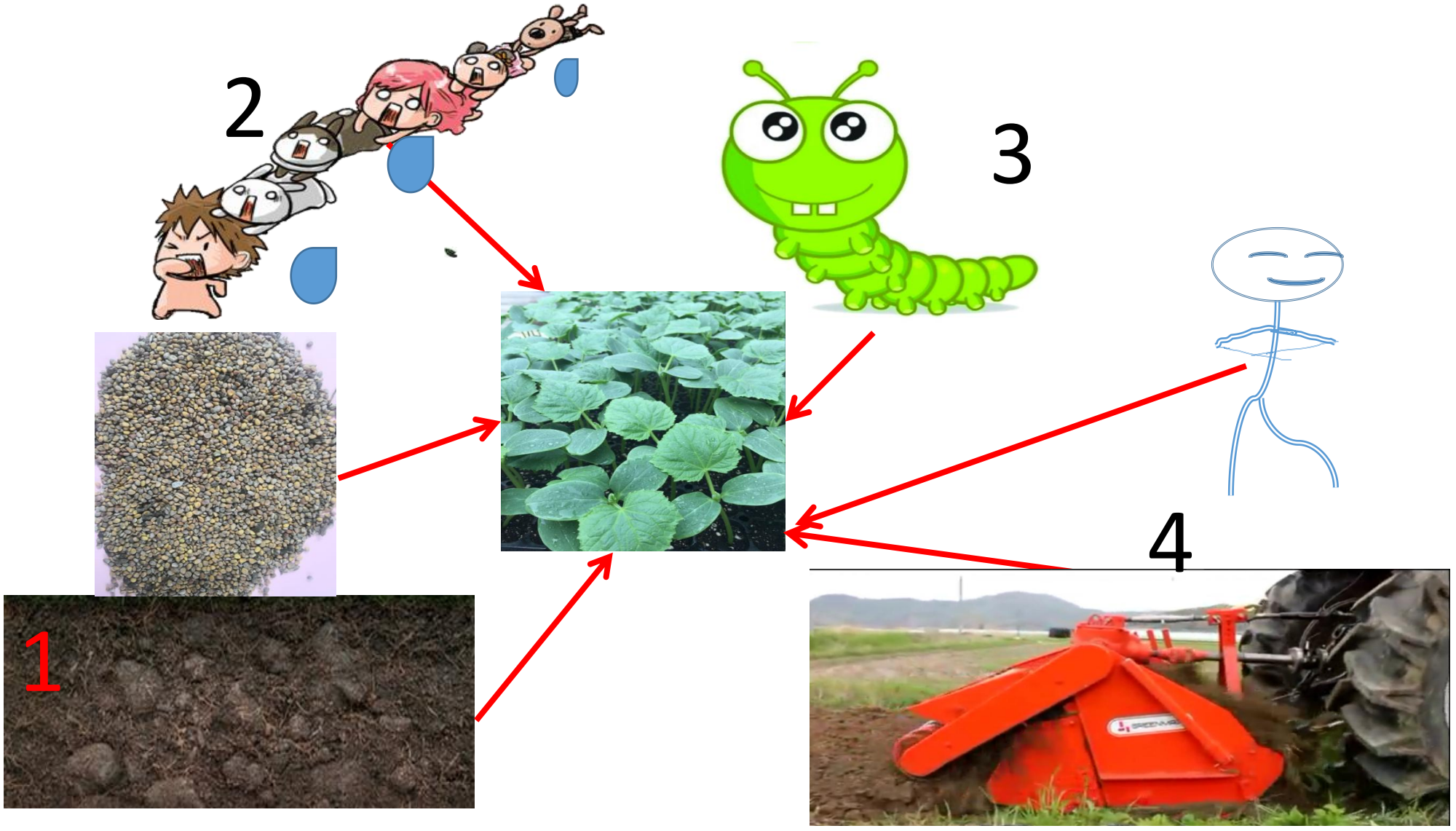
2. Field diagnosis and control measures of main vegetables diseases



2. Field diagnosis and control measures of main vegetables diseases

- **Section 8 The main route of disease transmission**



Route 1 soil-borne and seed-borne disease

Many pathogens can survive in the soil for 3~6 months or even 3 years with the infected tissue or other remnants, and seeds also can carry fungi, bacteria, viruses and other pathogens and still alive after sewing in soil. So many pathogens can transmitted by soil or seeds.

Section 9 Root rot and stem base rot (fungi)

Scope of infection

Root rot and stem base rot can occur in many crops, such as celery, cucurbitaceae vegetables(cucumber, watermelon, muskmelon), solanaceous vegetable(tomato, eggplant, pepper), strawberry, onion and so on.

pathogen

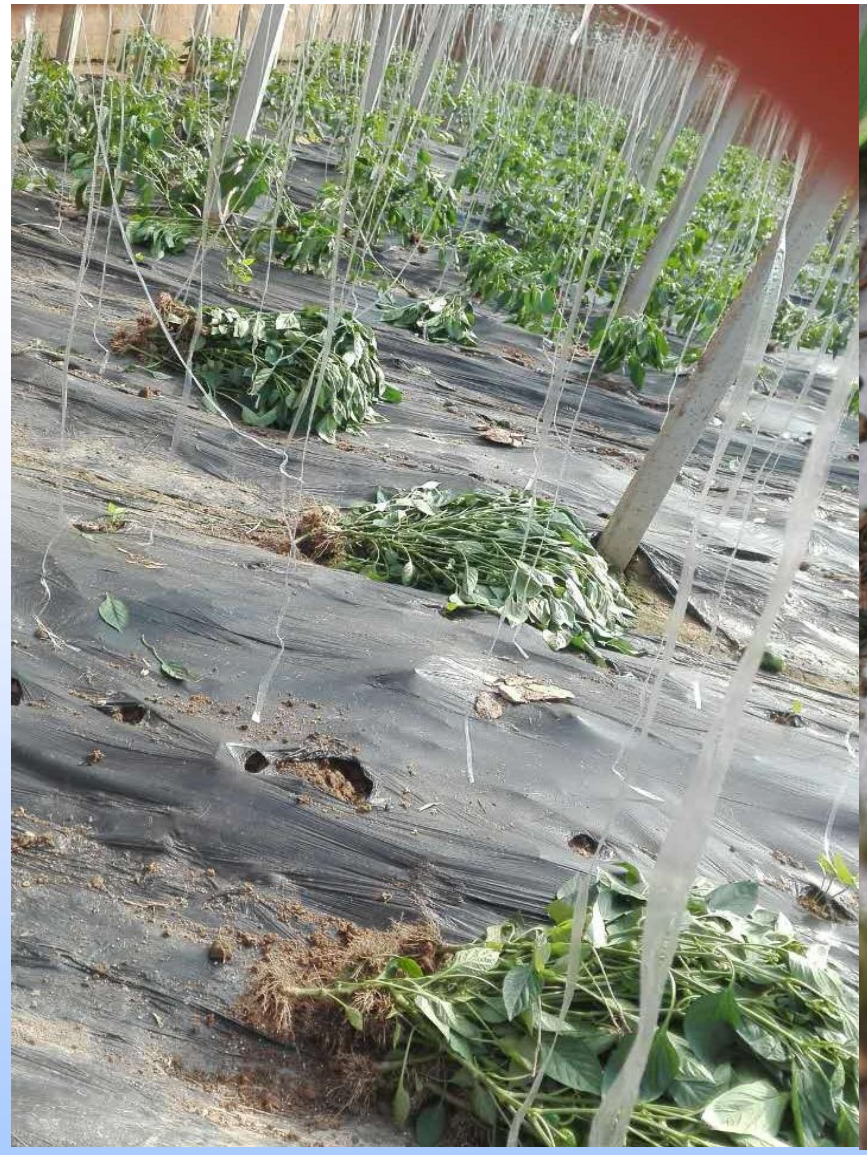
These disease often caused by Fusarium oxysporum or Fusarium solani.

Field symptom

Watermelon wilter under high sunlight

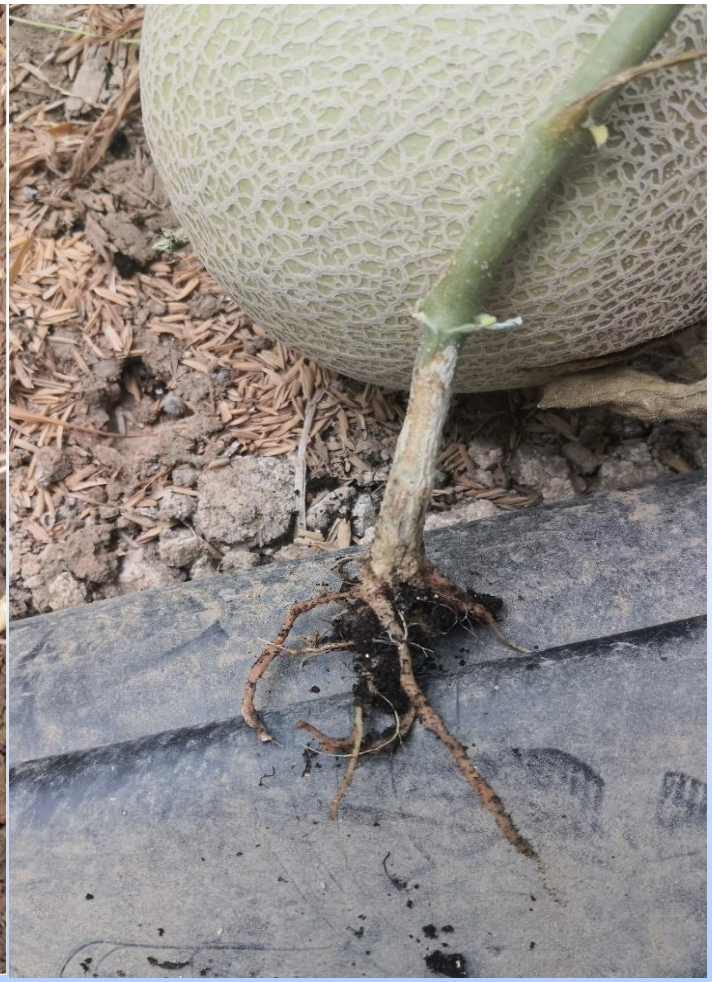
Root rot occurred in weaker plants

Field symptom- Pepper root rot and stem base rot



Different symptoms of tomato root rot





Root rot in maskmelon

Cause and Control measures

The reasons that make the plants' root rot are as below

There are many microbe in the soil, include pathogen Fusarium oxysporum or Fusarium solani. They are all fungi. Before infection, damage to the seedlings often occur first by **high soil moisture content** or **high concentrations of fertilizer** or **high temperature with high humidity** or **low temperature with high humidity.**

No matter high soil moisture content, high humidity, high concentrations of fertilizer or abnormal soil temperature, they all can make roots weaker, the root can not breath or uptake nutrition, and anaerobic respiration and damage occur in plant.

Fungi isolated from strawberry root rot

Pythium myriotylum isolated from ginger root rot

mycelia behave different

Control measures

1. Remove the factors causing root damage

Supplying plant with comfortable water and fertilizer. It is necessary to know the weather conditions for the next few days. Do not water before cold air comes and also the midday in hot day. Fertilizer supplying including the amount and the specifications is more complicated, it takes you some time to get the information about the performance of seedlings nutrition need and that of the soil. The amount and the specification of the fertilizer used are also connect with the amount of the water, so at the beginning supplying fertilizer with the principle of low concentration and multiple times.

2. Supplying more fully decomposed organic fertilizer

High organic matter contributes to the formation of soil granular structure, which help to loose the soil and maintain water and fertilizer in soil. The roots in this kind of soil stretch longer, for example cucumber root can grow over 2 meters. Besides high organic matter contributes also to balance the microbe in soil. The accumulation of pathogens is necessary for its epidemics

3. Chemical pesticides

Once root rot occurs, Chemical pesticides is the last means of remedy

The infected root was irrigated with 150~200ml 70% Thiophanate-Methyl wettable powder 800~1000 times solution mixed with 77% copper sulfate calcium wettable powder 400~500 times , or irrigated with 150ml ~200ml 70% hymexazol wettable powder 3000 times solution.

These measures can be done before planting seedlings. Only dip the roots in the solution for 2-3 seconds, then planting. This measure can prevent root rot occur

Section 10 gummy stem blight(fungi)

Scope of infection

Gummy stem blight occur mainly in Cucurbitaceae vegetables, such as cucumber, watermelon, muskmelon, and very serious in continuous watermelon planting field

pathogen

These disease often caused by *mycosphaerella melonis*, a kind of fungi

Causes

disease on the seeds or in the soil, high humidity in the field, high planting density and excessive nitrogen supplying are the main reason. Strengthening cultivation management can effectively reduce the occurrence of this disease.

gummy stem blight infected cucumber leaves

Something gummy come out first at early infected stage

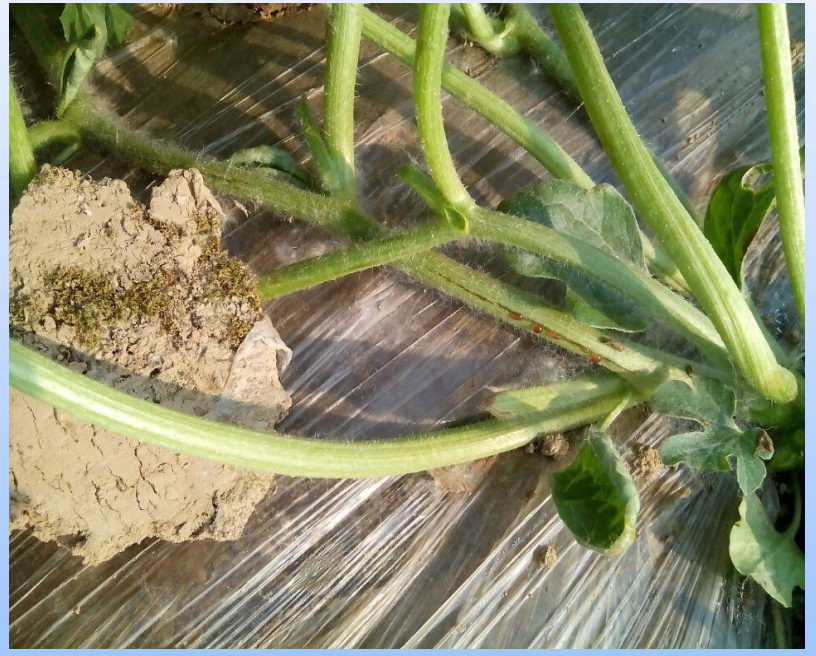
typical V-shaped lesions

Black particles on the V-shaped lesions is its spore

Infected melon stem

Infected cucumber stem

Infected watermelon stem



Infected watermelon stem

Control measures

1. Seed treatment

Ensure that seeds pathogen-free first. Do as section 4 introduction

2. Cultivation

Reduce relative humidity below 80%, reduce seedling density and let in sunlight and wind, balance the nutrient supply of nitrogen, phosphorus, potassium, calcium and magnesium.

3. Chemical pesticides

Once seedlings infected, Chemical pesticides list below can be used to control the gummy stem blight.
Chemical main ingredients' English name is :
pyraclostrobin, difenoconazole, myclobutanil, vinclozolin, 6% azoxystrobin mixed with 50% chlorothalonil, or Phenazino-1-carboxylic acid

Section 11 bacterial soft rot

Scope of infection

bacterial soft rot can occur in many vegetables, cucurbitaceae crops, crucifer crops, solanaceous crops, and onion and garlic plants such as cucumber, watermelon, muskmelon, summer squash, Chinese cabbage, broccoli, cabbage, radish, potato, tomato, pepper, leeks, onion, celery et.al. all can be infected. **Soft rot** is the most obvious characteristic.

pathogen

These disease often caused by one kind of bacteria, eg. *Erwinia carotovora subsp.* bacterial canker, *Ralstonia solanacearum et.al.,*

Bacterium overflow in infected tissue by microscope

epidemic causes

Beside the pathogen exists, the presence of wound is necessary for bacterial infection, including natural cracks, insect bites, disease marks and mechanical wounds. And the epidemic of bacterial diseases also need humid and rainy days. In early October this year, there are 9 rainy or cloudy days with low temperature, so it's reported that the soft rot bacterial disease in Chinese cabbage and cucumber is very serious. Weather condition and soft rot field symptom list below.

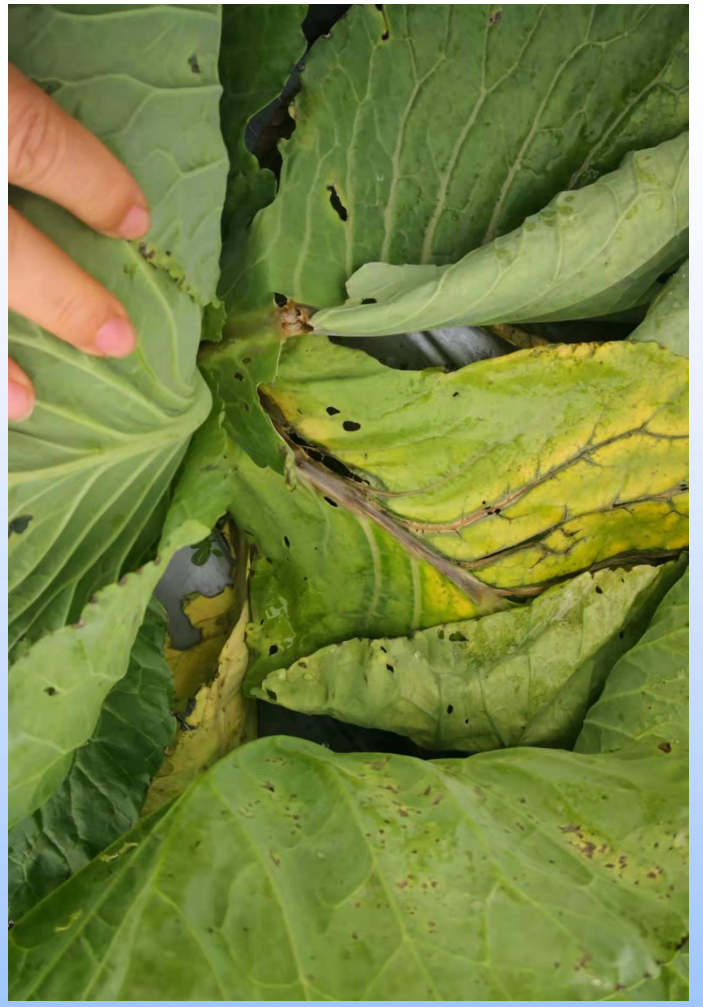
Weather condition in early October of 2021

Date	highest temperature(℃)	lowest temperature(℃)	weather situation
2021-10-02	27	21	cloudy
2021-10-03	27	21	thunderstorm turned to moderate rain
2021-10-04	22	14	Moderate to heavy rain
2021-10-05	16	13	Light rain
2021-10-06	15	13	Light rain to moderate rain
2021-10-07	16	12	Overcast to cloudy
2021-10-08	20	11	Cloudy to light rain
2021-10-09	21	14	Cloudy to light rain
2021-10-10	17	10	Cloudy

Field symptom

Chinese cabbage soft rot and the different Resistance among varieties

Symptom of Soft rot in Chinese cabbage and cabbage



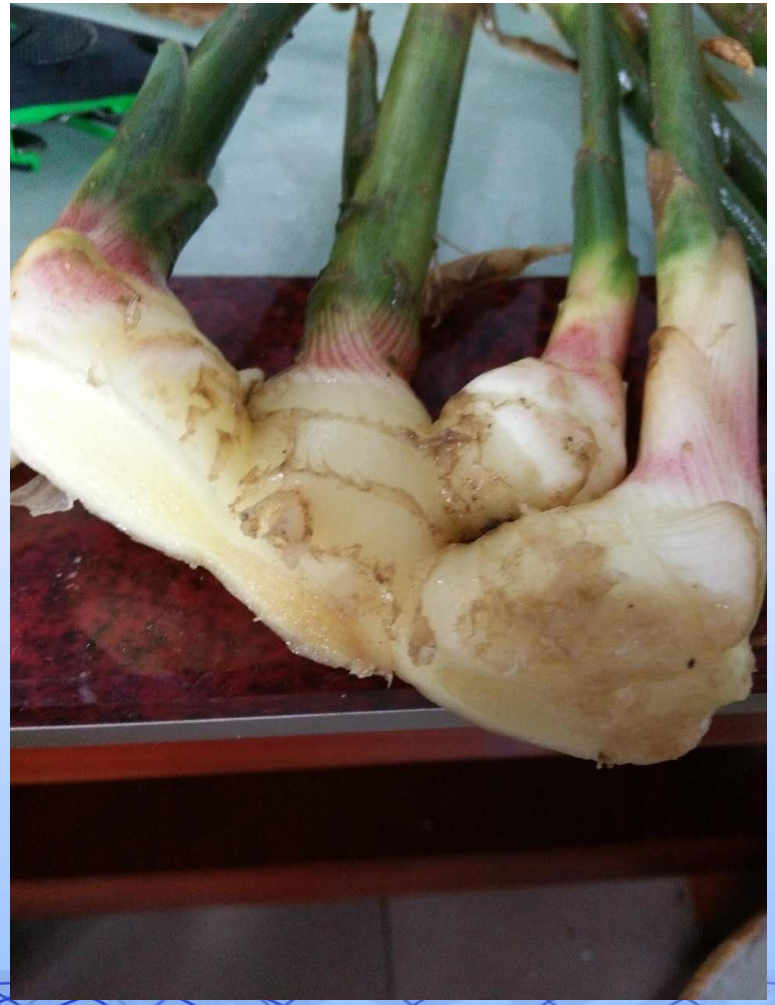
Different symptom of soft rot in different cucumber varieties leaves infected with the same pathogen

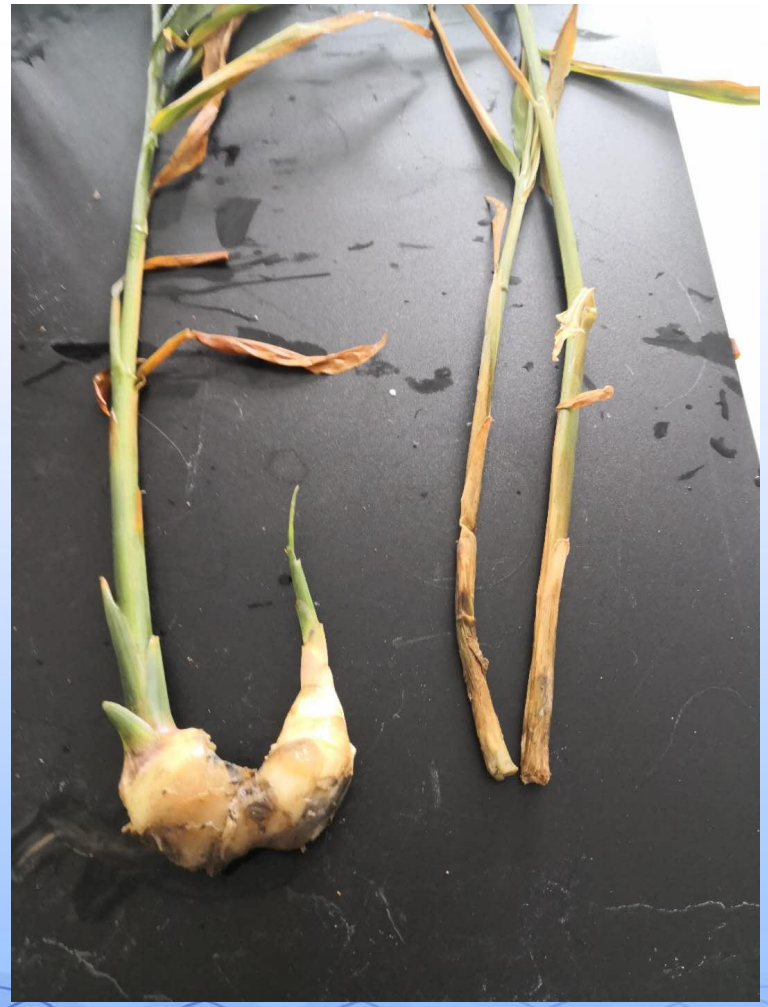
Symptom of Soft rot in cucumber stems leaves and fruits

Symptom of soft rot in summer squash stems

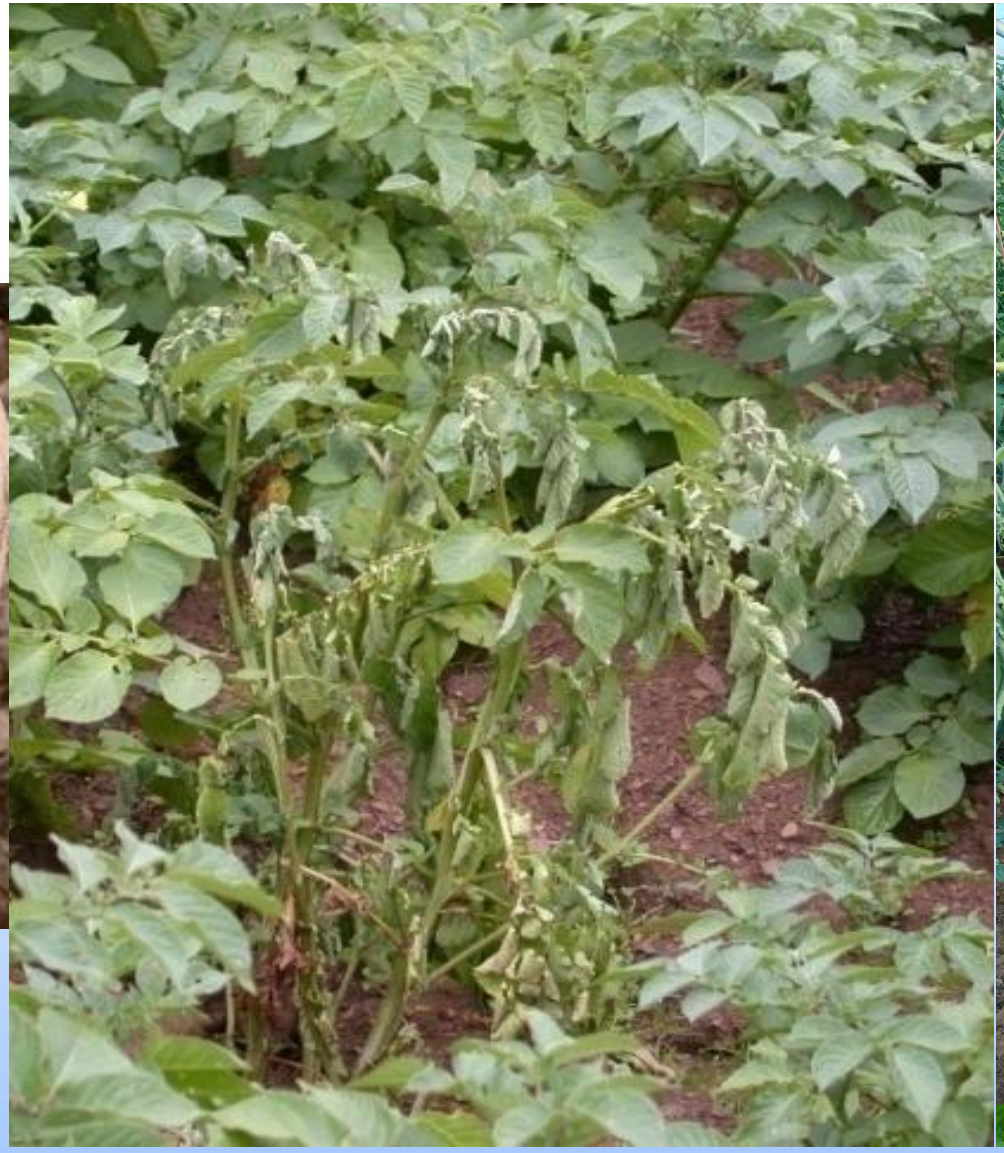
bacterial canker in tomato stem, leave, petiole and fruits

Ralstonia solanacearum cause damage to ginger





Ralstonia solanacearum cause damage to Solanaceae crop potato and tomato



Control measures

1. Remove the factors causing wounds

No wounds no infection. Pruning, forking, leaf picking, fruit picking, strong wind, heavy rain, excessive watering, high concentration of fertilizer and so on, all these farming operations are easy to cause damage to the plant, form wounds. If these situation happen, no hesitate to spray pesticides.

2. Chemical pesticides

For the bacterial disease, the effective chemicals are antibiotin and copper reagents. Antibiotin including Vernamycin, polyamycin, agricultural streptomycin, oxytetracycline et al. copper reagents. There are two types of this kind of chemical, inorganic copper ion and organic copper reagents.

inorganic copper ion mainly used for prevention. Such as Bordeaux mixture, Copper hydroxide, copper oxychloride, inorganic copper ionsare alkaline, can not be mixed with acidic pesticides and fertilizers and should be pay attention to the concentration and time while using. Do not spray when there is dew, do not spray when the temperature is too high, and do not spray before and after flowering. Otherwise there will be drug harm.

Organic copper reagents including Cupric quinoline, Cupric thiamethoxylum, Cupric thiessen, Cupric succinate, use according to manufacturer's instructions.

Route 2 Pathogen spread by Airflow

- This kind of diseases has obvious seasonality, such as powdery mildew, downy mildew, gray mold.

Section 12 powdery mildew

Scope of infection

Powdery mildew is a kind of world wide disease which occurs in many important crops like vegetables(Cucurbitaceae crops, crucifer crop, solanaceous crops), flowers, fruits and wheat and difficult to control.

pathogen

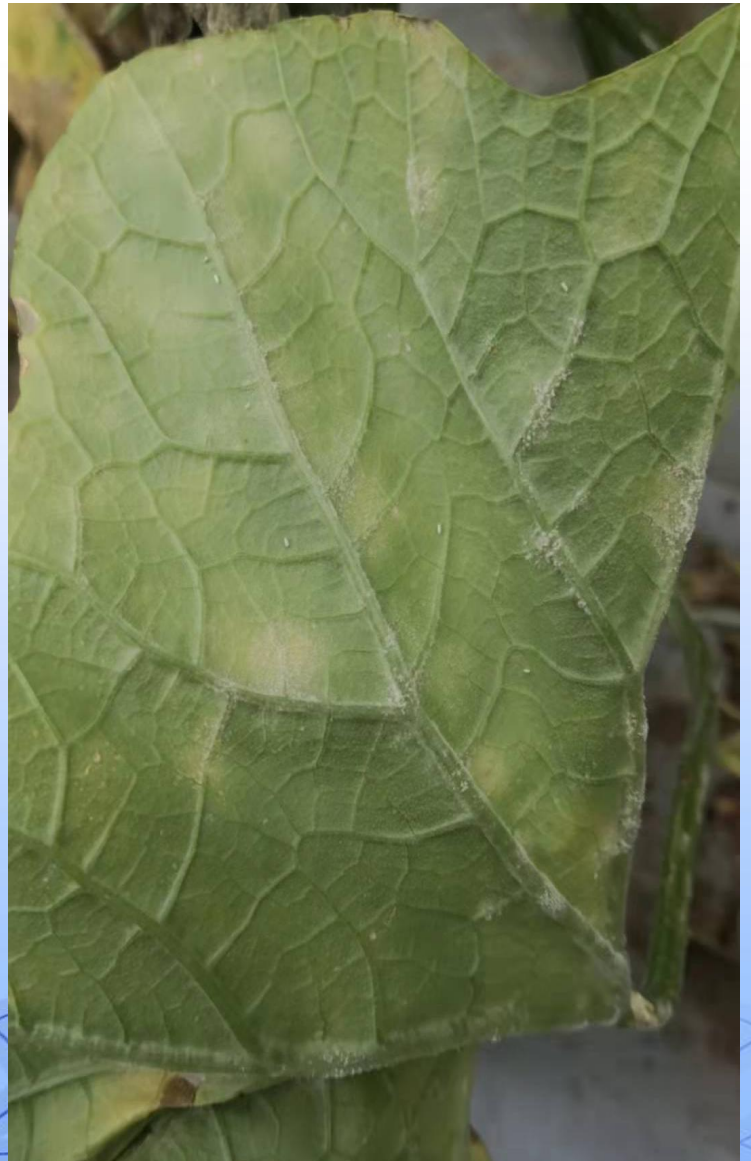
Powdery mildew belongs to Erysiphe of Ascomycota, and has different type of specialization.
Most of the pathogen infect vegetables can not grown on artificial media, and can only be parasitic on living .

epidemic causes

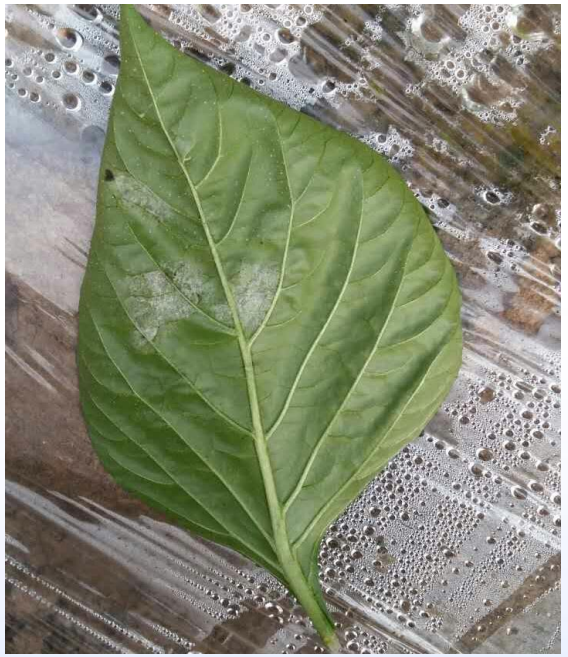
There are two causes for its epidemic : one is Susceptible varieties and the other is environmental conditions are suitable for pathogen, with the help of the airflow, it can spread long distance.

Field symptom

Symptom in leaves of cucurbitaceae crops



Infected pepper leaves upperside and underside



Infected tomato leaves

Control measures

1. Using powdery mildew resistant varieties, Some varieties are immune to powdery mildew.

2. Enhance fertilizer and water management, and ensure that the seedlings are healthy. Reduce field humidity to render it unsuitable for pathogens.

3. Using chemical pesticides
At the beginning of powdery mildew occur, Chemical pesticides is very effective, such as difenoconazole, isopyrazam mixed with azoxystrobin, or fluopyram mixed with trifloxystrobin. Early detected and early treated is the key for effective control

Section 13 downy mildew and late blight

Scope of infection

Downy mildew also has different type of specialization. Here we only discuss the pathogens infect Cucurbitaceae crops, Allium crops and Crucifer crop. Late blight only refers to that of Solanaceous crops. For the onset condition and the method of control are basically the same, so put them together to introduce. Downy mildew only infects crop leaves, while late blight infects leaves, stems and fruits.

pathogen

Downy mildew has different type of specialization. Pathogen infect Cucurbitaceae crops is *Psedudoperonospora cubensis.* Pathogen infect Allium crops is *Peronospora schleidenii,* Pathogen infect Crucifer crop is *Peronospora parasitica.* Most of downy mildew can not grown on artificial media, and can only be parasitic on living . Pathogen of late blight is *Phytophthora infestans.*

epidemic causes

There are two causes for their epidemic : one is susceptible varieties and the other is environmental conditions are suitable for pathogen, especially the temperature difference between morning, evening and noon is too large. This condition help the spread of pathogen.

Field symptom

Upper side

underside

downy mildew infected cucumber leaves

downy mildew infected melon leaves

Upper side

underside

downy mildew infected spinash leaves

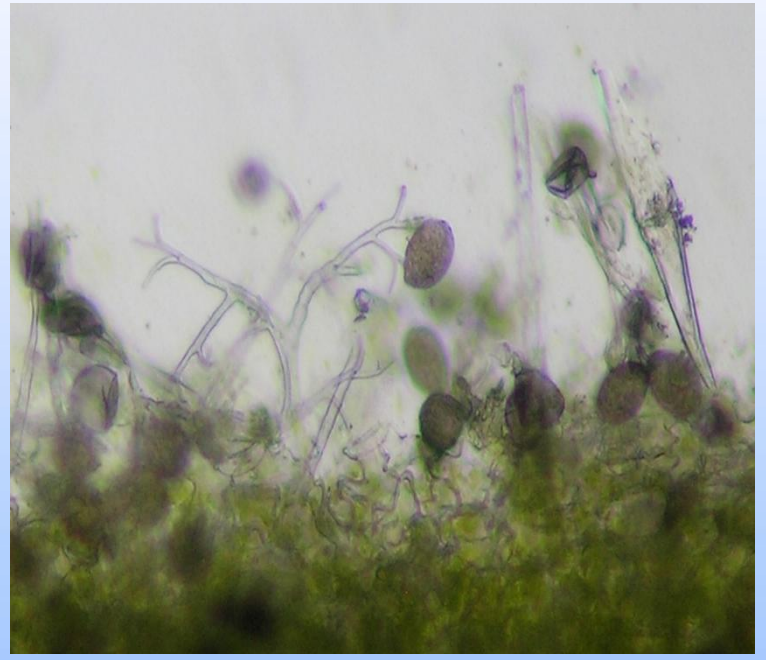
downy mildew infected oilseed rape leaves

Upper side

underside

downy mildew infected Chinese cabbage leaves

downy mildew infected onions leaves



Pathogen by microscope

Late blight infected potato leaves and tuber

Late blight infected tomato stems and fruits

Control measures

1. Using downy mildew resistant varieties, usually varieties resistant to powdery mildew also has some resistant to downy mildew. Crop rotation is also helpful

2. Enhance fertilizer and water management, and ensure that the seedlings are healthy. Planting with reasonable dense. Minimize the temperature difference morning, evening and noon .

3.Using chemical pesticides

At the beginning of downy mildew occur, Chemical pesticides is very effective for controll, such as dimethomorph, cymoxanil, enestroburin, tebuconazole, azoxystrobin, propamocarb or fluopicolide mixed with propamocarb. Early detected and early treated is the key for effective control

Route 3 Pathogen mechanical transmission by human beings or machine

Section 12 Root knot nematode(Meloidogyne spp.)-- Now spread mainly by machine

Scope of infection

Root-knot nematodes occurs all over the world. The host range of it is very wide, and the affected crops belong to more than 3 000 species of 114 families, among which Cucurbitaceae vegetables, solanaceous vegetables, cruciferae crops, leguminous are the most seriously damaged.

pathogenesis

At present, there are more than 90 species of root-knot nematodes reported, but there are mainly 4 species that cause damage to plants, namely M. incognita, M. Javanica, M. Renaria and M.hapla., Root-knot nematodes are distributed in the soil 5-30 cm. They destroy the root tissues of crops and absorb nutrients by invading the roots of plants and forming nodules, thus destroying the entire metabolic system and even causing the compound infection of fungi and bacteria, resulting in, and crop yield reduction or even plant death. Root-knot nematode disease is **very difficult** to control.

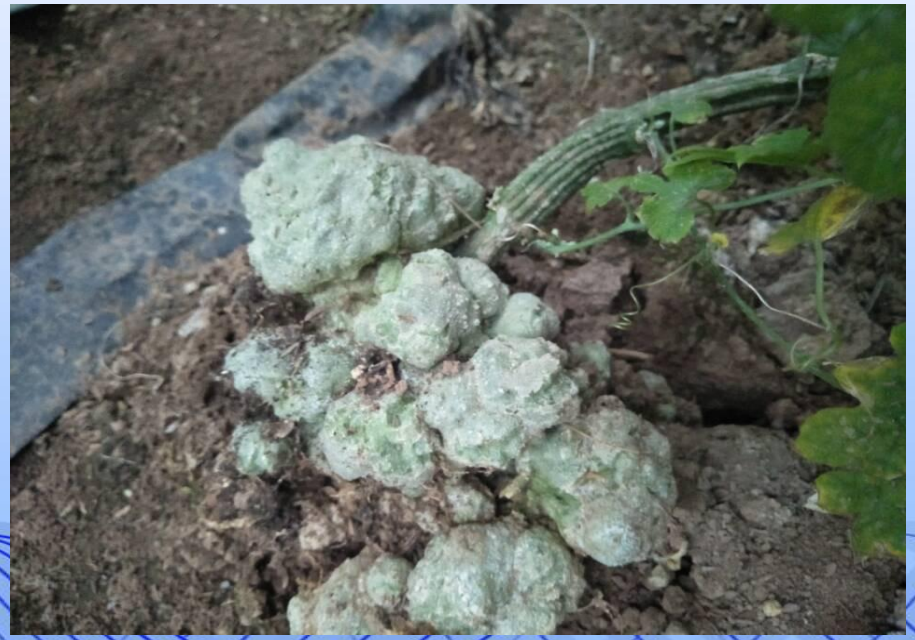
root not nematode infected watermelon and its root

Infected tomato

Infected potato tuber

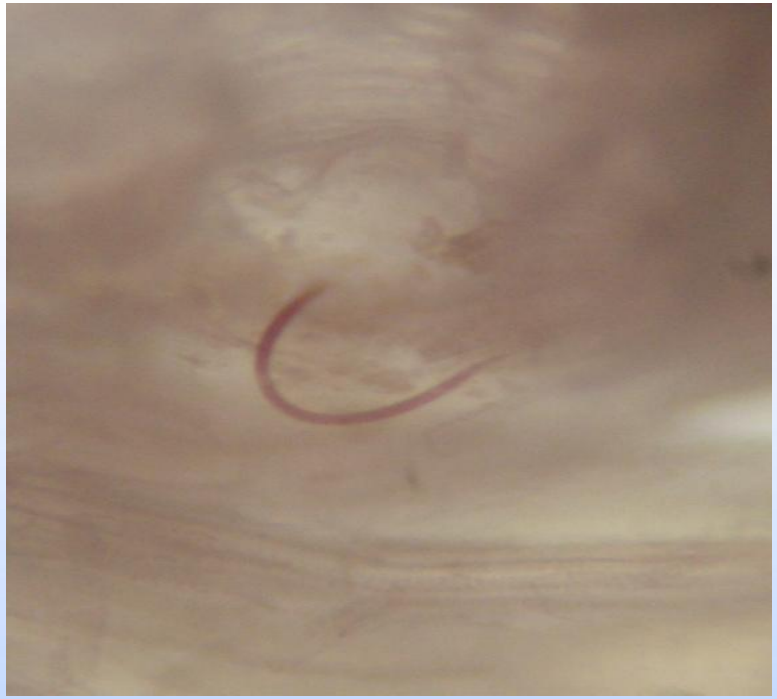
Infected tomato root

Infected bitter gourd root

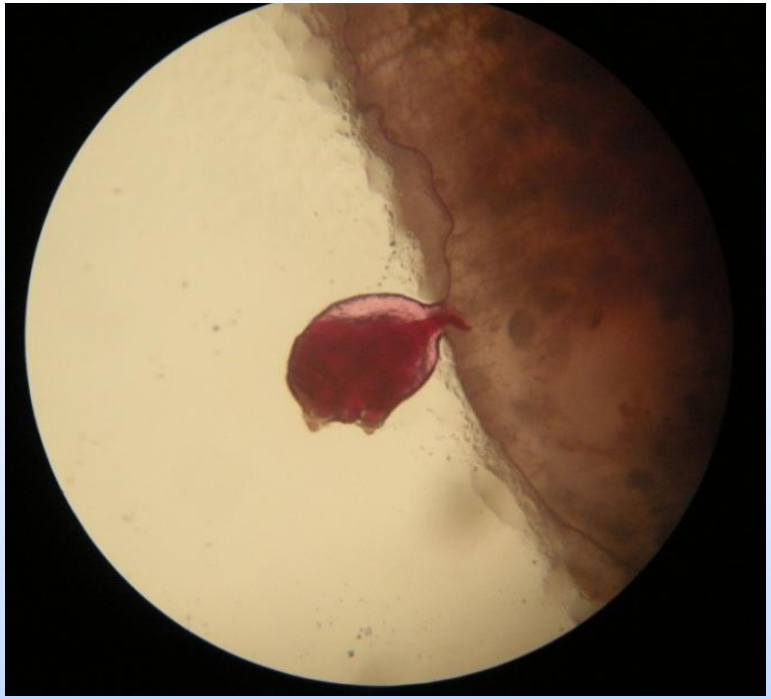


Infected ginger tuber

root knot nematode in the root



Female root-knot nematodes



Control measures

1. Soil disinfection for heavy infected soil

Soil disinfection is effective for nematode and other pathogen. After vegetable harvest, organic fertilizer and crop remnants together with soil disinfectant are evenly applied into the soil through rotary cultivator, then covered with film for sealing, and irrigated under the film, using the heat from solar energy and heat from fermentation of organic fertilizer and crop remnants combined with toxic gas produced by the soil disinfectant recompositing to kill pathogens and nematode. Usually the disinfection last for 20~25days. Remove the film one week before planting to let the rest of the toxic gas out.

The process is described as pictures show

Process of soil disinfection with lime nitrogen

1. Spreading disinfectant, such as lime nitrogen

2. Spreading wheat straw or other crop remnents

3. Disinfectants and organic materials ploughed into soil mechanically or artificially

4. Ridging help for watering

5. Covering film

6. Surrounding soil for sealing

7. Watering under film

2. Chemical reagent treatment of infected fields after planting

Once crops are planted in the field, soil disinfection cannot be carried out. But some chemical reagents can be used with seedlings, to reduce the harm of root knot nematode. These chemical reagents are: fosthiazate, fluopyram and some Bacillus. Using these reagents according to manufacturer's instructions

3. Field diagnosis and control measures of main vegetables insect pests

Route 4 Pathogen transmitted by insect pest

The pest itself deals damage to crops by feeding, at the same time they can spread some virus by feeding, This loss is greater than that of eating itself. Most viruses are transmitted by insect pest, so control insect pest is the key to control viruses.

tomato yellow leaf curl virus transmitted by whitefly

Section 13 aphids and whitefly

Honeydew secreted by whiteflies and their dead body together on the surface of leaves and fruits

Whitefly on upper side ofpepper leaves

Whitefly like gather on underside of leaves

Nymph of whitefly

Aphids like gathered on the underside of the leaves or on the tip tender branches

Control measures

1) Physical pest control

Build an arch greenhouse covered with 60 mesh net and vegetables plant inside to keep the small insects out like the picture shows below

Pests are small, arch greenhouse covered with 60 mesh net or more thicker

- sticking aphid or whitefly by hanging yellow or blue board in greenhouse, 10 ~15 cm above the crop. Aphid or whitefly like the yellow colour, so the board can work.

Yellow board +blue board in pepper producing green house

Yellow board only in summer squash greenhouse

Reflective film or silver grey film reflect light to drive aphids and whitefly away

2) Using chemical pesticide

Imidacloprid, pymetrozine, spirotetramat, thiacloprid, dinotefuran, sulfoxaflor, pyriproxyfen or spirotetramat mixed with thiacloprid. All these pesticides are effective to kill aphides and whitefly. And should be used as early as possible.

Section 14 Thrips

Thrips are widely distributed throughout the world, eating almost all vegetable crops and are one of the major economic pests. They often file through the epidermal tissue of the plant with a rasping-mouthparts to suck its juice, causing plant wilting, affecting the yield, quality and commodity. And also they can transmit viruses, eg tomato spotted wilt virus(TSWV) .

Different thrips on the underside of cucumber leaves

TSWV infected pepper fruits

TSWV infected tomato fruits

Field symptom

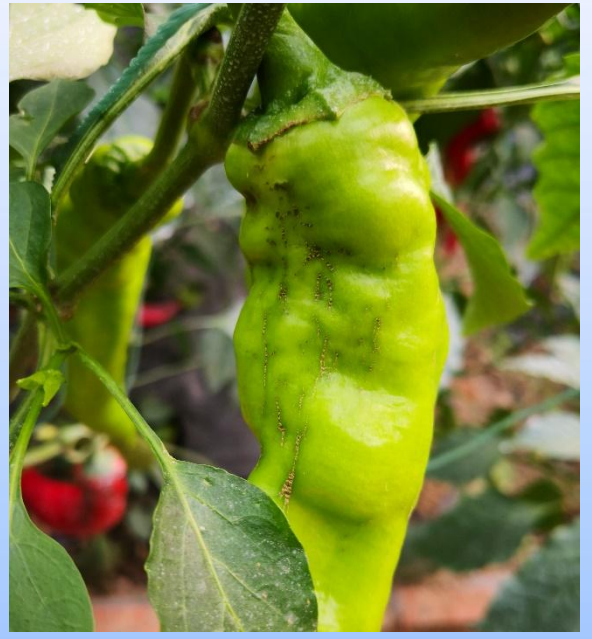
Thrips like to gather in flowers or on the underside of young leaves

Scar on eggplant and cucumber. Poor fruit taste and appearance

Field symptom

Scar left to tomato fruit after sucking

Scar on pepper fruits



Control measures

Thrips are small and physical control is not ideal. Chemical pesticide is the most effective method at present. They reproduce very quickly and must be controlled at early stage. Thrips hatch as adults in the soil, So when spraying pesticide, must connect the ground together. Thrips have a variety of insect coexisting, so compounding reagents provide relatively good effects. Compounding reagents describe as below:

1) flonicamid mixed with imidacloprid
2) Spirotetramat mixed with imidacloprid
3) Spinetoram mixed with acetamiprid
4) Bifenthrin mixed with thiamethoxam
5) Emamectin Benzoate

Section 15 flesh worm

Flesh worm is a common name for these insect pests'larvae with largest size than aphid and thrip, and make great damage to vegetables. Usually refers to *Diaphania indica*, *Plutella xylostella*, *Spodoptera exigua*, *Spodoptera litura* Fabricius. *Diaphania indica* mainly does harm to Cucurbitaceae crops and solanaceous crops. *Plutella xylostella* mainly does harm to crucifer crops. *Spodoptera exigua* and *Spodoptera litura* Fabricius like Solanaceous crops, Crucifer crops and even Liliaceae crops.



Field symptom

flesh worm do harm to different vegetables

Control measures

1) Physical pest control

arch greenhouse covering with net also can be used here, for both moth and larvae are larger, bigger hole net can be used, like 30 mesh net.

2) Trap and killing

Light trap and sex pheromone trap widely used to trap and kill moth, to decrease the population.

sex pheromone trap used

3) Using chemical pesticide

Chemical pesticide uses the earlier the better. The chemicals below are used for the larvae. including

Chlorantraniliprol, chlorfluazuron, buprofezin, chlorbenzuron, Methoxyfenozide, Hexaflumuron. And some of them work better together, like Spinetoram with Methoxyfenozide, Spinetoram with Methoxyfenozide, Chlorantraniliprol with Thiamethoxam, Emamectin Benzoate with indoxacarb.

All these chemicals are effective against these flesh worm. If you find some in your field, do not hesitate to buy some chemicals I list above.

4. basic knowledge for chemical pesticides

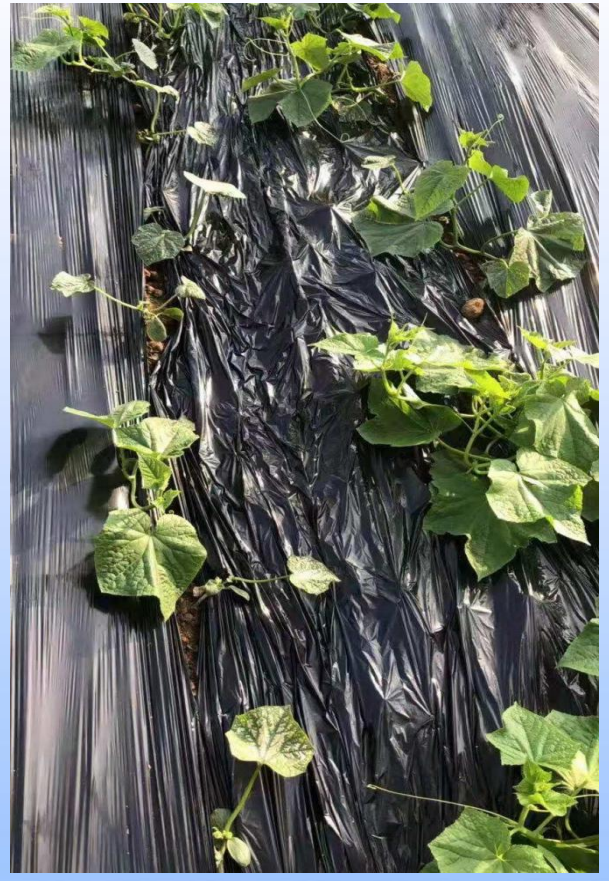
While using chemical pesticides to control diseases and insect pests, some basic knowledge needs to be mentioned

4. basic knowledge for chemical pesticides

1) Chemical pesticides have no effect on physiological diseases.
Pay much more attention to seedling changes during their growing, especially the changes after watering, fertilizing, spraying, weather changes. Physiological diseases should not be confused with pathological diseases.

2) Watch carefully and use Chemical pesticides only when an infected plant or larves or moth is found in the field or around

3) While spraying, Following the concentrations and intervals specified in the instructions, and should not increase the concentration privately. Seedling stage concentrations decrease, in case of pesticides damage as the picture show below.



4. basic knowledge for chemical pesticides

4) Try not to mix pesticides, fungicides and foliar fertilizers together in case of reduce the effectiveness or pesticides damages

5) Do not spraying in rainy days or with dew on leaf, or the temperature is too high and too low

6) Do not spray when the wind speed is more than 3 m/s especially for herbicide

7) Emulsifiable pesticides generally do not add synergistic reagents

8） Do not use the same pesticide over 3 time during the whole life span of the plant. For fear that resistance of pathogen against this pesticide


Thank you for your attention
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