

INVESTIGATION ON MUSHROOM DISEASES IN CHINA

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ABSTRACT

Mushroom diseases were investigated in over 22 provinces in China on 15 different kinds of mushrooms and pathogenicity of disease isolates was tested. In total 9 diseases of mycelium and 20 of fruit bodies were evaluated and these included green, brown, white moulds, scars, cancer, spots, blotches of various types in addition to wet bubble, bacterial diseases, etc.

Keywords: wet bubble, brown blotch, slippery scar, black spot, bacterial rot

INTRODUCTION

China is a major country of edible mushroom cultivation in the world, and the commonly cultivated mushrooms are *Lentinula edodes*, *Pleurotus ostreatus*, *Auricularia polytricha*, *P. eryngii*, *Coprinus comatus*, *Agaricus bisporus*, *Flammulina velutipes*, *Auricularia auricula-judae*, *Ganoderma lucidum*, *P. nebrodensis*. The occurrence of diseases has impeded the development of mushroom industry in China. Diseases like stipe canker on *Coprinus*, slipper scar on *Auricularia* have been reported in the country [1, 2]. Systematic investigation on the edible mushroom diseases was carried out in more than 22 provinces in China that have a wide range of mushrooms under cultivation since 2009.

MATERIALS AND METHODS

Mushroom diseases were continuously investigated on more than 15 kinds of mushrooms. The disease occurring area, occurring period, severity, occurrence condition, symptoms, transmission route, pathogen source, variety resistance and cultivation method were studied. Most pathogens were isolated and identified by morphology and its analysis. The pathogenicity of isolates was confirmed by the Koch's rule.

RESULTS AND DISCUSSION

Fourteen competitors were found in the wood log, bagged sawdust and compost during the cultivation including *L. edodes*, *A. auricula-judae*, *A. bisporus*, *P. ostreatus* and *F. velutipes*. Nine mycelial mycoparasites and 20 fruit body diseases were found and identified successively (Table 1). Five most serious mushroom diseases were selected as the research focus.

Wet bubble disease of *Agaricus bisporus*

The surface of morbid mushroom casing generated white fluffy hyphae. Fruit body presented symptoms of puffball-like or distortion or brown blotch (Fig. 1). Brown liquid also occurred sometimes. Its pathogen is *Hypomyces perniciosus* Magnus is a common soil microorganism. Casing soil and old wooden bed were the most important pathogen sources. The severity of wet bubble disease was more when compost was fermented incompletely. High temperature and high humidity favour the disease. The disease spread was mostly through water spray.

Brown blotch disease of *Pleurotus ostreatus*

When oyster mushroom was infected by *Pseudomonas tolaasii* on the surface of the fruit body appear brown blotch or patches of yellow spot. There was always a yellow or red circle pattern around the spot (Fig. 2). Diseased fruit body stop developing. Incomplete sterilized compost and surrounding rubbish were the main pathogen sources. Spread of the bacteria pathogen relied principally on the action of spray water. A temperature 18-22 °C, poor ventilation, and water films on the mushroom surface appeared to promote the occurrence of the disease.

Table 1. The mushroom infectious diseases list in China

	Disease	Pathogen	Hosts	Pathogenicsite
1	Black spot	<i>Hypoxylon annulatum</i>	<i>A. auricula</i>	Mycelia
2	Trichoderma disease	<i>Trichoderma viride</i> , <i>T. koningii</i>	<i>A. auriculae</i>	Mycelia
3	Black spot	<i>Hypoxylon annulatum</i>	<i>Grifolafrondosa</i>	Mycelia
4	brown blotch	<i>Pseudomonas</i> sp.	<i>G. lucidum</i>	Mycelia
5	Slippery scar	<i>Scytalidium lignicola</i>	<i>A. polytricha</i>	Mycelia
6	Green mold	<i>Trichoderma viride</i> , <i>T. koningii</i>	<i>P. ostreatus</i>	Mycelia
7	White mould	uncertain	<i>L. edodes</i>	Mycelia
8	Brown slime moulds	Mycetozoa	<i>L. edodes</i>	Mycelia
9	Yellow slime moulds	Mycetozoa	<i>L. edodes</i>	Mycelia
10	Bacterial rotten	<i>Pseudomonas</i> sp.	<i>P. nebrodensis</i>	Fruit body
11	Black spot	<i>Verticillium fungicola</i>	<i>C. comatus</i>	Fruit body
12	Grey mold	<i>Cladobotryum protrusum</i>	<i>C. comatus</i>	Fruit body
13	Stipe canker	<i>Trichothecium roseum</i> [1]	<i>C. comatus</i>	Fruit body
14	Bacterial rotten	<i>Pseudomonas</i>	<i>F. velutipes</i>	Fruit body
15	Brown blotch	<i>Pseudomonas tolaasii</i>	<i>F. velutipes</i>	Fruit body
16	Pythium rot	<i>Cladobotryum vairum</i>	<i>F. velutipes</i>	Fruit body
17	Black spot	uncertain	<i>G. lucidum</i>	Fruit body
18	Green mold	<i>Trichoderma viride</i> , <i>T. koningii</i>	<i>G. lucidum</i>	Fruit body
19	Slime moulds	mycetozoa	<i>A. polytricha</i>	Fruit body
20	Brown blotch	<i>Pseudomonas tolaasii</i>	<i>P. ostreatus</i>	Fruit body
21	Dry bubble	<i>Verticillium fungicola</i>	<i>A. bisporus</i>	Fruit body
22	Brown blotch	<i>Pseudomonas putida</i>	<i>A. bisporus</i>	Fruit body
23	Wet blotch	uncertain	<i>A. bisporus</i>	Fruit body
24	Wet bubble	<i>Hypomyces perniciosus</i>	<i>A. bisporus</i>	Fruit body
25	Fruit body wilting	mycovirus	<i>L. edodes</i>	Fruit body
26	Nematode disease	<i>Ditylenchus myceliophagus</i> <i>Aphelenchoides composticola</i> <i>Rhabditis</i> sp.	<i>L.edodes</i>	Fruit body
27	Bacterial rotten	<i>Pseudomonas putida</i>	<i>P. eryngii</i>	Fruit body
28	Bacterial rotten	<i>Pseudomonas</i>	<i>P. geesteranus</i>	Fruit body
29	White mildew	uncertain	<i>Cordyceps militaris</i>	Fruit body



Figure 1. Symptom of wet bubble disease in *Agaricus bisporus*

Slippery scar disease in *Auricularia polytricha*

The pathogen, *Scytalidium lignicola*, infected the mycelia only of *A. polytricha* [2]. Slippery, glossy, and dark-brown scars were formed on the surface of infected mycelia in cultivated bag. There was a red-brown antagonistic line between the infected and healthy mycelia, and the margin of this line was irregular (Fig. 3). Grey white and thin mycelia grew on the PDA plates within 2-3 days. After 3-4 days, the colony became dark brown and flat, and the aerial mycelia started to flourish. The colony surface was glossy and honeycomb shaped, and produced catenulate chlamydospores. The most important reason of its occurrence could be attributed to the incomplete sterilization of the compost or the breakage of cultivated bags in the process of cultivation. Chlamydospores of the pathogen infect healthy bags from the puncture after pricking and harvesting via airflow and frequent spraying or pouring of water.



Figure 2. Symptom of brown blotch disease in *Pleurotus ostreatus*



Figure 3. Symptom of slippery scar disease in *Auricularia polytricha*

Black spot disease in *Coprinus comatus*

The cap of fruitbody formed black or brown patches, and the patch might crack along the scale when the humidity of shed was low, or generate a layer of white mildew if the humidity was high (Fig. 4). The initial inoculum sources of this disease were mainly from covering material and later spraying. The pathogen (*Verticillium fungicola*) produced large number of spores, then diffused by flow of air, water, or diseased mushroom debris. The temperature during 22-28 °C and water films on mushroom surface were found to favour the disease development.

Bacterial rot disease in *Pleurotus eryngii*

The infected mushrooms have watery spots on the stipe and cap, even the whole fruitbody covered by disease spots if the invasion of *Pseudomonas* was particularly serious. Finally fruit bodies rotted, and appeared rough yellow-tan fetid bacterial ooze on the surface (Fig. 5). Bacteria mainly originated from contaminated composts and unclean water, then spread by spraying. Hydrops in the opening site of bag, flooded primordium, water films on mushroom surface all easily result in the occurrence of this disease, especially for those mushrooms growing in high temperature, high humidity and poor ventilation.



Figure 4. Symptom of black spot disease in *Coprinus comatus*



Figure 5. Bacterial rotten disease in *Pleurotus eryngii*

Besides these five important mushroom diseases, mushroom-stick rot of *L. edodes* caused by *Trichoderma* spp. occurred seriously too. The high temperature in mushroom shed resulted in decrease of disease resistance of mushroom mycelia. If the bag has a breakage simultaneously, *Trichoderma* spp. or other wood-rotting pathogens would invade, then occupy the substrates. The mushroom-stick would rot after the compost decomposed due to pathogens (Fig. 6).

The main factors for disease occurrence appeared to be improper pasteurization of compost, imperfect disinfection



Figure 6. Mushroom-stick rot of *Lentinus edodes* caused by *Trichoderma* spp.

of cropping, high temperature and humidity in the cropping rooms/environment breakage of cultural bags and reduced disease resistance of mushroom mycelia. Furthermore, improper management would result in abnormal fruit body, such as excessive ventilation, high levels of carbon dioxide, low temperature and heavy use of pesticides, all of which need the attention of mushroom growers. Mushroom virus disease caused by mycovirus are also worth researching. Some symptoms of mycelia decline and fruit body wilting have been suspected to be connected with virus. The virus diseases are latent and spread through infected spores.

General control measures of mushroom disease in China

According to the pathogenesis of these diseases, the corresponding preventive and control measures were made in order to reduce the economic losses as much as possible that are caused by the diseases. On the basis of production model and level of edible mushroom in China, integrated control measures for the mushroom diseases have been put forward. These includes:

1. Selecting strains with high resistance, ensure spawn purity and vigour.
2. Choose fresh compost with low water contents and addition of 2-3 per cent lime. Thorough sterilization of substrates and use of high quality cultivation substrates.
3. Proper disinfection and maintenance of hygienic conditions in the inoculation/spawning area.
4. Use solarized fluviatile mud and sub-soil below 20 cm depth from paddy field.
5. Maintain appropriate temperature, humidity and ventilation in the cropping rooms.
6. Spray appropriate quality water during cropping and avoid long wetness of mushroom fruit bodies by introducing ventilation.
7. Take timely measures in case of disease outbreak. When disease occurs on fruit body or mushroom bed, the infected fruit bodies should be removed. Then cover the infection site with lime. Remove infected substrate along with mushrooms from the adjoining area immediately and spray fungicides like sporgon. If necessary, the infected bags should be discarded and burned.
8. Clean up the waste bags and covering material after the harvest. In the idle period remember to solarize shed and shelves by means of disclosing the outer mulch.

REFERENCES

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