Title of the Technology: Management of Wet Bubble Disease (WBD) using understanding of its pathogenesis in Button Mushroom

General Part-1

Technology Code:- :

Organization Details...

Subject Matter Division	:	Horticultural Science
Organization Name	:	ICAR-Directorate of Mushroom Research ,Solan
Regional Station if any :	:	Not Applicable
AICRP name if any (AICRP)	:	AICRP Mushroom, Solan
Principal Inventor	:	Dr. Ved Prakash Sharma
Principal Inventor Designation:	:	Director
Principal Inventor Email	:	vpsharma93@gmail.com
Principal Inventor Address	:	ICAR-Directorate of Mushroom Research, Chambaghat, Solan (HP)

Details of Inventors.

Principal Inventor	:	Dr. Ved Prakash Sharma
Principal Inventor Designation:	:	Director
Principal Inventor Email	:	vpsharma93@gmail.com
Principal Inventor Address	:	ICAR-Directorate of Mushroom Research, Chambaghat, Solan (HP)
Co-Inventor Name	:	Dr. Anil Kumar (Scientist), Dr. Satish Kumar (Principal Scientist)
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Technology Name	:	Management of Wet Bubble Disease (WBD) using understanding of its pathogenesis in Button Mushroom

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Technology Details..

Major resource	:	Product and Process

Minor Subject Classification	:	Agriculture
Minor Subject Sub Classification	:	Agricultural research
Technology Group	:	Protection technology
Technology Related To	:	Disease management and Pathogenesis

Complete Details of Technology:

Wet Bubble Disease (WBD) was first reported for Peris in 1888. The disease has also been reported to assume serious proportions in other major mushroom growing countries of the world such as France, United Kingdom, Netherlands, USA, China, Tiwan, South Africa, Brazil, Hungary, Australia and Poland. In India, this disease reported for the first time in 1978 in Jammu and Kashmir. Later, this disease has been reported from the state of Himachal Prasdesh, Haryana and Maharastra. WBD causes extensive damage by bringing soft rot or decay of whole fruiting body. If not controlled well in time, the pathogen causes havoc damaging the entire crop. The disease is most prevalent in India in hilly areas. The disease is characterized by the development of whitish mouldy growth of mycelium on portions of fruit bodies. It spreads covering the entire cap eventually reducing the sporophore to a foul smelling white mass. If the pathogen infects mushroom before the differentiation of stipe and pileus, the sclerodermoid masses are formed, whereas infection after differentiation results in the production of thickened stipe with deformation of gills. Wet bubble pathogen (Mycogone perniciosa) of button mushroom has a world-wide distribution and can cause severe crop losses. Infected fruit bodies, spent mushroom substrate, farm yard manure, substrate material, ground water etc. are the major sources of inoculum. Disease transmits through contaminated irrigation water, air, casing soil, picker's hands, insects (like flies and mites). If the pathogen infects mushroom before the differentiation of stipe and pileus, the sclerodermoid masses are formed. Whereas, infection after differentiation results in the production of thickened stipe with deformation of gills. M. perniciosa produces small thin-walled phialoconidia on Verticillium- like conidiophores and bicellular conidia which are commonly referred to as either aleuriospores or chlamydospores. In our studies growing room treatment and pasteurization/chemical sterilization of casing soil were targeted. Proper pasteurization of casing at 650C must be done with 65% moisture. Treat empty room with 2% formalin and maintain the temperature between 35-400C. Spot treatment with common salt in the infected bags and beds to check the development and further spread to healthy areas. Use foot dips at the entrance. Harvesting should be done from new rooms to older rooms. Use light trap for monitoring and controlling fungal gnats. After harvest treat the growing rooms with 2% formalin before disposing off the bags or post crop provision can be used. In latter method the room temperature is increased above 700C for 2-3 hrs that kill all the contaminants. Dispose off

spent mushroom substrate in pits away from mushroom farm and cover it with layer of soil. Disinfect the machinery, equipment and the corridor following the route of transportation, the nets, cloths and other inventory with 2% formalin solution before starting work. Keep the room clean where the casing soil is stored along with the area adjacent to it. Alternatively, a spray of 0.8 percent formalin on to casing surface, immediately after casing, can be effective. However, this concentration can be injurious if used at later stage in crop. Using standard crop management practices and be the earliest to jump to disease control strategies is a key for successful management of WBD.

Brief Description of Technology Including Salient Features:

Mushrooms are edible macro-fungi and are treated like as a vegetable crop in India and in the other parts of the world. Like all other vegetables these are also ravaged by number of biotic and abiotic stresses which affect the growth and yield of mushrooms adversely. Among biotic factors fungi, bacteria, virus, insect/pests etc are the major impediments in the successful cultivation of different mushroom crops. Fungal diseases of mushrooms viz., wet bubble (Mycogone perniciosa), dry bubble (Lecanicillium fungicola), web cob (Cladobotryum dendroides), green mould (Trichoderma spp.) etc. are more devastating as compared to viral and bacterial diseases of mushrooms. Among these WBD is a worldwide problem and it has catastrophic effect on the mushroom farming in different mushroom growing areas of the world. If the weather conditions are favorable the disease development it could cause complete crop failure. This disease is being managed mainly by using non-chemical methods. Besides this, many workers have also tested different chemicals including fungicides, fertilizers etc. against this disease. However, till date no fungicide has been developed specifically to be used on mushroom crops for the management of mycoparasites. There is a very limited use of fungicides in controlling mushroom diseases and competitor moulds and those chemicals which are in practice are under strict rules and regulations. This is due to the fact that in case of mushroom crops both pathogen and crop are fungi. There are some specific chemicals which are permitted by the competent authority of the respective country like iprodione and prochloraz- Mn by spenish legistation, carbendazim and thiophanate methyl permissible in European countries, thiabendazole and thiphanate methyl permissible in USA (https://americanmushroom.org bestpractice_IPM_fungicides.htm) etc. However, in India none of the fungicides have the label claim. All the fungicides used in European countries or elsewhere are used on mushrooms in India. This disease is caused by Mycogone perniciosa Magn. And the perfect stage is hypomyces perniciosa. Mycelium of the pathogen is white, compact and fluffy mycelium. Hyphae branched interwoven, septate, hyline measuring 200 x 3-5m having sub-verticillate to verticillate branches which bear thin walled, one-celled conidia measuring 5-10 x 4-5m. Large two-celled chlamydospore present; upper cell warty, thick walled, globose, bright coloured measuring 15-30 x 10-20m, lower cell hyaline, smooth and measure 5-10 x 4-5m. Though M. perniciosa is a major pathogen of Agaricus bisporus, however, it is capable of infecting other mushroom species and crops like A. campestris, Pleurotus eryngii and P. nebrodensis. Spread of M. perniciosa occurs primarily through casing soil and the infection can be air-borne, water borne or may be mechanically carried by mites and flies. Spread through contact occurred readily during watering and especially harvesting. It was also observed that

contaminated containers can be a source of spread over greater distances. Disease transmission through insects has also been reported in the literature. Chalmydospores have been reported to survive for long time (upto 3 years) in casing soil and may serve as primary inoculums. The aleurospore produced on the surface of monstrous structures are probably responsible for secondary infection. M. perniciosa is very sensitive to comparatively high temperature. Potato Dextrose Agar (PDA) has been recorded as best medium to obtain maximum growth of the pathogen with pH and optimum temperature 6.0 and 250C respectively. Mannose and asparagines have been reported as best sources of carbon and nitrogen, respectively. Compost extract agar medium observed as the best medium for the mycelia growth and malt extract peptone dextrose agar medium for spore production.

Elimination of the primary source of infection i.e. chlamydospores present in casing soil, air, infected trash and spent compost through effective pasteurization and proper disposal of SMS. Intensive crop care is required after casing because the causal pathogen (Mycogone perniciosa) gets entry into the mycelium at the stage of pinhead formation. Secondary spread is by means of conidia, which are carried by water, air, casing soil, picker's hands, insects (like flies and mites). Early diagnosis of disease in form of sclerodermoid masses followed by spot treatment with common salt is very helpful in confining the disease to lesser area. Infected fruit bodies should be carefully uprooted if possible wrap it before removal and burry away from the mushroom house to prevent the secondary spread. Treat empty room with 2% formalin and if possible maintain the temperature between 35-400C after treatment. Beside traditional treatment with formalin post-crop cook out provision can also be used wherein temperature of the room is increased above 700C for 3-4 hrs to kill all the contaminants.

Benefits/Utility :

WBD of Agaricus bisporus caused by Mycogone perniciosa, is very contagious and results in severe crop losses. Understanding of Pathogenesis of WBD occurring during this mycotic infection of A. bisporus is very helpful to identify the sensitive stages of host. Our results revealed that the pathogen adheres to and penetrates the host during any stage of fruit body development except spawn run stage. When young primordia are infected, sclerodermoid masses are formed and nascent fruit bodies are not differentiated into their characteristic parts such as pileus, stipe etc. We found that pinhead formation stage is the most vulnerable crop stage where the pathogen gets the entry into it. Preventive measures like reduction in inoculum level, control of insect vectors are of paramount importance to manage WBD. Key to identify the disease at early crop stage and effective control strategies will be certainly helpful for the growers to manage WBD well in time and consequently in enhancing their profit.

Precaution With The Technology

1. Quality substrate materials must be utilized. 2. Recommended concentration of pesticide and method of application must be used. 3. Good Agricultural Practices (GAP) must be followed for crop management 4. Environmental conditions must be maintained as per the prescribed limits.

Impact, If Adopted

Helps in early diagnosis of WBD and in its effective management which helps to enhance the mushroom production and in turn higher economical returns to the mushroom growers.

Social Impact

Mushrooms are perishable commodity therefore even a mild WBD infection render it unfit for market and human consumption. Because of misconceptions in the farmers about the behavior and type of mushroom crops, they don't maintain hygiene and optimum environmental conditions in the mushroom house. Because of that many mycoparasites get entry into growing rooms. Additionally due to lack of knowledge about the early disease symptom of WBD growers get late to prompt to application of any suitable crop protection agent. Most of the growers understand WBD at advance stages of its pathogenesis which make the process of disease management more complicated. Our findings familiarize the growers with the keys to early diagnosis of WBD and effective protective and curative management strategies. Since the technology is easy to use, reliable and safe, therefore it is perfect option for the farmer to gain the higher profits.

TargetUsers/Stake holders	:	Mushroom growers and entrepreneurs

Technology Contact..

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Keyword for Technology	:	Pathogenesis· Mycoparasitism · Mycogone perniciosa · Wet Bubble Disease ·Agaricus bisporus

Technology Development Details Part-2

Project Details (Through which technology was developed)	:	Holistic management of diseases and insect/pests of mushroom crops

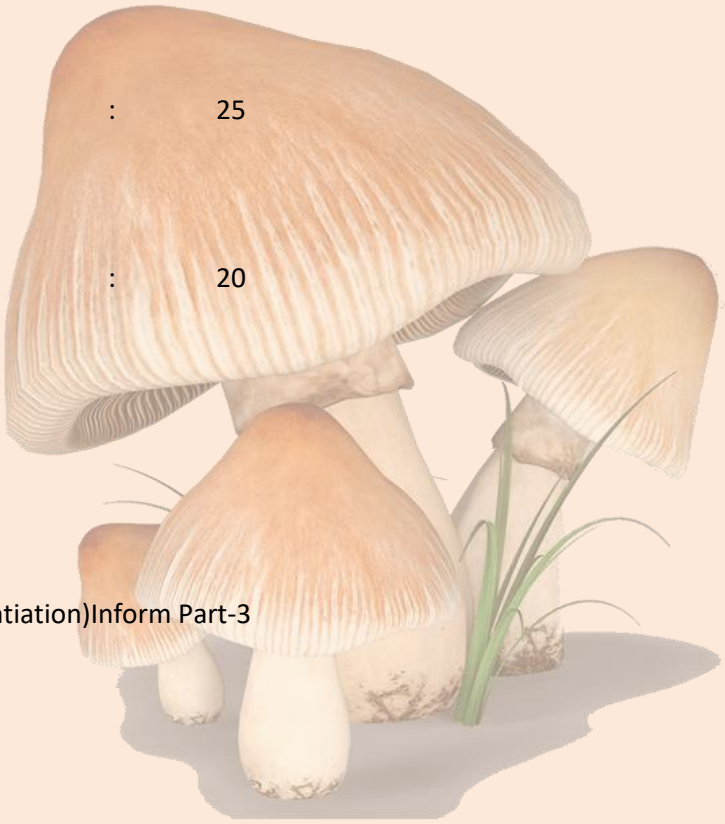
Technology Validated by	:	Institute
Technology Validation Details..		
Subject Matter Division	:	Horticultural Science
Organization Name(if within ICAR)	:	ICAR-Directorate of Mushroom Research,Solan
Organization Name(if outside ICAR,Please enter)	:	--
Year of Release/Adoption(YYYY)	:	12-2019
Country	:	India
Through Technology Transfer	:	YES
Is There Any Other Process/Product/Technology	:	Diseases management in mushrooms

that Is
Critical Or Contributes To
The Successful Use Of
Technology

Minimum Temperature : 14

Maximum Temperature : 25

Average Temperature : 20



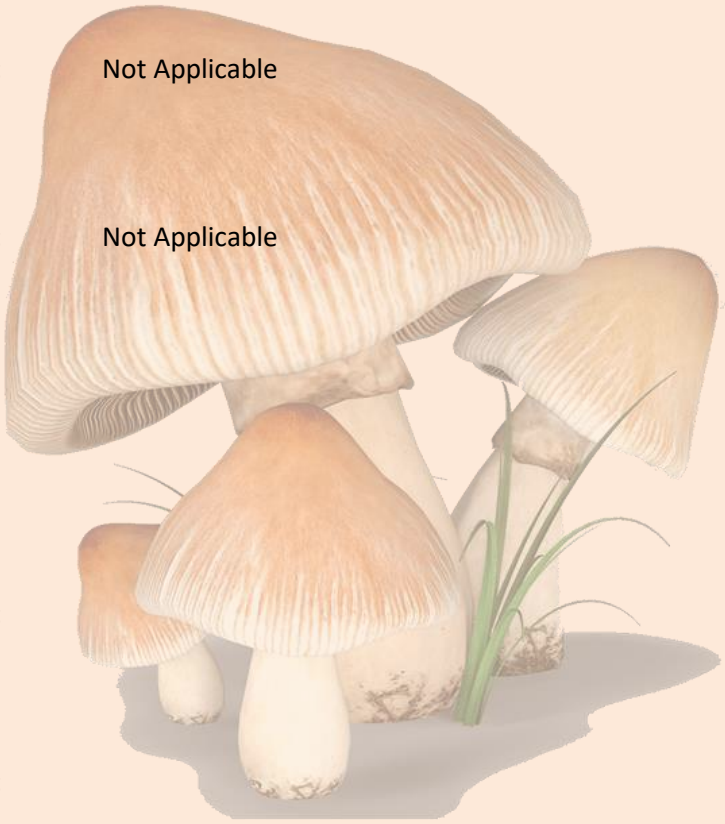
Applies To(Regional Differentiation)Inform Part-3

Location...

Zone(As per the planning commission) : Not Applicable

Sub zone(As per the planning commission) : Not Applicable

AgroEcological Zone(NBSS & LUP)	:	Not Applicable
AgroEcological Sub Zone(NBSS & LUP)	:	Not Applicable
State Name	:	Not Applicable
District Name	:	Not Applicable
Soil Type/Resource Type..		
Soil Order	:	
Soil Sub Order	:	
Soil great group	:	
Soil great sub group	:	



Commodity
Details..

Commodity :

Commodity Type :

Commodity Name :

Publication Related To Technology Part-4

Research Paper information..

Anil Kumar, VP Sharma, Satish Kumar and Manoj Nath. 2021. De novo genome sequencing of mycoparasite Mycogone perniciosa strain MgR1 sheds new light on its biological complexity. Brazilian Journal of Microbiology

52:1545–1556. https://doi.org/10.1007/s42770-021-00535-x

Popular articles

Anil Kumar, VP Sharma and Satish Kumar. 2020. Mycoparasitism of Mycogone perniciosa in edible fungi. Science for Agriculture and Allied Sector. 2(9): 1-6.