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Pest, Disease and Abiotic Disorder Management in Paddy Straw Mushroom (*Volvariella volvacea*): An Integrated Approach

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Paddy straw mushroom (*V. volvacea*) occupies a prominent position in the global edible mushroom industry, particularly across South and Southeast Asia, where it is cultivated on agricultural lignocellulosic residues, primarily rice straw, under warm and humid conditions. Its relatively short cropping cycle of approximately 10 to 14 days from spawning to harvest, combined with minimal capital requirements, renders it an accessible and attractive livelihood option for smallholder farmers. Despite these advantages, the inherent sensitivity of *V. volvacea* to environmental fluctuations and its susceptibility to a diverse array of biological adversaries present considerable challenges to consistent production. The successful management of these constraints is therefore a prerequisite for realizing the crop's full productive potential. A systematic understanding of the etiology, symptomatology, and management of pests, pathogens, and environmental disorders is essential for developing robust cultivation protocols and guiding extension recommendations.

Major Pests of Paddy Straw Mushroom

Arthropod pests and other invertebrate organisms represent a significant source of crop loss throughout the various stages of paddy straw mushroom cultivation. The principal pest groups and their associated damage are described below.

Mites (Acari)

Mites constitute one of the most economically damaging pest groups in mushroom cultivation. Several acarid species, including those belonging to the families Tarsonemidae and Acaridae, colonize mushroom substrates and feed on both the mycelium and the developing sporophores. Infested beds may exhibit retarded mycelial colonization, surface discoloration, and a generalized reduction in fruiting body size and quantity. High population densities are commonly associated with poor sanitation and inadequately pasteurized substrates.

Nematodes (Nematoda)

Plant-parasitic and fungivorous nematodes, frequently present in contaminated straw or irrigation water, pose a persistent threat to mycelial integrity. These microscopic metazoans penetrate substrate particles and feeding sites within the hyphal network, disrupting the spawn-running phase and significantly retarding colonization. Nematode infestations are particularly prevalent under conditions of excessive substrate moisture and elevated ambient temperatures.



Dipteran Flies (Diptera)

Several dipteran species, most notably sciarid and phorid flies (families Sciaridae and Phoridae), are primary insect pests of cultivated mushrooms. Adult females deposit eggs within the substrate, and the resulting larvae cause extensive tissue damage through direct feeding on mushroom accelerated decay, and pronounced marketability losses.

Beetles and Springtails (Coleoptera and Collembola)

Coleopteran beetles and collembolan springtails represent additional invertebrate pests that feed upon developing mushrooms during the fruiting phase. Beetle larvae and adults create visible perforations and surface abrasions on sporophores, while springtails preferentially graze on mycelium and young primordia. Both groups proliferate rapidly under conditions of excessive substrate moisture and poor growing room hygiene.

Management Strategies for Pest Control

An integrated approach to pest management, emphasizing preventive cultural practices, is generally more effective and sustainable than reactive chemical interventions. The following evidence-based strategies are recommended:

- Utilization of structurally intact, low-contamination paddy straw as the primary cultivation substrate, as deteriorated or field-contaminated material substantially elevates pest risk.
- Thorough pasteurization or sterilization of substrate prior to inoculation, preferably by steam treatment at 60–80°C for a minimum of one hour, to reduce resident pest populations.
- Maintenance of strict hygienic standards within cultivation facilities, including regular disinfection of growing structures, tools, trays, and equipment with approved disinfectants.
- Prompt removal and appropriate disposal of pest-infested or otherwise compromised substrate beds to prevent secondary infestation within the growing environment.
- Avoidance of waterlogged or poorly drained cultivation areas, as excess moisture creates favorable conditions for mite, nematode, and dipteran reproduction.
- Installation of fine-mesh insect exclusion netting over ventilation openings and entry points to impede the ingress of adult flies and other flying insects.
- Regular and systematic inspection of beds throughout the cultivation cycle to facilitate early detection and timely intervention.
- Application of registered biological control agents or, where absolutely necessary, approved acaricides or insecticides at recommended rates, with due consideration for food safety and regulatory requirements.

Common Diseases of Paddy Straw Mushroom:

Fungal pathogens, bacterial organisms, and competing saprotrophic moulds represent the principal disease agents in *V. volvacea* cultivation. These adversaries are particularly prevalent when hygienic standards are compromised or environmental conditions deviate from optimal parameters.

Green Mould Disease (*Trichoderma* spp.)

Green mould, predominantly caused by *Trichoderma harzianum* and allied species, is among the most frequently encountered and destructive fungal diseases in mushroom cultivation globally. The pathogen produces characteristic green sporulating colonies on the substrate surface, exerting antagonistic effects on mushroom mycelium through competitive exclusion for nutrients and space, as well as through the elaboration of mycoparasitic enzymes and secondary metabolites. Outbreaks are commonly associated with improperly pasteurized substrate, contaminated spawn, or breaches in growing room sanitation.

Bacterial Blotch and Soft Rot

Bacterial diseases, principally attributable to *Pseudomonas tolaasii* and related fluorescent pseudomonads, manifest as water-soaked lesions, brown discoloration, and progressive softening of the sporophore tissue. Disease development is strongly favored by persistently

elevated relative humidity, free water on fruiting body surfaces, and inadequate air movement. Bacterial rot can cause significant post-harvest losses in addition to field-level yield reductions.

Ink Cap Mould (*Coprinus* spp.)

Species of *Coprinus* and related coprinoid genera are opportunistic saprotrophic competitors that colonize inadequately pasteurized substrates. Their rapid vegetative growth enables them to pre-empt the available nutrient base, thereby suppressing the establishment and spread of *V. volvacea* mycelium and leading to marked reductions in fruiting body number and yield.

***Aspergillus* and *Penicillium* Species**

Various *Aspergillus* and *Penicillium* species function as substrate contaminants, particularly when pasteurization is incomplete or when inoculation is conducted under non-aseptic conditions. These xerophytic and mesophilic fungi compete aggressively with mushroom mycelium for colonizable substrate, frequently producing mycotoxins that may further inhibit mushroom development and pose food safety concerns.

Management Strategies for Disease Control

Disease prevention through proactive cultural management is considerably more cost-effective and reliable than curative treatment in mushroom cultivation systems. The following integrated disease management practices are recommended:

- Procurement of spawn exclusively from accredited and quality-assured sources with demonstrated freedom from fungal and bacterial pathogens.
- Implementation of rigorous substrate pasteurization protocols to eliminate or substantially reduce the inoculum load of competing and pathogenic microorganisms prior to spawn deployment.
- Maintenance of growing room temperature and relative humidity within species-appropriate ranges, avoiding prolonged deviations that favor pathogen development.
- Provision of adequate and uniformly distributed air circulation to prevent surface moisture accumulation on fruiting bodies and substrate, which constitutes a primary predisposing factor for bacterial and fungal disease.
- Immediate identification and removal of contaminated substrate beds, followed by thorough decontamination of the affected growing area to curtail lateral disease spread.
- Routine cleaning and periodic disinfection of all growing infrastructure, including floors, walls, shelving, harvest containers, and hand tools.
- Avoidance of excessive bed density, which restricts air movement and creates microclimatic conditions conducive to disease development.
- Cautious and targeted application of approved fungicides or bactericides in cases of severe and confirmed disease incidence, strictly in accordance with label instructions and applicable food safety regulations.

Abiotic Disorders in Paddy Straw Mushroom Cultivation

In addition to biotic stresses, *V. volvacea* cultivation is susceptible to a range of physiological and developmental disorders attributable to suboptimal environmental conditions. Unlike pathogen-mediated diseases, these abiotic disorders are not transmissible but may cause substantial and widespread yield losses when environmental management is inadequate.

Retarded or Absent Mycelial Colonization

Failure of the mycelium to colonize the substrate fully and within the expected timeframe typically results from exposure to temperatures outside the optimal range of 30–35°C, the use of spawn with compromised viability, or insufficient substrate moisture content. At temperatures below approximately 28°C, mycelial growth rate declines markedly, while temperatures exceeding 40°C may cause irreversible hyphal damage.

Substrate Desiccation

Desiccation of the cultivation substrate, resulting in premature termination of fruiting body development, is a direct consequence of inadequate substrate moisture maintenance and low ambient relative humidity. This disorder is particularly prevalent during periods of high

evaporative demand or when irrigation schedules are irregular. Affected beds display a white, powdery surface with arrested or shrunken primordia.

Malformed Fruiting Bodies

Morphological aberrations in fruiting body development, including cap elongation, stipe distortion, and failure of the universal veil to rupture normally, are primarily associated with elevated concentrations of carbon dioxide within the growing environment, resulting from inadequate ventilation. Temperature instability during critical developmental phases may additionally contribute to sporophore malformation.

Management of Abiotic Disorders

The control of abiotic disorders is fundamentally contingent upon the establishment and maintenance of species-appropriate environmental conditions throughout the cultivation cycle. The following management guidelines are recommended:

- Maintenance of growing room temperature within the range of 30–35°C during the mycelial colonization phase and 28–32°C during the fruiting stage, with continuous temperature monitoring using calibrated instruments.
- Regulation of relative humidity at 80–90%, with targeted humidification systems employed to compensate for ambient evaporative demand during hot or dry periods.
- Provision of adequate and evenly distributed forced or natural ventilation to maintain CO₂ concentrations below approximately 1,000 ppm, thereby preventing morphogenic disturbances in fruiting body development.
- Implementation of a consistent and substrate moisture-responsive irrigation regime, using clean potable water, to prevent both desiccation and waterlogging of beds.
- Shielding of cultivation beds from direct solar radiation and heavy rainfall through appropriate structural design, as both can induce acute thermal and mechanical stress.
- Periodic assessment of substrate moisture content, ambient temperature, humidity, and CO₂ levels using reliable monitoring instrumentation to enable proactive corrective interventions.

Conclusion

Pest infestations, pathogenic diseases, and abiotic physiological disorders collectively constitute the primary constraints on productivity and product quality in paddy straw mushroom (*V. volvacea*) cultivation. However, evidence from production systems across tropical Asia indicates that these challenges are substantially manageable through the consistent application of integrated management practices. Such an approach encompasses the use of high-quality, pathogen-free spawn; rigorous substrate pasteurization; maintenance of optimal growing environment parameters; strict cultivation hygiene; and systematic monitoring for early detection of emerging problems. The adoption of these scientifically validated practices enables growers to sustain high and consistent yields while minimizing production losses and reducing dependence on chemical inputs. With appropriate institutional support for farmer training and knowledge dissemination, paddy straw mushroom cultivation can be developed into a reliable and economically sustainable component of smallholder agricultural systems in the tropics.

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