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Practice Abstract 1

BIOSCHAMP Project

Grant Agreement No. 101000651

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Disclaimer and acknowledgements

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Horizon 2020 European Union Funding for Research & Innovation

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Executive Summary

In the Description of Action (DoA), under WP7 in "Task T7.4. Dissemination activities", it is indicated that during the whole course of the project, twelve "Practice Abstracts" will be distributed in two packs of 6, addressed to mushroom growers and to be distributed in EIP-Agri website (using EIP format) for broad dissemination.

The EIP-AGRI common format facilitates knowledge flows on H2020 innovative and practice-oriented projects from the start until the end of the project. The use of this format also enables farmers, advisers, researchers and all other actors across the EU to contact each other. The use of the EIP-AGRI common format facilitates not only the exchange of knowledge, but also the contact between potential partners in innovation projects. It contributes to building up a unique repository of practical knowledge across the EU via the EIP-AGRI project database which supports the dissemination of results of all interactive innovation projects.

In addition to EIP Common format, a BIOSCHAMP template has been prepared for practice abstracts to be published at the project website, using a more friendly-dissemination format for end users.

The thematic of the first 6 PA has been decided in the basis of actual needs of European mushroom sector, and there are based in the scope of BIOSCHAMP project.

1. Introduction

1.1 About the project

The button mushroom is a singular crop that requires to apply suitable casing materials with adequate physical-chemical and microbiological properties to obtain commercially profitable productions. A compost totally colonized by the mushroom mycelium needs to be topped by this material where fruiting occurs (transition stage from the vegetative mycelium to the reproductive tissue, the mushrooms). However, the base material (natural black peat) that we currently use as casing is a non-renewable material extracted from natural peatlands, its replacement rate is very low and the exploitation of peatlands has a great environmental impact, so the extraction is being currently limited or even banned in countries like Germany

The current profitability of the crop, with reduced business margins, demands that growers need to generate high and sustained productions. One of the main limiting factors of crop yield are fungal diseases that can cause very significant losses. To fight them, we currently apply preventive phytosanitary treatments, although we have a reduced range of fungicides of chemical origin. The redundant use of the same active principles facilitates the development of resistance among fungal parasites and it is not expected that alternative substances of chemical origin will appear in the medium term, since any fungicide applied in cultivation requires high selectivity to prevent damage for the cultivated mycelium.

Europe is the second largest producer of edible mushrooms in the world after China. The white button mushroom is the most cultivated and consumed species. At the European level, this activity is valued at 33.7 million euros (2017) and it is estimated that it will reach 66.8 million euros in 2026.

BIOSCHAMP is born as a European commitment designed tailor-made for the mushroom sector with the aim of generating an integrated solution for the production of alternative sustainable casing materials to current peat-based materials, and enriched with selected microbial communities to biostimulate the growth and fruiting of the mushrooms, while preventing fungal diseases occurrence. The intended results will reduce dependence and use of pesticides and will contribute to improving the productivity, sustainability and profitability of the European mushroom sector.

1.2 Scope of the document

This document introduces the concept of EIP-Agri practice abstracts (PA) and compiles the first 6 first PA of BIOSCHAMP project.

The PA presented in this deliverable have been presented in English (as mandatory language) and Spanish (project coordinator language).

The PA have been designed according to EIP-Agri common format for practice abstracts publication. In addition, the consortium has designed an own model for BIOSCHAMP.

This deliverable is the result of part of Task 7.4 “Dissemination actions” of BIOSCHAMP Project

1.3 Objectives

Practice abstracts describe the main information, recommendation and practice to serve the end-users in their daily practice. These end-users are mainly mushroom growers, but it also includes other actors in agriculture sector, researching and policy making.

According to the Dissemination and Communication Plan reported in Deliverable 7.1, practice abstracts will contribute to increase the impact of project solutions.

Practice abstracts will contribute to the following topics:

- Enhance agriculture good practices in mushroom sector.
- Increase the knowledge of growers in how to fight against pests and diseases.
- Improve resilience of mushroom growers.
- Increase the circular economy approaches in agri-sector.

Practice abstracts will also contribute to the expected impacts on target audiences such as mushroom growers and farmers in order to provide roadmaps and scenarios for transition towards prudent use of pesticides and peat, as well as provide suggestions and recommendations on new tools for preventive approach of diseases control.

2. EIP-AGRI Common format

EIP-AGRI common format is published in the "Annex to the EIP guidelines of December 2014, as updated for the Rural Development Committee of 16 March 2016, including info on synergies and complementarities developed between the Horizon 2020 EU research policy and the rural development policy under the CAP", named GUIDELINES ON PROGRAMMING FOR INNOVATION AND THE IMPLEMENTATION OF THE EIP FOR AGRICULTURAL PRODUCTIVITY AND SUSTAINABILITY.

The common format is described as an interactive innovation approach under the European Innovation Partnership Agricultural Productivity and Sustainability (EIP-AGRI) fosters the development of demand-driven innovation through projects, turning creative new ideas into practical applications thanks to interactions between partners, the sharing of knowledge and effective intermediation and dissemination.

The EIP common format consists of a set of basic elements characterising the project and includes one or more "practice abstract(s)".

The format has been developed with two objectives: enable contacting partners and incentivise efficient knowledge exchange, and to disseminate the results of the project in a concise and easy understandable way to practitioners.

The Common format should include the following obligatory elements:

- Title of the project: short and easily understandable.
- Editor of the text
- Project coordinator
- Project partners
- Keyword-category
- Project period
- Project status
- Main funding source
- Total budget
- Geographical location
- Final report
- Practice abstract.
    - Objective of the project
    - Short summary for practitioners, containing main results or outcomes of the activity and the main practical recommendations.

2.1 BIOSCHAMP on EIP-AGRI common format

In this section there is shown how the BIOSCHAMP project is presented in EIP-Agri format, submitted for publication in "project information" sheet.

Project identifier: 2020H2020_101000651_BIOSCHAMP
Title of the project: BIOSCHAMP - Biostimulant of alternative casing for a sustainable and profitable mushroom industry
Geographical location (country of the coordinator): ES
Main geographical location NUTS3 (of coordinator): ES230 – La Rioja
Editor of the text: ASOCIACION PROFESIONAL DE PRODUCTORES DE SUSTRATOS Y HONGOS DE LA RIOJA, NAVARRA Y ARAGÓN
Project period:

- Start year: 2020
- End year: 2024

Project status: ongoing
Main funding source: H2020
Total Budget: 4,176,611.25
Objective of the project: In this project, we will develop an integrated approach to fight against the main health challenges in mushroom production (parasitic fungi and bacteria). With the development of a microbiota enriched casing soil we will decrease the need for pesticides, and we will contribute to improve the productivity, the sustainability and the profitability of the European mushroom sector.

The overall objective of the BIOSCHAMP project is to demonstrate the viability of decreasing pesticides use in mushroom cultivation by making use of peat alternative casing material enriched with selected biostimulant microbiota as a safeguard for the profitability of mushroom businesses.

Description of the context of the project: Mushroom cultivation is a highly particular agricultural activity. Growing conditions are quite unique: cultured indoors, with high humidity ($\geqslant$70%) and mild temperature (24 ^{o}C), throughout the entire year. The controlled growing conditions facilitate a stable production non-dependent on changing climatic conditions, but also brings disadvantages, e.g. warm and humid conditions in mushroom farms favor the growth of pathogens, especially parasitic fungi or bacteria.

The control of parasitic fungi in mushroom production is specially challenging because both parasites and host belong to the same kingdom (fungi), therefore efficient but selective fungicides are required but usually not sufficient to fight outbreaks.

The main fungicides used today (prochloraz-Mn, metrafenone or chlorothalonil) are likely to be banned by the 2021-2023 period. Due to the particularities of this crop and the limited size of its sector compared to the larger market of vegetable crops, the industry has not developed novel active substances to fight against these pathogens and replace obsolete ones (many evidences of resistance among fungal parasites have been already reported), which endangers its commercial viability.

In addition to this, according to a recent report published by EFSA, more than 15% of the cultivated fungi contain pesticide residue. Although samples were not exceeding Maximum Residue Levels (MRLs) it represents a threat for the mushroom sector that could see its marketability limited if residue-free policies are imposed by retailers. Further information is needed for substrate producers and growers to reduce pesticides in mushroom.

3. Practice Abstracts

For the first batch, in total 6 practice abstracts have been released.

The PA have been performed in two different formats, both according to EIP-Agri rules, one using the EIP-Agri template and a second one presented in a dedicated format for BIOSCHAMP project. This last version is shown in Annexes and uploaded to project website.

In the following sections there are presented the PA in the EIP-Agri format.

3.1 Practice abstract 1: Resistance to fungicides in mushroom cultivation

Short title: Resistance to fungicides in mushroom cultivation

Short summary for practitioners:

Problem:
The limited active ingredients available to fight biotic disorders in mushroom crops, together with an inadequate management of the approved formulations, facilitate the outbreak of harmful resistant pathogens in the mushroom industry.

Solution:
Specific biostimulant solutions with antifungal activity for mushroom pathogens, like the one developed by BIOSCHAMP. Biostimulation in the cultivation of Agaricus bisporus will reduce yield losses caused by mycoparasites.

Benefit:
1.A decrease in the dependency on fungicides of chemical origin.

2.Prevention of resistant strains while extending the useful life of the authorized active ingredients.

3.Reduction of the environmental impact of the cultivated mushroom sector.

Practical recommendations:
Key measurements should prevent disease outbreaks through good cultural practices. To select the most suitable control mechanisms:

- Use biological control methods.
- Do not use preventive phytosanitary treatments during cultivation in the absence of pathogens.
- Identify risk thresholds that allow the application of effective treatments.
- Do not use phytosanitary products in case of low disease incidence.
- Use selective phytosanitary products for the disease detected.
- Whenever possible, alternate between products with different mechanisms of action.
- Follow the application dose indicated by the manufacturer in the label.

3.2 Practice abstract 2: Mushroom cultivation as an opportunity to close the loop for the circular economy

Short title: Mushroom cultivation: an opportunity to close the loop for the circular economy

Short summary for practitioners:

The current production system is based on a linear model. A "disposable" one-way system where natural resources are transformed into materials & products.

Circular systems favour the recovery of materials & prevents the perpetuation of resource losses, all the while generating profit.

Mushroom cultivation is circular in nature, it uses residues from livestock activities (chicken & horse manure), agriculture (wheat straw) to produce substrates.

The potential of mushrooms makes them even more interesting as an agricultural practice. For example, mushrooms are a great nutritional addition for vegans & vegetarians: they contain high-quality proteins similar to eggs or milk; bioactive compounds (antioxidants); and different micronutrients usually deficient in Western diets (like selenium or vit D).

- Minimize the carbon footprint of the agricultural industry.

- Supports circular production systems & the agri-food sector.

- Brings job opportunities in rural areas at risk of depopulation.

Practical recommendations:
Some key aspects to have into account when taking the first steps into mushroom cultivation to make the most of circularity:

- Review internal practices: maximize the recovery of by-products or residues from already existing agricultural and livestock activities.

- Review opportunities: it is also possible to reuse locally available resources.

- Review the process and how to better integrate it with your current practices. Make the most of short transformation and valorisation value chains.

- Introduce new alternative bio-based materials to the current peat-based ones to cover the compost colonised by the mushroom mycelium.

- Use biostimulant in cultivation to reduce chemical agents used for disease control.

3.3 Practice abstract 3: Casing in mushroom cultivation

Short title: Casing in mushroom cultivation

Short summary for practitioners:

Peat is the main component of mushroom casing. The industry is highly dependent on peat since the alternatives are neither agronomically nor economically efficient.

Peat is a natural material considered as a non-renewable fossil resource and its extraction has adverse effects like impact on unique ecosystems and contribution to global warming. Since peatlands are carbon sinks, conservation of peatlands prevents the release of CO2 into the atmosphere. Peat extraction is increasingly restrictive in Europe, making the material less available and more expensive.

BIOSCHAMP uses biomass-based sustainable materials to replace peat as casing material.

- Improvement of mushroom farms profitability.

- Easier access to a variety of casing materials, manufactured locally using available products, reducing the carbon footprint and the substrate costs.

- Development of agronomically valid alternatives to non-renewable materials.

Recommendations for the hygienic management of mushroom casing:

Hygiene represents a fundamental aspect for the application of casing soil.

- Every access to the facilities must have disinfectant mats for footwear.

- The trucks carrying casing should be thoroughly cleaned.

- The casing must be stored indoors, to prevent contaminations.

- Casing containers must be properly cleaned.

- Workers must develop their activity in sanitized environments and use clean equipment.

- Keep the packages closed until the casing is used.

- Avoid contact of the casing material with surfaces outside of the disinfected areas.

Recommendations for the preparation of the casing:

- The casing material must be adequately moistened to prevent structural losses.

- Apply the casing with the correct moisture level.

3.4 Practice abstract 4: Good practices in mushroom cultivation to prevent diseases

Short title: Good practices in mushroom cultivation to prevent diseases

Short summary for practitioners:

The increasingly limited availability of authorized active ingredients to fight against fungal diseases in mushroom cultivation requires development of integrated management of pests and diseases.

Good practices during mushroom cultivation minimize yield losses caused by fungal diseases; lowering the reliance upon phytosanitary products increasingly expensive and less available.

Overall reduction of the environmental impact of the sector.

Prevention of disease occurrence and spread are key practical aspects for mushroom cultivation.

Good cultivation practices:

- Avoid leaving decaying mushrooms in the facilities.
- Remove the stems from casing soil after harvesting.
- Sweep floors and clean growing rooms frequently.
- Remove potential sources of infection (discarded mushrooms, bubbles) near the crops and infected mushrooms as soon as possible.
- Disinfection of machinery, equipment and shoes at the entrance and exit of the cropping facilities.
- Use air filters to prevent the spread of pests and diseases.

Crop hygiene:

- Workers must start picking growing rooms from younger flushes to the oldest ones.
- Change disposable gloves for each room.
- Disinfect collection tools and equipment for each room.
- A worker must be in charge of identifying pathogens in the crop.
- Placement of antitrips mesh in the ventilation openings.
- Prevent the circulation of dust in the installation. Moisten floors before sweeping.
- Store casing materials in clean, closed areas covered with plastic.

Dissinfectation measures:

- Steam disinfection at 65-70ºC for 9-12 hours prior to emptying the room is the most effective treatment (cook-out).
- Clean surfaces with a pressure water sprayer before applying disinfection agents.

3.5 Practice abstract 5: Good practices to deal with cobweb disease

Short title: Good practices to deal with cobweb disease in mushroom cultivation.

Short summary for practitioners:

Cobweb disease is affecting mushroom crops at European level. In addition, the resistance of this disease to commonly used methods to fight it is increasing. For example, the BIOSCHAMP project has detected strains of Cladobotryum mycophilum resistant to the widely used and recommended active substance metrafenone.

Prevention must preclude sporulation and conidia dispersal from punctual outbreaks.

The BIOSCHAMP project recommends the use of specific biostimulant solutions with antifun-gal activity to prevent the germination and development of the causative agent of the disease: mycelium of Cladobotryum spp.

Good cultivation practices & biostimulant solutions provide alternative & effective control measures to prevent diseases.

The main control measure is prevention. Control methods should aim to prevent the spread of the disease.

Specific measures to apply once the disease has appeared:

- Maintain relative humidity (RH) 1-2% lower than usual to prevent conidia germination and disease spread.

- Avoid irrigation on disease colonies.

- Cover the colonies with salt: apply damp paper over diseased patched and add salt to it, in order to avoid the dispersion of the spores.

- Turn off fans or reduce their flowrate in cultivation rooms showing the disease.

- Filter all the air that enters the cultivation room.

- Filter exhaust air to prevent the spore release outside the growing facility.

Recommendations on the use of biostimulants:
This solution is provided based upon scientific evidence about the initial source of infection; the preventive treatment of specific sources of disease; and the prevention of its spread. The BIOSCHAMP project works on creating solutions with this scope.

3.6 Practice abstract 6: identification, prevention and control of dry bubble

Short title: Identification, prevention and control of dry bubble

Short summary for practitioners:

Dry bubble caused by the fungal pathogen Lecanicillium fungicola causes several production losses. There is only one pesticide agent authorized and it is only available until June 2023.

The BIOSCHAMP project recommends the use of specific biostimulant solutions, like the use of specific Bacillus strains with selective antifungal activity.

It is essential to locate the early outbreaks of disease by making frequent visits to the crop with a flashlight to facilitate the identification of the disease in the casing. The dispersion of the dry bubble requires vectors that distribute pathogenic spores.

Measures to apply once the disease has appeared:

- Remove the bubbles (undifferentiated diseased tissue) with a bag/tissue to avoid touching it into a bucket with salt or disinfectant.
- Avoid irrigation on bubbles.
- Cover with salt the hole from where we have removed the bubble.
- Avoid touching the bubble, and if you do touch it, change your gloves immediately.
- Use hydroalcoholic gel to disinfect the hands of the harversters.
- Use adequate filters that prevent the entry of diptera into the crop.

Good cultivation practices to prevent dispersion:

- Effective control of the populations of dipterans.
- Use black lights in the gates and plastic treated with insecticide for the control of pests.
- Use adhesive plates with pheromones to attract dipterans.
- Store casing containers in a clean area.
- Discard the leftover casing material.
- Use adequate air filters.

Use of biostimulants:

BIOSCHAMP identified bacterial strains from Bacillus genus, native from the casing material, that produce secondary metabolites that inhibit the germination and growth of the fungal pathogen, limiting the capacity of infection.

4. Availability of the resources

4.1 Upload to project website

To make the practices abstracts available, BIOSCHAMP project uploaded to the project website.

They are available by clicking in the “Dissemination” tab.

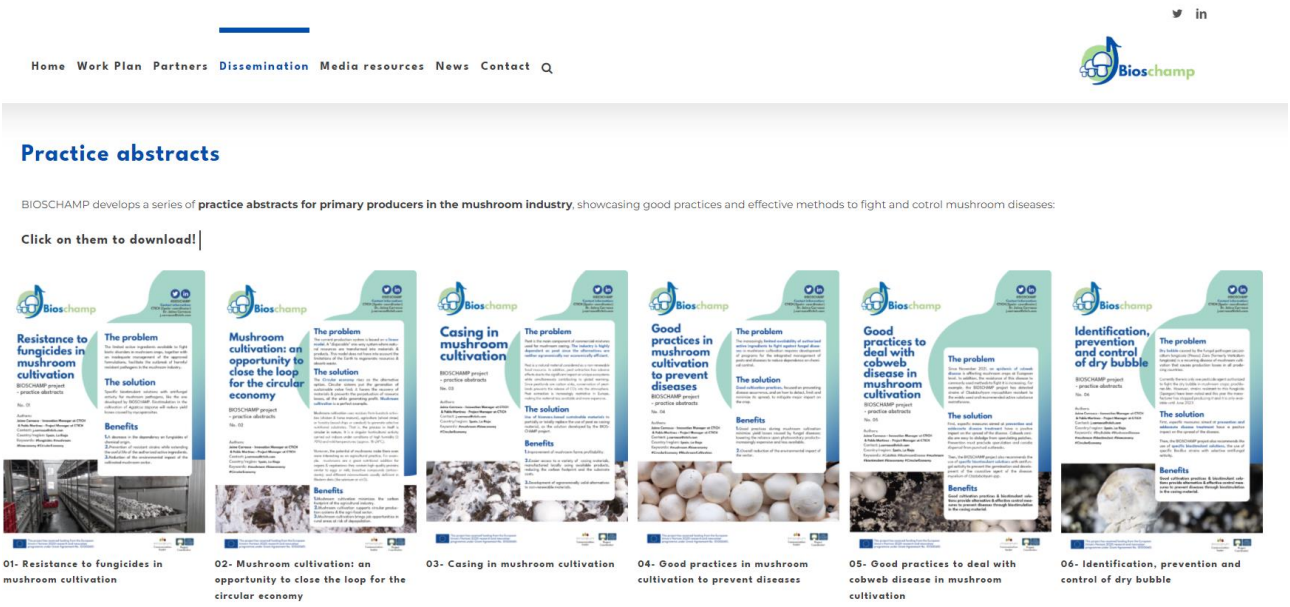

Figure 1. Visualization of the practice abstract in the project website

Click on the links to access to the corresponding Practice Abstract.

Practice Abstract 1

Practice Abstract 2

Practice Abstract 3

Practice Abstract 4

Practice Abstract 5

Practice Abstract 6

4.2 Upload to EIP-AGRI website and other platforms

According to the Grant Agreement, the practice abstracts will be submitted and distributed to the EIP AGRI website. The submission is already requested and as soon as the EIP AGRI team review and approve the BIOSCHAMP project practice abstracts, they will be available on the mentioned website.

The URL and project preview on EIP AGRI project website will be included in the Deliverable 7.10, corresponding to the rest of practice abstracts to be submitted, at M40 (January 2024).

BIOSCHAMP project will assess the possibility to upload the practice abstract to other open access platforms or databases (Open Research Europe, OpenAIRE, ZENODO) in order to maximise the impact of the materials.

5. Conclusions

Deliverable 7.9 shows the first 6 BIOSCHAMP practice abstracts published.

The PA have been submitted to EIP-Agri website for publication and are already available in BIOSCHAMP website (www.bioschamp.eu).

This PA include practical recommendations for end users, focused on mushroom sector, the main stakeholder's group of BIOSCHAMP project.

The final results of the project solutions developed and outcomes on the ongoing studies will be included in the second batch of PA, that will be submitted in Deliverable 7.10 at the end of the project (M40).

6. Annexes

Practice abstract 1: Resistance to fungicides in mushroom cultivation

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Resistance to fungicides in mushroom cultivation

BIOSCHAMP project
- practice abstracts

No. 01

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Keywords: #fungicides #mushroom #bioeconomy #CircularEconomy

The problem

The limited active ingredients available to fight biotic disorders in mushroom crops, together with an inadequate management of the approved formulations, facilitate the outbreak of harmful resistant pathogens in the mushroom industry.

The solution

Specific biostimulant solutions with antifungal activity for mushroom pathogens, like the one developed by BIOSCHAMP. Biostimulation in the cultivation of *Agaricus bisporus* will reduce yield losses caused by mycoparasites.

Benefits

1. A decrease in the dependency on fungicides of chemical origin.
2. Prevention of resistant strains while extending the useful life of the authorized active ingredients.
3. Reduction of the environmental impact of the cultivated mushroom sector.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 101000651.

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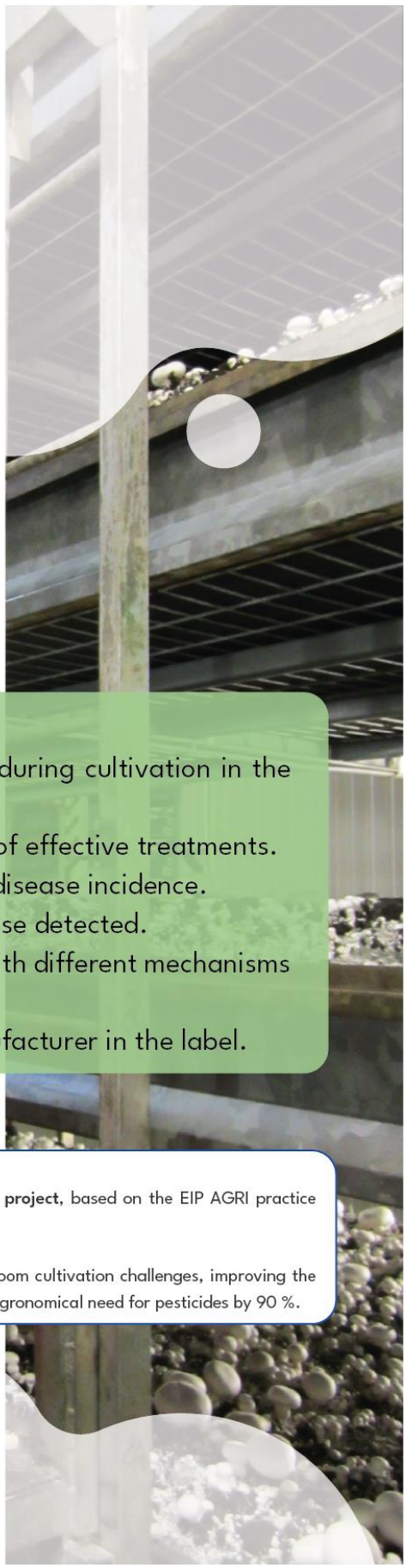

Resistance to fungicides in mushroom cultivation

Practical recommendations

Key measurements should prevent disease outbreaks through good cultural practices. To select the most suitable control mechanisms:

-Use biological control methods.
-Do not use preventive phytosanitary treatments during cultivation in the absence of pathogens.
-Identify risk thresholds that allow the application of effective treatments.
-Do not use phytosanitary products in case of low disease incidence.
-Use selective phytosanitary products for the disease detected.
-Whenever possible, alternate between products with different mechanisms of action.
-Follow the application dose indicated by the manufacturer in the label.

About BIOSCHAMP and this practice abstact

This practice abstract was elaborated in the **BIOSCHAMP project**, based on the EIP AGRI practice abstract format. © 2022

Project duration: from October 2020 to March 2024.

Goal: develop an integrated approach to tackle the mushroom cultivation challenges, improving the mushroom sector industrial profitability while reducing the agronomical need for pesticides by 90 %.

Practice abstract 2: Mushroom cultivation as an opportunity to close the loop for the circular economy

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Mushroom cultivation: an opportunity to close the loop for the circular economy

BIOSCHAMP project
- practice abstracts

No. 02

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Keywords: #mushroom #bioeconomy #CircularEconomy

The problem

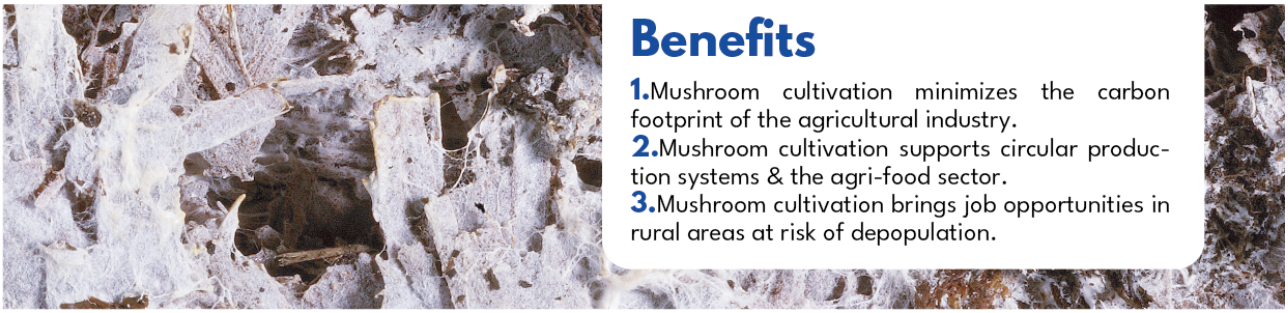
The current production system is based on **a linear model**. A "disposable" one-way system where natural resources are transformed into materials & products. This model does not have into account the limitations of the Earth to regenerate resources & absorb waste.

The solution

The **Circular economy** rises as the alternative option. Circular sistems put the generation of sustainable value first: it favors the recovery of materials & prevents the perpetuation of resource losses, all the while generating profit. **Mushroom cultivation** is a perfect example.

Mushroom cultivation uses residues from livestock activities (chicken & horse manure), agriculture (wheat straw) or forestry (wood chips or sawdust) to generate selective nutritional substrates. That is, the process in itself is circular in nature. It is a singular horticultural activity carried out indoors under conditions of high humidity (≥ 70%) and mild temperatures (approx. 18-24°C).

Moreover, the potential of mushrooms make them even more interesting as an agricultural practice. For example, mushrooms are a great nutritional addition for vegans & vegetarians: they contain high-quality proteins similar to eggs or milk; bioactive compounds (antioxidants); and different micronutrients usually deficient in Western diets (like selenium or vit D).



Benefits

1. Mushroom cultivation minimizes the carbon footprint of the agricultural industry.
2. Mushroom cultivation supports circular production systems & the agri-food sector.
3. Mushroom cultivation brings job opportunities in rural areas at risk of depopulation.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 101000651.

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Project Coordinator

Mushroom cultivation as an opportunity to close the loop for the circular economy

Practical recommendations

Some key aspects to have into account when taking the first steps into mushroom cultivation to make the most of circulatiry:

-Review internal practices: maximize the recovery of by-products or residues from alre-ady existing agricultural and livestock activities.

-Review opportunities: it is also possible to reuse locally available resources.

-Review the process and how to better integrate it with your current practices. Mushroom cultivation is a short-transformation process with fast access to the market in most regions in the EU.

-Introduce new alternative bio-based materials to the current peat-based ones to cover the compost colonised by the mushroom mycelium.

-Use biostimulant in cultivation to reduce chemical agents used for disease control.

About BIOSCHAMP and this practice abstract

This practice abstract was elaborated in the **BIOSCHAMP project**, based on the EIP AGRI practice abstract format. © 2022

Project duration: from October 2020 to March 2024.

Goal: develop an integrated approach to tackle the mushroom cultivation challenges, improving the mushroom sector industrial profitability while reducing the agronomical need for pesticides by 90 %.

Practice abstract 3: Casing in mushroom cultivation

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Casing in mushroom cultivation

BIOSCHAMP project
- practice abstracts

No. 03

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Keywords: #mushroom #bioeconomy #CircularEconomy

The problem

Peat is the main component of commercial mixtures used for mushroom casing. **The industry is highly dependent on peat since the alternatives are neither agronomically nor economically efficient.**

Peat is a natural material considered as a non-renewable fossil resource. In addition, peat extraction has adverse effects due to the significant impact on unique ecosystems while simultaneously contributing to global warming. Since peatlands are carbon sinks, conservation of peatlands prevents the release of CO_2 into the atmosphere. Peat extraction is increasingly restrictive in Europe, making the material less available and more expensive.

The solution

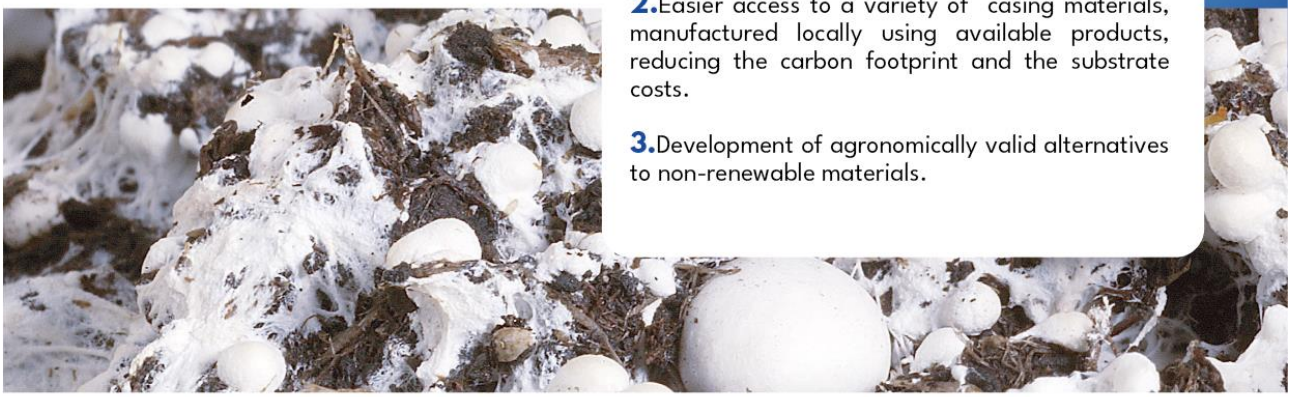
Use of biomass-based sustainable materials to partially or totally replace the use of peat as casing material, as the solution developed by the BIOSCHAMP project.

Benefits

1. Improvement of mushroom farms profitability.

2. Easier access to a variety of casing materials, manufactured locally using available products, reducing the carbon footprint and the substrate costs.

3. Development of agronomically valid alternatives to non-renewable materials.



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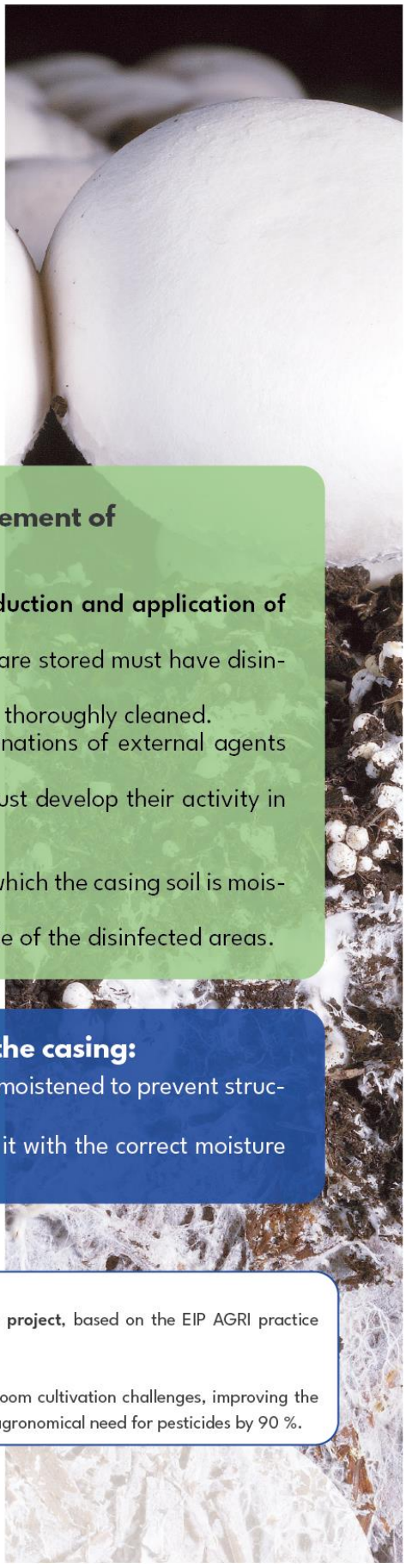

Casing in mushroom cultivation

Practical recommendations

(1) Recommendations for the hygienic management of mushroom casing:

Hygiene represents a fundamental aspect for the production and application of casing soil used in mushroom cultivation.

-Every access to the facilities where the casing materials are stored must have disinfectant mats for footwear.
-The trucks carrying mushroom casing material should be thoroughly cleaned.
-The casing must be stored indoors, to prevent contaminations of external agents such as pathogenic spores.
-Casing containers must be properly cleaned. Workers must develop their activity in sanitized environments, and use clean equipment.
-Keep the packages closed until the casing is used.
-Pay special attention to the hygiene of the equipment in which the casing soil is moistened and mixed.
-Avoid contact of the casing material with surfaces outside of the disinfected areas.

(2)Recommendations for the preparation of the casing:

- Humidification: the casing material must be adequately moistened to prevent structural losses.
- Check the humidity level before using the casing: apply it with the correct moisture level.

About BIOSCHAMP and this practice abstract

This practice abstract was elaborated in the **BIOSCHAMP project**, based on the EIP AGRI practice abstract format. © 2022

Project duration: from October 2020 to March 2024.

Goal: develop an integrated approach to tackle the mushroom cultivation challenges, improving the mushroom sector industrial profitability while reducing the agronomical need for pesticides by 90 %.

Practice abstract 4: Good practices in mushroom cultivation

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Good practices in mushroom cultivation to prevent diseases

BIOSCHAMP project
- practice abstracts

No. 04

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Keywords: #mushroom #bioeconomy #CircularEconomy #MushroomCultivation

The problem

The increasingly **limited availability of authorized active ingredients to fight against fungal diseases** in mushroom cultivation requires development of programs for the integrated management of pests and diseases to reduce dependence on chemical control.

The solution

Good cultivation practices, focused on preventing disease occurrence, and on how to detect, limit and minimize its spread, to mitigate major impact on the crop.

Benefits

1. Good practices during mushroom cultivation minimize yield losses caused by fungal diseases; lowering the reliance upon phytosanitary products- increasingly expensive and less available.

2. Overall reduction of the environmental impact of the sector.

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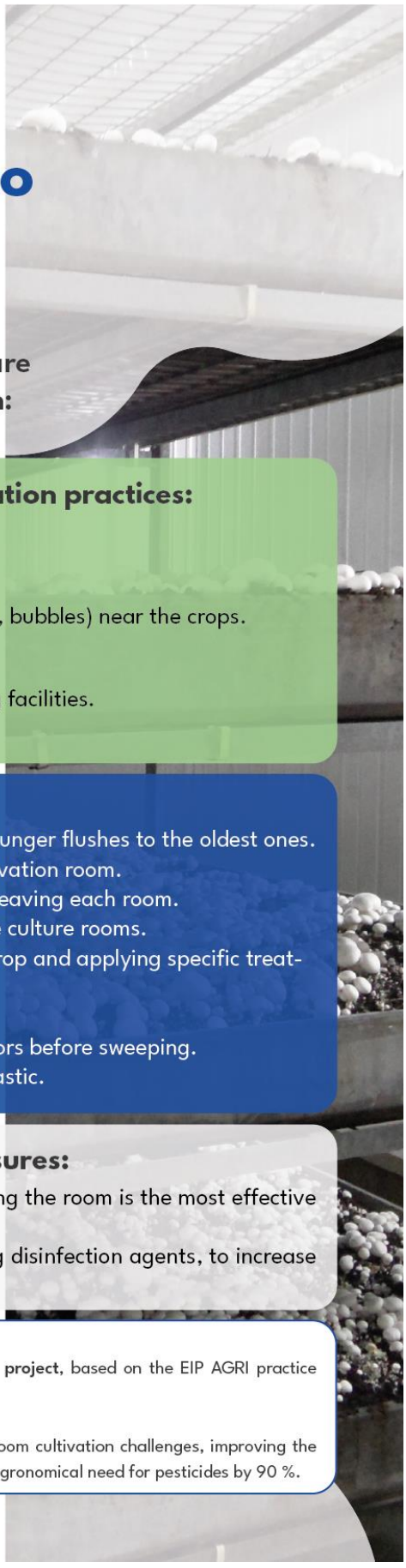
Good practices in mushroom cultivation to prevent diseases

Practical recommendations

Prevention of disease occurrence and spread are key practical aspects for mushroom cultivation:



(1) Recommendations on general good cultivation practices:

-Avoid leaving decaying mushrooms in the facilities.
-Remove the stems from casing soil after harvesting.
-Sweep floors and clean growing rooms frequently.
-Remove potential sources of infection (discarded mushrooms, bubbles) near the crops.
-Remove infected mushrooms as soon as possible.
-Disinfect machinery and equipment.
-Disinfection of shoes at the entrance and exit of the cropping facilities.
-Use air filters to prevent the spread of pests and diseases.

(2)Recommendations on crop hygiene

-The harvest teams must start picking growing rooms from younger flushes to the oldest ones.
-Disposable gloves should be used and changed for each cultivation room.
-All collection tools and equipment must be disinfected when leaving each room.
-Use of carpets or pits with disinfectant at the entrance of the culture rooms.
-A worker must be in charge of identifying pathogens in the crop and applying specific treatments to prevent their spread.
-Placement of antitrips mesh in the ventilation openings.
-Prevent the circulation of dust in the installation. Moisten floors before sweeping.
-Store casing materials in clean, closed areas covered with plastic.

(3) Recommendations on dissinfectation measures:

-Steam disinfection at 65-70°C for 9-12 hours prior to emptying the room is the most effective treatment (cook-out).
-Clean surfaces with a pressure water sprayer before applying disinfection agents, to increase their effect.

About BIOSCHAMP and this practice abstract

This practice abstract was elaborated in the **BIOSCHAMP project**, based on the EIP AGRI practice abstract format. © 2022

Project duration: from October 2020 to March 2024.

Goal: develop an integrated approach to tackle the mushroom cultivation challenges, improving the mushroom sector industrial profitability while reducing the agronomical need for pesticides by 90 %.

Practice abstract 5: Good practices to deal with cobweb disease

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Good practices to deal with cobweb disease in mushroom cultivation

BIOSCHAMP project
- practice abstracts

No. 05

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Keywords: #CobWeb #MushroomDisease #mushroom #biostimulant #bioeconomy #CircularEconomy

The problem

Since November 2021, **an epidemic of cobweb disease** is affecting mushroom crops at European level. In addition, the resistance of this disease to commonly used methods to fight it is increasing. For example, the BIOSCHAMP project has detected strains of *Cladobotryum mycophilum* resistant to the widely used and recommended active substance metrafenone.

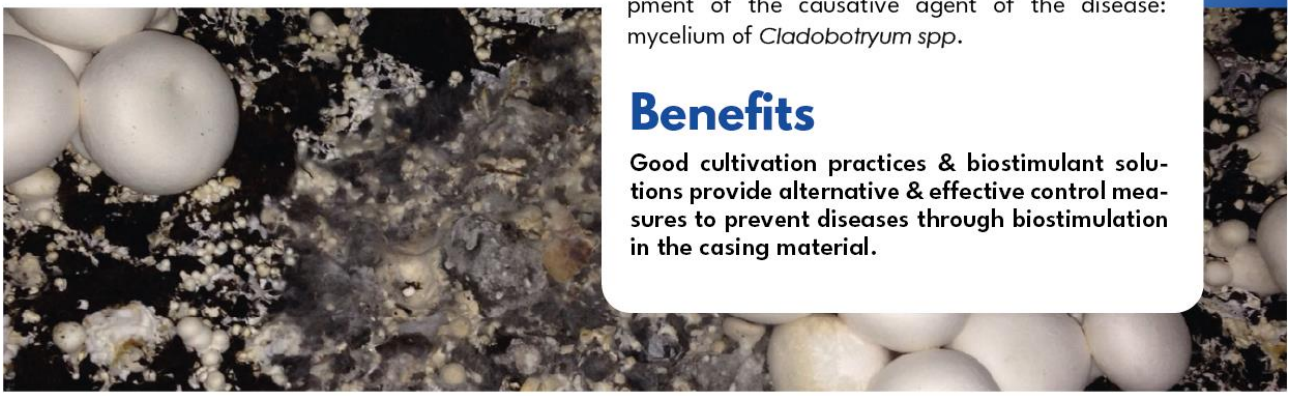
The solution

First, especfic measures aimed at **prevention and addecaute disease treatment** have a positve impact on the spread of the disease. Cobweb conidia are easy to dislodge from sporulating patches. Prevention must preclude sporulation and conidia dispersal from punctual outbreaks.

Then, the BIOSCHAMP project also recommends the use of **specific biostimulant solutions** with antifungal activity to prevent the germination and development of the causative agent of the disease: mycelium of *Cladobotryum spp*.

Benefits

Good cultivation practices & biostimulant solutions provide alternative & effective control measures to prevent diseases through biostimulation in the casing material.



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Good practices to deal with cobweb disease in mushroom cultivation

Practical recommendations

The main control measure is prevention. Control methods should aim to prevent the spread of the disease.

(1) Recommendations on specific measures to apply once the disease has appeared

-Maintain relative humidity (RH) 1-2% lower than usual to prevent conidia germination and disease spread.
-Avoid irrigation on disease colonies.
-Cover the colonies with salt: apply damp paper over diseased patched and add salt to it, in order to avoid the dispersion of the spores.
-Turn off fans or reduce their flowrate in cultivation rooms showing the disease.
-Filter all the air that enters the cultivation room.
-It is advisable to filter exhaust air to prevent the spore release outside the growing facility.

(2) Recommendations on good cultivation practices focusing on prevention:

-Avoid leaving decaying fruiting bodies on mushroom beds.
-Remove stems after harvesting.
-Sweep floors and clean the growing rooms frequently, and keep floors moist.
-Avoid leaving sources of infection (discarded or diseased mushrooms) near the crops.
-Remove infected mushrooms as soon as possible.
-Disinfect machinery and equipment.
-Carry out sanitizing treatments with steam or with disinfectants on the post-cultivation substrate in situ, prior to its removal.
-Disinfection of shoes at the entrance and exit of the crops.

(3) Recommendations on the use of biostimulants

This solution is provided based upon scientific evidence about the initial source of infection; the preventive treatment of specific sources of disease; and the prevention of its spread. The BIOSCHAMP project works on creating solutions with this scope.

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Project duration: from October 2020 to March 2024.

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Practice abstract 6: identification, prevention and control of dry bubble

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Identification, prevention and control of dry bubble

BIOSCHAMP project
- practice abstracts

No. 06

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Keywords: #DryBubble #MushroomDisease #mushroom #biostimulant #bioeconomy #CircularEconomy

The problem

Dry bubble caused by the fungal pathogen *Lecanicillium fungicola* (Preuss) Zare (formerly *Verticilium fungicola*) is a recurring disease of mushroom cultivation that causes production losses in all producing countries.

Currently there is only one pesticide agent authorized to fight the dry bubble in mushroom crops: prochloraz-Mn. However, strains resistant to this fungicide (Sporgon) have been noted and this year the manufacturer has stopped producing it and it is only available until June 2023

The solution

First, especfic measures aimed at **prevention and addecaute disease treatment** have a positve impact on the spread of the disease.

Then, the BIOSCHAMP project also recommends the use of **specific biostimulant solutions,** the use of specific Bacillus strains with selective antifungal activity.

Benefits

Good cultivation practices & biostimulant solutions provide alternative & effective control measures to prevent diseases through biostimulation in the casing material.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 101000651.

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Identification, prevention and control of dry bubble

Practical recommendations

It is essential to locate the early outbreaks of disease by making frequent visits to the crop with a flashlight to facilitate the identification of the disease that appears in the casing. The dispersion of the dry bubble (it generates spores with a sticky tegument that adheres them to the surfaces) requires vectors that distribute pathogenic spores.

(1) Recommendations on specific measures to apply once the disease has appeared:

-Remove the bubbles (undifferentiated diseased tissue) with a bag/tissue to avoid touching it into a bucket with salt or desincfectant.
-Avoid irrigation on bubbles that will facilitate the dispersion of spores.
-Cover with salt the hole from where we have removed the bubble.
-Avoid touching the bubble, and if you do touch it, change your gloves immediately.
-Use hydroalcoholic gel to disinfect the hands of the harversters.
-Use adequate filters that prevent the entry of diptera into the crop.

(2) Recommendations on general good cultivation practices to prevent dispersion:

-Effective control of the populations of dipterans (phorids and sciarids) that are dispersal vectors.
-Use black lights in the gates and plastic treated with insecticide for the control of pests.
-Use adhesive plates with pheromones to attract dipterans.
-Store casing containers in a clean area to prevent contamination.
-Discard the leftover casing material from covering a previous crop.
-Use adequate air filters to prevent spread of the disease.

(3) Recommendations on the use of biostimulants

The use of different bacterial strains from *Bacillus genus*, native from the casing material, produces secondary metabolites that inhibit the germination and growth of the fungal pathogen, limiting the capacity of infection. BIOSCHAMP identified these strains and their effects as inhibitors of the mentioned disease.

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