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MushTV – Providing IPM solutions to the mushroom industry



Key external stakeholders:

European mushroom industry, mushroom consultants, mushroom allied trades, plant protection and biocide companies, scientists, policy makers

Practical implications for stakeholders:

MushTV is a network of 18 mushroom grower associations, compost producers, businesses and research organisations from across Europe working together to tackle real industry concerns. Over a 39 month period scientists worked closely with industry and generated new tools and knowledge to underpin an integrated pest management (IPM) approach to disease control as required by the Sustainable Use of Pesticides Directive 2009/128/EC (SUD). The main outcomes are:

- Major advances in our knowledge and understanding of compost green mould, how it spreads within the bulk Phase 3 system of compost production, how it can be detected and how it can be controlled.
- Major advances in our knowledge and understanding of the virus causing brown cap mushroom disease: where it occurs on industry facilities, how it can be detected and how it can be controlled.
- Practical IPM solutions and technologies for the sector

Main results:

- Two new diagnostic methods developed – one molecular-based test (qPCR) for Brown Cap Mushroom Disease caused by a virus and one volatile-based test for compost green mould caused by the mould *Trichoderma aggressivum*
- Four technical factsheets providing practical IPM solutions and advice to the industry
- New information on the efficacy of various disinfectants at killing pathogen propagules
- Sixteen fungal viruses identified that are new to science
- *Agaricus bisporus* Virus 16 (AbV16) identified as the causal agent of brown cap mushroom disease
- New knowledge on how *T. aggressivum* spreads within the system of bulk phase 3 compost
- New knowledge highlighting the difficulty of finding biopesticides that are effective against the main diseases of mushrooms

Opportunity / Benefit:

The European mushroom industry has access to the latest knowledge, tests and practical advice on how to control problematic disease issues within an IPM framework. In addition the MushTV consortium sees collaboration as the way forward to find solutions to common problems

Collaborating Institutions:

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1. Project background:

One of the key challenges facing the mushroom industry is the regulatory obligation to adopt an 'Integrated Pest Management' (IPM) approach to pest and disease control, as stipulated in the Sustainable Use of pesticides Directive 2009/128/EC (SUD), in order to safeguard our environment and the consumer. Two compost-related diseases concerned the MushTV network at the start of this project; 'compost green mould' caused by *Trichoderma aggressivum* and 'Brown Cap Mushroom Disease' caused by a virus that makes mushrooms turn brown and loose quality. Both can infect at an early stage in the cycle and severely reduce production. In addition, the industry has few chemical products available to control disease outbreaks so it relies heavily on understanding the biology of the problem organisms and excellent hygiene standards. Finding IPM-compatible and biopesticide products for the control of diseases such as Cobweb, Dry Bubble and Wet Bubble for when they get out of control is also desirable as there are few products available for use.

2. Questions addressed by the project:

- How effective are disinfectants at killing pathogens on mushroom facilities, especially when they are present in organic matter?
- Can we use the genetic characteristics of the virus complex that make up MVX in a new diagnostic test and can we name the virus or viruses that cause Brown Cap Mushroom disease?
- Can we elucidate how *T. aggressivum* grows and spreads within the bulk Phase 3 system of compost production?
- Can volatile organic compounds (VOCs) be used to detect *T. aggressivum* during the spawn-running period to give an early warning of its presence?
- Can we identify a biopesticide to give control of the main diseases of mushrooms?
- Can we detect pathogens on farms and compost facilities to identify areas of vulnerability in the production cycle?

3. The experimental studies:

Five research organizations across Europe conducted experiments according to the research questions being asked. All experimental trials were planned in consultation with biometricians. Randomized designs and replication were used as required. All trials were repeated and data were analysed appropriately.

4. Main results:

Diagnostic Tools. Two new diagnostic methods were developed – one molecular-based test (qPCR) for Brown Cap Mushroom Disease caused by a virus and one volatile-based test for compost green mould caused by the mould *Trichoderma aggressivum*. New diagnostic methods provide the industry with the means to monitor for disease presence. Such monitoring provides an early warning system to growers and composters and can alert them to the need to review procedures in their hygiene systems that may have allowed unwanted organisms to slip through unnoticed.

Knowledge Transfer. MushTV scientists have worked with industry to identify key action points needed to implement effective IPM. A series of technical factsheets, with IPM-compatible strategies at their core, have been produced and disseminated to the industry. They provide new knowledge and advice on (a) effective use of disinfectants in mushroom production; (b) understanding *Trichoderma aggressivum* in bulk Phase 3 compost; (c) prevention of Brown Cap Mushroom Disease and (d) control of fungal diseases of mushrooms.



Advancing the frontiers of science. Research by MushTV scientists has advanced the scientific knowledge base in several areas. They have characterised and identified 16 fungal viruses new to science, including two that are associated with the Brown Cap Mushroom Disease - *Agaricus bisporus* Virus 16 (AbV-16) and *Agaricus bisporus* Virus 6 (AbV-6). All the genome sequences of the novel viruses will be published in 2015 and will be available to the scientific community. A new qPCR based method to detect the viruses has been developed as well as a new method for the isolation of RNA from humic-rich mushroom compost. The way in which *T. aggressivum* is dispersed within large batches of Phase 3 compost has been elucidated and described. Surveys of grower and compost facilities have identified vulnerabilities in current hygiene systems, highlighting where action is needed to minimise crop losses. Research has also identified a group of biochemically-related volatile compounds that were repeatedly detected in *T. aggressivum*-infected compost during the Phase 3 process. Under experimental conditions, the pattern of the emitted group of compounds was different between infected and non-infected compost so a detection technique may be possible at commercial scale, but further development is needed before commercialisation can take place. These advances in methods and knowledge will be published in peer-review journals in the coming year.

5. Opportunity/Benefit:

The European mushroom industry has access to the latest knowledge, tests and practical advice on how to control problematic disease issues within an IPM framework, enabling them to comply with SUD regulations. In addition, by working together to resolve common problems, MushTV has fostered a sense of collaboration and friendship between people who are often competitors in the mushroom market place. This, has been one of the outstanding achievements of the MushTV project. The MushTV 'network' looks forward to working together in the future to address other challenges of mutual concern.

6. Dissemination:

A total of 51 dissemination activities were completed during the course of the project. The technological advances achieved during MushTV were disseminated to grower members of all participating grower associations at the end of the project. A series of grower workshops were held in February and March 2015 (outlined below) where growers were involved in active discussions with the researchers and where hard copies of all factsheets were available to take away (apart from the Dutch versions where only the online version was available).

Grower Organisation	Workshop Date	Venue	Number
CMP, Ireland and Northway PO, Northern Ireland	25 March 2015	Monaghan, Ireland	25
CMP, Ireland	31 March 2015	Tipperary, Ireland	25
VOC, Belgium	25 March 2015	Inagro, Belgium	12
SBGU, Poland	24 March 2015	Skiernewiece, Poland	40
Funghi, Netherlands	26 Feb 2015	Wageningen, Netherlands	110
AHDB, England	18 March 2015	Stratford upon Avon, England	27
Total attendance:			239

In-house workshops were also organised for the technical staff at several compost facilities across Europe.

The scientists who were directly involved in the research activities at the various research organisations gave a number of scientific and other presentations at various scientific meetings, conferences and events, disseminating some of the results to the wider scientific, political or general audience (See Table A2 in Final Report).

A number of general dissemination articles were published during the course of the project for both the wider mushroom industry as well as for more general audiences (See Appendix 1/Table A2 in Final Report).

Factsheets and an educational video are available at www.MushTV.eu

Main publications:

Five scientific papers are in preparation for peer review in 2015/2016

Popular publications:

Grogan, H. (2015). MushTV – providing IPM solutions to the industry. Mushroom Business, Edition 70, April 2015, pp. 20-22.

Grogan, H. (2015). MushTV – Providing IPM solutions to the Mushroom Industry. The Parliament Magazine, issue 405, 9 February 2015, P.81.

Burton, K., and Grogan H. (2015). Collaboration brings new opportunities for EU mushroom research. Politics First Magazine, Vol. 5, Issue 20, March/April 2015, p85.

Grogan, H. ABND Kilpatrick, M. (2014) Tuned into disease control. HDC News No 199, pp.28-29.

Grogan, H. *et al.* (2013). MushTV. TRResearch, Vol 8, No. 3, Pp.36-37.

Pyck, N. (2012). MushTV puts pathogens in the picture. Mushroom Business, Edition 55, November 2013, p. 4.



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