Assured Produce

Crop Specific Protocol

MUSHROOMS

(CROP ID: 22)

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Thanks are also due to Dr John L Burden and Dr John Fletcher for this revision of the protocol.

Preface

This crop specific protocol has been written to complement and avoid duplicating the generic principles of the scheme and appendices.

It is advisable to read the Assured Produce Generic Crop Protocol Standards and the Assured Produce Generic Protocol Guidance Notes (referred to in this document as the Generic Standards and Generic Guidance Notes) first before reading this crop specific protocol.

This protocol is designed to stimulate thought in the mind of the reader.

This crop specific protocol contains crop specific parameters and guidance, where applicable, for the requirements stated in the Generic Standards.

All statements in this protocol containing the words "strongly recommended" (in bold type) will be verified during the Assured Produce assessment and their compliance will form a part of the certification/approval decision. The score required for these "strongly recommended" control points can be found on the final page of this document and in the checklists produced by Assured Produce licensed certification bodies.

Disclaimer and trade mark acknowledgement

Although every effort has been made to ensure accuracy, Assured Produce does not accept any responsibility for errors and omissions.

Trade names are only used in this protocol where use of that specific product is essential. All such products are annotated ® and all trademark rights are hereby acknowledged.

Note

EC Review: Major withdrawal of pesticide products
All pesticide information quoted in this Crop Specific protocol was last updated in January 2006.

The EC Review of pesticides registered in or before 1993 will not be completed until 2008 at the earliest. There was a major withdrawal of pesticide products in 2003 as a result of the Review and several active substances approved for minor uses were not supported by crop protection companies. Certain uses of some of these substances can continue in the UK because they are covered by ‘Essential Use’ derogations. Some active substances have also failed to achieve Annex 1 listing (e.g. simazine) and
some additional Essential Uses have been granted until 31 December 2007. **There may be other withdrawals or revocations.**

Products containing substances which have been revoked are shown on the PSD website (www.pesticides.gov.uk).

**Long Term Arrangements for Extension of Use (LTAEU)**
The PSD have decided it is no longer possible to maintain the Long Term Arrangements for Extension of Use (LTAEU) in their current format and are gradually replacing these Arrangements with Specific Off-Label Approvals (SOLAs). The work will not be completed until early summer 2006. **These replacement SOLAs will be shown on the PSD website when they become available.**

Growers can continue to use approvals under the LTAEU until such time that all relevant SOLAs have been issued by PSD, and until the arrangements are withdrawn by PSD – At that time growers must ensure that they have access to the relevant SOLA notice of approval. In order to comply with current legislation, you should download a SOLA onto your personal computer or retain a paper copy before using any SOLA.

A list indicating the SOLAs which have been requested is available from the PSD website using the following link:

http://www.pesticides.gov.uk/food_safety.asp?id=1576

An announcement detailing the proposed date for revocation of the Long Term Arrangements for Extension of use will be featured on the PSD website, the AP website and in HDC publications and grower press.

Growers should check with their advisers, manufacturers, the Assured Produce website ‘Newsflashes’ and the PSD website (www.pesticides.gov.uk)

Any new standards have been prefixed in the text with **(NEW)**
1 General introduction

Following a systematic approach will help growers to identify and manage the risks involved in crop production. This protocol is based on a typical crop production process. Using a flowchart approach, food safety, Health & Safety, environmental and quality hazards are identified. Appropriate controls may then be established to minimise risk. Food safety and Health & Safety issues always take precedence over quality and environmental controls.

The flow chart is structured as shown below; the sectional layout of both this protocol and the crop specific protocols follow the same structure.

SITE SELECTION

SITE MANAGEMENT

VARIETY SELECTION

NUTRITION

IRRIGATION

PEST CONTROL

DISEASE CONTROL

WEED CONTROL

HARVEST & STORAGE

The content of each crop specific protocol is reviewed annually by informed farmers and growers, food technologists, scientists, the relevant fresh produce association, processors and agronomic consultants. Updated editions are issued prior to the cropping season.

The review process considers both new developments and all relevant technology which has emerged throughout the course of the previous year and which have been found to be both workable by the grower and beneficial to the environment. As one aim of the Scheme is to transfer such information and technologies to growers, attention is drawn to those features of specific relevance to ICM by using italic script. In order that growers may be confident that they are working to a current document, each protocol is dated and numbered.
2 Planning and records

See Generic Standards and/or Generic Guidance Notes.

Not all comments in these documents are relevant to Mushrooms.

3 Site selection

See Generic Standards and/or Generic Guidance Notes.

Not all comments in these documents are relevant to Mushrooms.

4 Site management

4.1 Soil mapping

See Generic Standards and/or Generic Guidance Notes.

Not all comments in these documents are relevant to Mushrooms.

4.2 Soil management

See Generic Standards and/or Generic Guidance Notes.

Not all comments in these documents are relevant to Mushrooms.

4.3 Soil fumigation

See Generic Standards and/or Generic Guidance Notes.

Not all comments in these documents are relevant to Mushrooms.

4.4 Substrates

See Generic Standards and/or Generic Guidance Notes.

Not all comments in these documents are relevant to Mushrooms.

4.5 Drilling and transplanting

See Generic Standards and/or Generic Guidance Notes.

Not all comments in these documents are relevant to Mushrooms.
4.6 Systems of production

There are a variety of Mushroom production systems. All have a common biology, but differ widely in the 'system' of production employed.

The production of raw or Phase I compost is also common to all with some exceptions in which experimentation is taking place to reduce odour pollution.

4.6.1 Composting

Phase I

In essence Phase I compost production consists of wetting and blending the raw ingredients, straw (predominantly wheat), (though other threshed plant crops are also now being used), horse manure, poultry litter and occasional other straw-based manures. Not all the ingredients are used by all compost manufacturers. Nowadays for homogeneity synthetic composts made of straw and poultry litter are used by many large producers, also most straws are pre-wetted for a period before the nitrogenous materials are added to the mixture.

The blending process is carried out in rough stacks and can take as little as a week if bunker technology is used or slightly longer if traditional `windrows' are used. Bunkers are being used increasingly by compost manufacturers as they facilitate forced air movement through the compost mass, so favouring ideal conditions within the compost for the micro-organisms to function.

Gypsum and nitrogenous additives have historically been incorporated at various stages in the procedure, but in order to improve homogeneity of the compost, most additives are now added near the beginning of the process.

During the process, biological fermentation takes place and the compost is frequently turned to blend the ingredients and to ensure that the various zones within the compost mass experience the full range of heat and oxygen profiles that occur.

At the completion of Phase I, which takes between two and three weeks, the subsequent path the compost may follow varies, depending upon the system employed.

Phase II

Fermentation is completed during the Phase II composting process. In this stage the material pasteurised to kill potentially harmful organisms, the free ammonia, is either fixed within the biomass, or dispersed and .the compost is “conditioned” by the composting flora to become a selective material that favours the growth of mushroom mycelium over that of other potential competitor organisms.
Phase II composting may take place either in specially designed and constructed phase II tunnels, (if the compost is prepared in bulk), in specific peat heating rooms (if the compost is in trays) or even in certain systems in situ in the growing houses. Batch sizes can vary greatly from 10 – 20 tonnes to up to 200 tonnes in large bulk systems.

The bulk tunnels now employed vary in construction, but have in common a method of forcing air through the compost, (either via a plenum chamber beneath a slatted floor covered with a net, or by pipes within the floor of the container that force air, via small spigots attached to them, directly into the compost mass. The air forced into the compost helps to control the temperature within the compost mass and provides the oxygen for the active micro-organisms involved in the process. In contrast compost filled into trays or shelves is aerated and the temperature controlled by air passing over and around the containers in either specialised Phase II buildings or in cropping houses.

**Phase III or spawn-running**

Spawn running is the accepted term to describe the process of colonising the compost with mushroom mycelium: when fully colonised the material is then called phase III material.

Historically this phase has been carried out within the growing houses, but increasingly over the last decade phase III compost has become more readily available from the compost manufacturers in the UK and from Europe. Spawn is mixed into Phase II compost, either as it travels from the bulk Phase II tunnel to the growing container, (be that shelf, tray, bag or block), or by mixing it into compost in situ in shelves, or by emptying and refilling trays.

In all instances the common purpose of this phase, regardless of growing system, is to maintain compost temperatures at around 25°C. Bags and blocks may be individually protected by the polythene of the containers used, but in all other instances the parameters of CO₂ and humidity are kept high within the spawn running rooms to encourage mushroom mycelium growth throughout the compost. Nowadays in the UK, bags are being used less because they are not so easy to incorporate within mechanised growing systems.

By the beginning, or in a few cases the end of spawn running, a wide range of mushroom growing systems emerge from the common beginning of Phase I composting. The interrelationship of the differing production systems is laid out in the following diagram.

Systems of production are distinguished primarily by the growing facility used for cropping and a brief description of the main systems follows. However, the diagram shows the progress of different systems illustrating that a superficially similar system may have followed a different route.

Systems are sometimes further distinguished by whether they are in situ single zone systems, or 3 to 4 zone systems whereby containers, usually trays, are moved from one building and environment to another, (e.g. peak-heat, spawn running, holding and cropping rooms). Further
subdivisions could be made with the advent of bulk Phase II and III. However, the purpose of this description is to outline the variation, whilst stressing the common themes.

4.6.2 Shelf system

In this system of growing, cropping takes place on shelving, now usually constructed of aluminium, and can be 3, 4, 5 or 6 shelves high. Rooms may contain 2, 3 or more tiers of shelves.

The shelves may be filled with Phase I compost, but are most commonly filled with Phase II or Phase III compost.

Whichever type of compost is used, it is now most commonly winched in and out on nets. Apart from the filling and emptying equipment, the system is characterised by the use of light machinery that uses the shelving as tracking. It brings gantry engineering to the crop facilitating spawning, casing, levelling, ruffling and cutting Mushrooms for processing.

4.6.3 Tray system

Compost is contained in trays (usually of timber construction) of various dimensions, with either fixed legs or removable spacing blocks.

It is quite common for Phases II and III to be carried out in the trays.
Where Phase II is conducted in the trays they are often stacked in specially constructed houses up to 10 or 12 high. After the phase II process and when the compost has been spawned, these trays are then moved to a different set of houses specially designed to facilitate an effective spawn run.

When the compost is fully colonised they are then cased and either again returned to specialist facilities to complete the case run or transferred to the growing houses to complete this stage. In the growing houses the trays are arranged in stacks, usually 4 high, in a number of patterns, to achieve a compromise between access for picking and maximum house utilisation.

The trays are normally handled using fork-lift trucks and the filling / emptying, spawning and casing operations are conducted on specially constructed handling lines.

The system is very flexible, but requires expensive filling, spawning and casing machinery and a great deal of labour in moving for any new treatment or environment. However, in order to shorten the cropping cycle still further some farms now retain the trays in specialist facilities right up to the time of cropping, (Phase V compost), only then moving them to the cropping houses. This maximises the volume that can be handled in the facility by radically shortening to time the trays are in the growing facility from 5 – 6 weeks with phase III compost to 3 weeks with Phase V compost.

4.6.4 The Bag system

The bag system is characterised by low investment in plant and machinery and a high labour input for filling, casing etc. Bags are grown in a distinctive system on one level, usually the floor: their configuration depending on the floor area available, but restricted to rows no wider than four bags to aid efficient harvesting.

On many farms bags have now been superseded by blocks, simply for the ease of handling and because the system can be more easily mechanised. In the past bags were an ideal system for basic mushroom production but as costs have escalated and labour has become more difficult to acquire, growing systems, relying on technology rather than labour, have tended to predominate in recent years.

4.6.5 Block system

Whilst the block system closely resembles the bag system, it differs in that Phase II or III compost is compressed into blocks and “containerised” in an over-wrap of polythene whereas bags are loosely filled polythene sacks. Because of their rigidity, blocks can be – and usually are - fitted into shelves and trays and thence, with some minor differences, become shelf or tray systems.
When used within shelf or tray systems, blocks are capable of becoming more mechanised and, as with all other currently employed systems and variations, are intrinsically compatible with ICM principles. As a result, the use of blocks has grown enormously in the last decade.

4.7 Compost production

The relationship between Mushroom compost and the cropping organism is a complex one. Mushroom compost provides the Mushroom both with its nutrient and its sole growing environment. It also provides the Mushroom producer with the main vehicle for commercial manipulation of the growing system.

The objective of this protocol is not, therefore, to provide a prescriptive account of either composting practices or nutrient analyses, although a brief description of composting was given in Section 4.6.1.

Every compost yard's procedures will vary in detail, but the fundamental practices are the same and aimed at homogenising the material and allowing composting or fermentation of the bulky material to proceed as effectively as possible.

However, composting is potentially polluting and this aspect must be addressed. Pollution can be caused by run off from the compost yard and odour from the composting process, (particularly where those process have not been performed effectively).

DEFRA Codes of Good Agricultural Practice for the Protection of Air and Water provide both practical guidance and background to the legislation and policing authorities.

4.7.1 Water

Run-off from compost yards may be heavily contaminated with organic matter. It is strongly recommended that to meet anti-pollution requirements all water run-off from compost yards and areas where compost is handled is contained for recycling, allowing only clean roof water into the normal drains.

Virtually all yards now have drainage to catchment tanks that are constantly aerated to avoid anaerobiosis. Spare capacity is usually required, either in the form of additional tanks or by over sizing the main tanks, to accommodate excessive rainwater, that may at times, fall on the catchment area.

If the run-off water from the compost yard is screened before it reaches the tanks, the tanks are adequately aerated with suitable pumping systems and the trapped leachate is delivered back to the compost stacks discretely (ensuring that large water droplets are formed thus avoiding spray drift), virtually all potential pollution problems from this source may be avoided.

Some farms may be adjacent to watercourses into which run-off from concrete surfaces, other than compost yards, will be discharged. Such concrete surfaces may be
contaminated with organic debris and pesticides associated with crop production. To prevent contaminated run-off from such concrete surfaces, from getting into soil or water courses, it is strongly recommended that run off samples from water discharged into water courses should be analysed for pesticides and organic matter, and if unacceptable levels are found, the run off should be contained and treated accordingly.

4.7.2 Air

Aerial pollution is less precise, less confinable and thus more subjectively assessed and more emotive. On the whole, therefore, it is potentially a greater problem than water-borne pollution.

A great deal can be accomplished towards minimising if not completely removing the problem. There has been much debate recently concerning the practicality of enclosing Mushroom compost yards and thus containing aerial pollution. Whilst this is in some ways an attractive solution it remains, and is likely to remain, a grossly uneconomic one.

It is generally recognised that the vast majority of offensive odours emanating from composting are produced during periods of anaerobiosis. Anaerobic conditions can be caused singly or in combination by, for example, materials being over-wet and consequently excluding air; or materials being left overlong in one position or in heaps that are too large so that the micro-flora are able to exhaust the oxygen supply.

Over-large heaps simply exacerbate any potentially anaerobic situation. Thus, whilst the principles of non-polluting compost are simple enough, achievement of them is often made difficult due to the logistical difficulties of moving hundreds if not thousands of tonnes of raw material around in a confined space.

The logistical and organisational skills required in moving bulky materials round, in what are almost inevitably constrictive yards (acres of concrete are very expensive) during the early stages of homogenisation and composting, are prodigious.

However, skilful analysis of potential problem areas and careful re-planning of physical procedures, has demonstrated that these problems can be virtually overcome whilst at the same time maintaining production of high quality compost.

In recent years bunker technologies have increasingly been employed in compost yards. By first effectively wetting the straw, before the nitrogenous materials are added and then filling them quickly into aerated bunkers the period that these materials are exposed to ambient conditions has been substantially reduced.

By forcing air into the mass of material, thereby keeping it aerobic, the length of time that traditionally the material was exposed to ambient conditions is significantly reduced and the organisms responsible for malodorous effects are thereby also significantly reduced.
4.7.3 Summary

The run-off liquor that is collected for recycling onto the compost must be run through a screen and constantly aerated.

It is strongly recommended that steps be taken to avoid anaerobic conditions, whenever possible, in the preparation of compost.

Dry poultry manure should be used and stored under cover.

Research funded by the mushroom industry and DEFRA has been undertaken to adapt the composting processes. This research has indicated that manipulation of pre-wet practices and positive aeration of the phase I process can, in some circumstances significantly reduce the production of offensive odours.

Owing to the fact that Mushroom compost raw ingredients include an appreciable quantity of animal manures, tests have been undertaken to establish the situation in relation to *E. coli*. The results indicate that finished Mushroom composts do not contain significant numbers of *E. coli*. The reasons no doubt are the high temperature regimes (70 - 80°C) during phase I, in conjunction with the high levels of ammonia, and particularly the controlled pasteurisation regime (60°C) during phase II composting.

However it is strongly recommended and seems wholly reasonable to occasionally test the finished product, i.e. Mushrooms, post harvest, to reaffirm this situation.

Compost producers should also be vigilant and aware of possible ramifications of avian flu entering the UK and of any restrictions that may be imposed on handling poultry manure. Alternative nitrogen sources should be examined.

4.8 Casing materials

Casing is currently a mixture of peat and lime. Both peat and lime sources are numerous and varied, ranging, respectively, from raw sphagnum to dark humified material and from ground limestone to sugar beet lime, produced during extraction of sugar.

It is recognised by the industry that a renewable alternative to peat for casing would be desirable however, the function of the casing layer is so crucial to the productivity and quality of Mushrooms and the precision of production, that it has proved difficult to find acceptable substitute materials. The casing layer is a critical zone in which triggering takes place from vegetative mycelium to the Mushroom sporophore (i.e. the Mushroom crop). Casing therefore has an enormous influence on the number, timing, weight and quality of the Mushroom crop. Some progress has been made in the area of peat alternatives however in that partial-substitution of peat with alternatives (eg coir, MRF) has been achieved.
Both DEFRA and industry-funded research and development, is concentrating at present upon maximising the various combinations of raw materials but also, and more relevantly to this protocol, upon gaining a deeper understanding of the functioning of the casing in relation to sporophore initiation and development.

One aspect of Mushroom production which should perhaps not be overlooked in this context, is the fact that the industry recycles approximately $\frac{1}{2}$ million tonnes of spent mushroom compost which is itself a peat substitute for land improvement. This material is increasingly being used as a substitute for poorer quality peat, which has traditionally been used to improve poor soils prior to and following planting schemes both domestic and industrial. However, because of the potential pest and disease hazards and textural problems associated with the material it is at the moment ruled out as a direct substitute for peat in mushroom casing in the UK, though in other countries with different economies, it is used successfully as a partial replacement.

4.9 Hygiene

Any consideration of Mushroom pests and, particularly, diseases should be prefaced by a discussion of the general principles of hygiene.

The enclosed, usually compact, continuously mono-cropping environment of Mushroom farms, offers a unique opportunity for pest and disease control by good hygiene practice.

Good hygiene practice is an absolute must in any modern mushroom growing facility – failure to adhere to it will allow pests and diseases to thrive with perhaps catastrophic impacts on the production and the economics of the grower’s business. The general principles of hygiene are simple enough and can be summarised as follows:

- exclusion
- containment
- elimination

In practice, hygiene can never be perfect, due to the physical difficulties and often cost implications of the required procedures. Imperfections in our knowledge of the epidemiology of any given pest or disease hamper perfect hygiene practices as does, at times, the inability to eliminate the problem by either chemical or physical means.

But having accepted the limitations of hygiene, it must be understood that hygiene forms the major foundation upon which to build an integrated crop management programme employing as constituents all other control mechanisms, including pesticides and biological control agents.
4.9.1 Exclusion

This concept recognises the fact that for the most part, pest and disease organisms will emanate from another adjacent crop and exclusion, in theory at least, is possible and, if accomplished, completely curative. Initial, primary infections are often very small and their source untraceable with any certainty. Gross contamination of the farm or raw materials is usually obvious and, therefore, combatable.

Exclusion takes many forms, ranging from absolute filtration of well-sealed Phase II rooms, dust and fly filters on cropping houses, to disciplined labour control that does not allow contamination by personnel, equipment and machinery from infected areas to clean ones.

4.9.2 Containment

When pest infestations or disease outbreaks occur, as they inevitably do even on the best-managed farms, damage can be limited by containment of the pest or disease to the crop in which it has occurred.

The means whereby this can be achieved, and the likelihood of success, will vary from one pest or disease problem to another and may be facilitated or otherwise by the layout of the farm.

As with the other general principles of hygiene control, specific priorities and particular methods will be referred to under sections dealing with the individual problems. However, it is always worth remembering that once an outbreak has occurred, this usually represents the largest and most potent source of infection for neighbouring and subsequent crops.

In a few instances, chemical control may be used for immediate elimination, but more normally the objective has to be to contain or confine the problem to the site of occurrence. This may take the form of removing or covering diseased Mushrooms on the mushroom bed, or the use of appropriate disinfectants on floors and equipment, but in most instances the most important tactic is careful staff management, as staff can move diseases effectively between crops. Contaminant pests, such as, Phorid, Sciarid and Cecid or mites, are very effective vectors both within houses and between them if both care and operational planning are not good.

Staff training is often required in order that pickers, in particular, can identify and avoid contact with problems.

4.9.3 Elimination

At the end of each crop, or earlier if exclusion and containment of pests or diseases have been unsuccessful, the problem, real or potential, must be eliminated from the farm to avoid levels of infection greater than any hygiene programme can accommodate.
At its simplest, this refers to killing off the finished crop and with it any pests or diseases that may be present, emptying the crop carefully and cleanly to avoid contaminating the farm environs and thoroughly cleansing the house and any emptying or filling machinery. The mechanisms for killing off crops will vary dependent on the growing system and include sterilisation by heat ("cooking-out") and disinfectant drenches and fogs. All good hygiene programmes contain the assumption that each component is flawed and subsequent ones must therefore be designed on that assumption.

For example, assuming that "cooked-out" compost is still potentially infected when it is emptied.

Superimposed upon these generalisations, concerning any hygiene programme, must be a clear understanding of the epidemiology of likely pest and diseases in order to facilitate accurate analysis of the most likely routes and times of infection.

5 Variety selection

See Generic Standards and/or Generic Guidance Notes.

Not all comments in these documents are relevant to Mushrooms.

6 Nutrition

See Generic Standards and/or Generic Guidance Notes.

Not all comments in these documents are relevant to Mushrooms.

7 Irrigation

See Generic Standards and/or Generic Guidance Notes.

Not all comments in these documents are relevant to Mushrooms.

8 Crop protection

8.1 The basic approach to crop protection

The guiding principle is that pesticide inputs should be minimised through prevention rather than cure. An integrated approach should be adopted to achieve this involving the following management steps:

Good management and cultural preventative techniques

Mushroom production has specific problems as a result of being an intensive, protected mono-crop exhibiting no varietal resistance to any pest or disease.
There are, however, various actions that can minimise the major pest problems, for example:

a) Good farm hygiene to avoid compost or Mushroom debris lingering about the farm.

b) Recognition of vulnerable stages within the production process and thereby highlighting entry points into the cropping cycle, such as Phase II cool-down, spawning and spawn-running, casing and case running rooms.

c) Regular fly trapping to anticipate pest build-up.

d) Sound observation of the developing, standing and harvested mushrooms.

It is strongly recommended that where possible crops should be cooked-out on completion to eliminate the risk of introducing diseases from old crops into new ones. Where cooking-out is not feasible then crops should be sprayed with a suitable disinfectant. All spent compost should be removed from the farm immediately after emptying and any crop debris cleared up immediately.

**Corrective action**

If the above fails to prevent or control the situation, the following approach should be adopted:

a) Where corrective action is required, biological and physical methods of pest control should be considered first.

   • Contain the diseased mushroom to prevent other vectors contacting with it and spreading it to other locations.

   • Ensure that hygiene procedures are being performed effectively.

   • Introduce biological controls known to be effective against the target organism.

   • Wash areas effectively, but be aware that splashing diseased material can spread spores as well.

b) If chemical control is needed, the following points should be considered, whilst ensuring effective control is achieved:

   • Use of the least toxic and persistent product

   • Use of products that do not affect biological control agents and naturally occurring beneficial organisms

   • Use of the minimum effective dose rate
• Using appropriate application methods with effectively maintained equipment, and spot treating wherever possible.

8.2 Plant protection product choice

See Generic Standards and/or Generic Guidance Notes.

Approved uses not included on the product label

In some circumstances product labels do not include all of the approved uses and growers and advisers wishing to check the approval notice of a particular product should note that this information is available from www.pesticides.gov.uk/psd_databases.asp

A search on the database for a product name should yield a results page. A click on the product name should link to a summary of the approval information. At the bottom of the summary are links to available notices which will give the statutory conditions of use.

In the case of products with older approval an electronic approval may not be available. In these cases growers should contact the PSD Information Services Branch for details of the approved conditions of use. Contact details are: p.s.d.information@psd.defra.gsi.gov.uk tel. 01904 455775.

8.3 Advice on the use of pesticides

See Generic Standards and/or Generic Guidance Notes

8.4 Application of pesticides

See Generic Standards and/or Generic Guidance Notes

8.5 Records of application

See Generic Standards and/or Generic Guidance Notes

8.6 Protective clothing/equipment

See Generic Standards and/or Generic Guidance Notes

8.7 Pesticide storage

See Generic Standards and/or Generic Guidance Notes

8.8 Empty pesticide containers

See Generic Standards and/or Generic Guidance Notes

Although every effort has been made to ensure accuracy, Assured Produce does not accept any responsibility for errors and omissions.
8.9 Pesticide residues in fresh produce

See Generic Standards and Generic Guidance Notes

See Generic Protocol Guidance Notes 8.9 for further background and generic advice.

Assured Produce is aware that a key area in the production of fresh produce which requires continued attention by growers and their advisors is that of keeping pesticide residues to a minimum. This issue is not just one of meeting the MRL trading standard but ensuring that any individual or multi residues are kept as low as possible below this level.

- Optimising late applications of fungicides and insecticides to the edible part of the crop.
- Optimising the use of post harvest treatments.
- Ensuring minimum harvest intervals are followed
- Ensuring that application equipment is applying products correctly

See Appendix 5 for the pesticide targets and guidelines on this crop.

8.10 Pest and Disease control

8.10.1 Pest control

8.10.1.1 Sciarid flies

Sciarids, mostly of the species *Lycoriella auripila*, are potentially very damaging Mushroom pests causing direct damage to mushroom tissue and crop loss from damage to the mycelial network that produces subsequent mushrooms. They also have a high nuisance value if present on marketed produce, and are also very effective vectors of several diseases.

Several generations of flies can affect one crop if they gain entry early enough and once a farm has a presence of flies a multiplicity of measures will have to be employed throughout the cycle, in order to combat the infestation:

**Physical protection when cooling Phase II compost**

This should largely be taken care of by the absolute filters that should be fitted to all Phase II rooms; whether they be bulk tunnels, tray peak-heats or in situ Phase II in cropping houses; to avoid the devastation that can result from virus infections.
In addition, however, all other points of entry, in particular door seals, ductwork and air-handling units should be made fly proof. It is generally assumed that rooms with over pressure will exclude unwanted organisms, but sciarids are known to be capable of entry against considerable forces of exhausting air, if there is no other barrier to stop them. Flies are attracted to exhausted air streams from mushroom facilities, so treatment, whether passive or active at these locations can be very beneficial as a control measure.

**Minimal exposure of Phase II compost at spawning**

It has been clearly demonstrated that this is a major potential weak area in the growing process and attempts to exclude sciarid flies at this stage is difficult but essential if control is to be effective.

Introducing filtered air and maintaining positive pressure in the spawning hall is essential if ingress of flies to the compost at this vulnerable stage in the process is to be achieved.

The faster that this process can be conducted, the more the potential risk of infestation by flies can be reduced.

Growers must be constantly aware of the vulnerability to infection at this stage and occurrences of unnecessary exposure MUST be identified and avoided.

**Protection of spawn-running rooms**

These flies are most attracted to freshly prepared un colonised compost in the early stages of the mushroom growing process.

Spawn-running and case-running may be carried out in varying circumstances ranging from purpose-built chambers to the final cropping houses. In all circumstances, control strategies depend upon filtering incoming air, sealing doors and all ductwork and extract frames and filters.

Protecting the compost during this phase can be difficult if the compost has to be moved across the farm to spawn running facilities. However, securing these areas from flies is essential if effective control is to be achieved. High levels of filtration are vital if the elimination of flies from the early stages of the process is to be achieved and successive generations of flies are to be excluded.

In those instances where spawn-running and case-running are carried out in purpose-built rooms, levels of exclusion similar to those for Phase II rooms is feasible. This may often exploit the cooling requirement of spawn-running by the re-circulation of cooled internal air, thus obviating the need for taking air into the rooms for long periods. But ductwork and door seals still need to be secure.
**Protection of compost in case running rooms**

The same comments expressed for spawn running apply equally to this process.

**Use of pesticides at spawn-running, in casing and during cropping**

Pesticides are often a hugely valuable buttress to the strategy of exclusion described above, but they are not always essential. The need to use pesticides can more easily be identified if regular trapping and monitoring of fly populations is undertaken.

Standard sticky traps or illuminated traps can be informative and effective in both monitoring and reducing the level of fly infestation. There use can also help to highlight any weaknesses in the exclusion/hygiene programme employed.

Mercury vapour traps are considered useful, by some growers, in removing adult flies from cropping house environments, and like sticky traps they are a useful monitor of fly activity.

**Chemical control:** Chemical and biological pesticides are available.

<table>
<thead>
<tr>
<th>Application Method</th>
<th>Active ingredient</th>
<th>Product</th>
</tr>
</thead>
</table>
| Casing drench treatments            | Diflubenzuron, pyrethrins and resmethrin, deltamethrin pyrethrins, *Steinernema feltiae* | Full Approval SOLA
|                                     |                                 | Dimilin Flo, Dimilin 25 WP
|                                     |                                 | Pynosect 30
|                                     |                                 | Decis, Decis Protech, Bandu
|                                     |                                 | Py Spray Garden Insect Killer
|                                     |                                 | Pynosect 30
|                                     |                                 | various (biological) |
| Fogging applications (pre-cropping and during cropping) | pyrethrins and resmethrin, deltamethrin, pyrethrins | SOLA |
|                                     |                                 | Pynosect 30
|                                     |                                 | Decis, Decis Protech, Bandu |
|                                     |                                 | Py Spray

(1) This formulation contains natural colour which can stain mushrooms so it should not be used when mushrooms are present.

The insect parasitic nematode *Steinernema feltiae* is available in several commercial formulations as a casing treatment.

There has been one case of diflubenzuron-resistant sciarid flies reported on a British farm in 2002.
8.10.1.2 Phorid flies (Megaselia spp)

*Megaselia halterata*

These flies are generally a less important pest than sciarid’s causing pro rata considerably less direct crop loss. They can be a great nuisance value to Mushroom pickers and are certainly instrumental in the spread of Mushroom diseases and if not controlled can reach huge populations and cause considerable direct losses.

As with sciarid fly control a multiplicity of control tactics involving both physical protection and the use of pesticides are required to produce a satisfactory control strategy in both spawn and case-running rooms.

The general principles of control are similar to those for sciarids, but the different life cycles of the two flies places specific emphases on the overall fly control strategy.

Where as sciarids are most attracted to freshly produced un-run compost and un-colonised casing, phorids are drawn to the growing mycelium. In contrast to sciarids, to which compost is most vulnerable from cooling down and during spawning, crops are most vulnerable to infestation by phorids during active spawn growth. In the past phorids were largely summer problems. Modern farms, however, provide conditions conducive to an all year round presence.

**Chemical control:**

<table>
<thead>
<tr>
<th>Application Method</th>
<th>Active ingredient</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fogging applications (pre-cropping and during cropping)</td>
<td>pyrethrins and resmethrin</td>
<td>SOLA Py Spray¹</td>
</tr>
<tr>
<td></td>
<td>deltamethrin,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>pyrethrins,</td>
<td>Decis, Decis Protech, Bandu</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Py Spray¹</td>
</tr>
<tr>
<td>Casing drench applications</td>
<td>pyrethrins and resmethrin</td>
<td>SOLA Py Spray¹</td>
</tr>
<tr>
<td></td>
<td>Deltamethrin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>pyrethrins,</td>
<td>Decis, Decis Protech, Bandu</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Py Spray¹</td>
</tr>
</tbody>
</table>

*(1)* This formulation contains natural colour which can stain mushrooms so it should not be used when mushrooms are present.

*Megaselia nigra*

This is an unimportant pest, but one that does infrequently still occur, causing severe damage to the stipes and caps of Mushrooms. If light is excluded from houses the problem is solved. If structural alterations are made to buildings, for example, to allow the ingress of cooled air, care should be taken not to inadvertently allow light spillage.
8.10.1.3 Cecid flies

There are two genera of cecid fly known to infest Mushroom farms, *Heteropeza* (white) and *Mycophila* (orange) cecids.

The paedogenic larvae, (larvae to larvae generations without going through a sexual phase), are less frequently seen than used to be the case due, most probably, to the greatly improved hygiene practices now employed on Mushroom farms and the increased use of deep dug peat in which the flies will not have laid eggs. However, their potential for spoilage is considerable and once a farm is contaminated they can be very persistent.

The overriding control strategy is hygiene:

**Protection of casing materials**

As with many pests, the earliness in the cycle that they gain entry and the level of initial infestation, will dictate the scale and seriousness of the subsequent outbreak. It is vital, therefore, to protect casing from contamination of any sort and much of what can be said in relation to protection against cecid larvae is equally true of other pests and diseases.

Where casing or casing materials are stored on farm, every effort should be made to disinfect the storage areas before the casing is received and to physically isolate the stored casing from chance infection by staff activity or wind blown dust.

Hygiene between casing batches is particularly important. Bins and bunkers must be thoroughly cleaned between one batch of casing and another.

Baled peat may constitute a high risk in that it is often stored for considerable periods and the external debris that accumulates on the bale wrapping is often not considered as a potential contaminant.

All surfaces, concrete, bunker walls, and handling equipment and machinery, pose threats of potential contamination. To achieve adequate protection, careful analysis is required of all the possible sources of contamination that casing mixing and application will present.

**Effective post crop sterilisation**

Both as a primary source of crop contamination and as the source whereby casing may become infected, it is important to ensure thorough post crop sterilisation. Chemical treatments are ineffective against this pest, an effective cook out is the best treatment.

The greatest risk of recycling and build-up of cecid problems is in the grain and joints of timber trays, and cracks in the floors: historically these have been the cause of most intractable cecid problems. Monitoring has shown that temperatures sufficient to kill cecids are difficult to achieve in such inaccessible places as between leg posts and thick sideboards. It isn't possible to be prescriptive in relation to the time required to achieve a kill in these circumstances, but in the cases of cecid outbreaks on tray farms that do not respond to normal control measures, extension of both
time and temperature of cook-out should be considered. Tray dipping preserves the timber and indirectly helps alleviate this problem.

**Inter-house isolation**

If cecid outbreaks occur they can be very easily spread from affected houses to younger cleaner ones by staff movements. The larvae adhere with great facility to clothing that has brushed against trays or shelves, as well as on the hands and feet of personnel such as pickers.

Strong effective hygiene precautions are necessary.

**8.10.1.4 Tarsonemid mites**

Tarsonemid mites cause a characteristic reddish-brown staining at the base of the stipe as a result of their feeding habit. If mite numbers are high the base of the stipe may be pointed and poorly anchored. Additionally, staining may also occur on the caps of the Mushrooms.

The now unusual presence of these mites, probably indicates a chance infection via raw material, neither is usually a constant source of infestation but once numbers are high they can, like cecids and nematodes, become problematical contaminant pests.

In common with some nematodes, consideration should also be given to the likelihood of a partial failure of Phase II that might initially permit the presence of this pest.

The hygiene required to control tarsonemid mites is essentially similar to that described for cecids.

In this instance as with most other pests and diseases, it is **strongly recommended** that cooked-out compost is removed from the farm immediately after emptying and disposed of in the most appropriate manner so eliminating the potential of re-introducing disease onto the farm (see section 8.1).

**Chemical control:** This is not currently possible.

**8.10.1.5 Red pepper mites**

Unlike tarsonemid mites, red pepper mites are readily visible. There is no direct control recommended, as they are considered indicative of the presence of *Trichoderma* mould within the compost upon which they feed.

Hygiene measures similar to those for tarsonemid mites are wise if less urgent. Elimination of the moulds they feed on, namely *Trichoderma* spp., must be the primary objective in controlling this, at times, costly nuisance. (See Section 8.10.2.6)

**Chemical control:** This is not currently possible.
8.10.1.6 Nematodes

Glistening ‘bristles' of migrating nematodes can sometimes be seen on the casing surface, each ‘bristle' consisting of many hundreds of nematodes. These are usually saprophagous nematodes. If there is no reason to suspect any failure of the phase II process, the cause for their presence is likely to be contamination of materials and hygiene measures similar to that described for cecids should be instigated.

a) Despite modern advances in compost technology, nematode infestations can still arise from inadequately pasteurised compost or contamination of Phase II compost by raw Phase I or a breakdown in hygiene procedures. Tracing the source of outbreaks, whether it is casing contamination or inadequate Phase II practices, often requires meticulous analysis of farm procedures and careful sampling.

Heavy infestations have been implicated, in certain circumstances, in significant crop loss.

b) Occasionally mycophagous nematodes occur. These infestations can cause serious loss and require stringent hygiene measures if they are to be eliminated.

The greatest danger in the rare instances in which these nematodes occur, is that their presence will either not be diagnosed or will be misdiagnosed. Unlike the common, often harmless, presence of saprophagous nematodes, mycophagous nematodes are always potentially very damaging to the crop.

Their original source, unless it is continuous, is probably less important than the fact that once established on a farm they can be very readily spread from older crops, in which numbers have built up, to younger cleaner ones.

Casing and cropping containers are particularly vulnerable to contamination.

Chemical control: This is not currently possible.

8.10.2 Disease control

8.10.2.1 Hygiene measures for Verticillium (dry bubble), Mycogone (wet bubble) and Dactylium (Cobweb).

a) Constant examination of the crop.

Regardless of the original source of disease organisms, which can arise from a number of sources, be it soil, dust, contaminated casing materials, or poor hygiene procedures on the farm, it is generally accepted that the major cause for serious disease outbreaks lies in undetected or un-contained disease on the farm. If diseases are not treated effectively they can quickly become a major threat to productivity and the economics of the farm.

It is essential, therefore, to maintain constant methodical vigilance of all crops. Staff involved in such tasks requires training in order to identify early disease
symptoms and the more subtle manifestations of disease. It is essential to have accurate diagnosis of which "bubble" or cobweb species is present as chemical control measures and treatment will differ.

b) Immediate isolation of observed diseased Mushrooms before harvesting or watering is essential in the effective control of these diseases.

Once disease has occurred on the beds, both watering and picking are the most effective methods of spread, particularly within a crop but in the case of pickers, also to other crops.

It is therefore essential that both identification and isolation of disease be regularly and routinely carried out prior to watering and harvesting. Isolation techniques are varied and differ slightly from one disease to another (e.g. a finite piece of bubble compared to a patch of cobweb) but all have a single objective, to contain the disease organism either by clean removal or by covering, for example with salt. The method chosen will vary depending upon the prevailing circumstances.

c) As an aid to hygiene, it is desirable to work in younger crops before moving on to older ones. Especially if there is a disease outbreak, work from clean to infected crops.

All harvesting equipment should be thoroughly cleaned with disinfectant before removal to another house. Ideally, such equipment should be confined to one house.

d) Avoid dust.

Dust, within a cropping house and on the farm in general, is a potent carrier of spores and mycelial fragments of the disease organisms and should be avoided as a high priority.

Dust filters on cropping houses have been shown to be effective in reducing disease levels. Phase II and Phase III rooms and spawning areas are now universally protected to such a high level that dust is automatically excluded.

e) Protect materials used in production - compost during spawn running - casing materials and casing during case running.

As with most diseases and some pests, early contamination applies almost uncontrollable pressure upon other control measures and the fungal diseases are no exception. Stringent hygiene applied to the storage and handling of casing is always well rewarded and is probably the major fundamental defence against the three main fungal pathogens.

f) Employ effective cook-out and crop disposal.
In similar vein, elimination of any disease in completed crops greatly aids the clean beginnings of subsequent ones.

g) Use of fungicides to synergise hygiene effects.

The judicious and sparing use of fungicides can greatly enhance the hygiene measures outlined. Fungicide should not be used prophylactically, but only when an occurrence of disease is anticipated, has occurred, or in those unfortunate situations where disease is endemic. To avoid the unnecessary use of fungicides the resistance of the pathogen should first be established.

h) Washing down is strongly recommended, though splashing mushroom beds is to be avoided at all cost. All Mushroom waste should be removed and disposed of in the most appropriate manner: this eliminates the risk of re-introducing disease on to the farm.

i) Fly control is especially necessary to aid disease control.

8.10.2.2 Verticillium (Dry bubble)

Dry bubble has shown itself to be a most devastating disease. Stringent hygiene practices should be employed to treat disease before cultural events occur. Watering the crop is especially risky as the spores are sticky and are dispersed effectively in water droplets. Spores also very easily become incorporated into the dust fraction on a farm and are spread very effectively by contact with harvesters or any fly that may alight on the infected mushroom surface.

Particular attention should be paid to preventing fresh casing from becoming contaminated with farm dust, especially if there is a severe outbreak of Verticillium on the farm. Fly control is especially necessary when Verticillium is a problem and cooking out crops early if they are severely infected will also assist in reducing the potential spread of the disease.

Chemical control:

Prochloraz is the only chemical that will give effective control of Verticillium as all isolates are resistant to carbendazim. Some isolates of Verticillium are more tolerant to prochloraz than others, but HDC funded research has shown that prochloraz will still give significant control of such isolates. In cases where the chemical does not appear to be effective it is worthwhile having isolates tested for tolerance. It is also worthwhile checking that the chemical is being applied at the correct rate.

8.10.2.3 Mycogone (Wet bubble)

Wet Bubble is a disease that can be introduced by casing contamination or dust blow around the farm or from soil in the vicinity. Early infection manifests itself by large swollen lumps of tissue, bursting through the casing layer often before a mushroom is harvested. In later
flushes smaller pins often show blanket infection that can be easily confused at first glance to a Verticillium infection.

It produces two spore types, one which is small and water-dispersed like Verticillium, and a second which is a large resting spore capable of persisting for a long time in the environment. Stringent hygiene should be employed to treat this disease.

Chemical control:

Prochloraz-manganese may still be used and Bavistin DF can be used as a spray but has a 14 day harvest interval so must be applied at casing to comply. On-farm trialling or a tolerance test may be necessary to ascertain which fungicide is the most efficacious.

8.10.2.4 Dactylium (Cladobotryum) (Cobweb)

This disease is now more common, possibly due to changes in fungicide use and cropping house environments. The principles of control are similar to those for Verticillium and Mycogone and centre around efficient hygiene. The spores of Dactylium, unlike those of Verticillium and Mycogone, are dry and are readily airborne if disturbed. It is essential therefore to closely monitor crops at risk and practise early containment of this disease. Patches of cobweb should be identified and treated immediately, not left until tomorrow: handle gently when treating and never water on untreated disease. Salting areas of disease must be preceded by gently covering the patch with damp tissue to prevent clouds of spores being disturbed and released into the air when salt is applied. This method of disease treatment is the most effective treatment.

The major crop loss caused by Dactylium is often due to spoilage from a cap spotting symptom as the spores are easily released and are quickly spread throughout the crop by the air handling system.

Disease monitoring staff should be familiar with this manifestation of the disease and be able to distinguish fungal spotting from bacterial blotch symptoms.

It is sometimes helpful to have laboratory diagnosis of this symptom as several organisms can cause cap spotting, including Verticillium and Trichoderma spp and Aphanocladium.

At least two species of Dactylium (Cladobotryum dendroides and C. mycophilum) can cause Cobweb disease. Resistance to carbendazim has been detected in a large proportion of C. mycophilum isolates but as no Carbedazim formulations are available for use on mushrooms, physical measures are the only options now available.
Although every effort has been made to ensure accuracy, Assured Produce does not accept any responsibility for errors and omissions.

Chemical control:

There is no specific Chemical control for Dactylium. Prochloraz is now the only chemical that can be used although it will only give limited control.

8.10.2.5 False Truffle (Diehliomyces)

This is now a relatively rare disease; modern composting facilities have almost eliminated it from commercial farms. It is a competitor mould of Agaricus in the compost. Avoidance of very high spawn running temperatures alleviates the problem. But an effective phase II and good hygiene procedures after Phase II are the best control measures.

No pesticides are approved.

8.10.2.6 Trichoderma (Green mould)

Trichoderma spp. cause a number of problems. The most serious one is compost green mould caused by Trichoderma harzianum Th2. This organism can cause severe crop losses. A well balanced compost formulation, followed by a good phase II procedure coupled to a high level of hygiene at spawning, filling, spawn and case run, is needed to control Trichoderma problems on the farm. In particular, because of it’s affinity to high carbohydrate levels, hygiene relating to spawn, spawn storage and spawn application is especially important, as is a well balanced carbon nitrogen ratio of the compost.

Several other species can occur on tray timbers, chogs and in casing and can cause serious Mushroom cap spotting problems. The symptoms are similar to cap spotting caused by Dactylium so it is important to correctly identify the organism responsible for the spotting symptom. Colonies of Trichoderma green mould on casing should be treated with salt prior to watering to prevent spores being splashed onto mushrooms.

Chemical control:

Mushroom spawn can be treated with carbendazim (off label recommendation) when there is a risk Trichoderma harzianum Th2 in the compost but it can no longer be applied to the crop to reduce the prevalence of Trichoderma moulds and associated cap spotting symptoms. There is currently only one formulation (Bavisitin DF) that can be sprayed, but this has a 14 day harvest interval and will be degraded or diluted by subsequent watering before the mushrooms appear. The surface presence of Trichoderma moulds and cap spotting symptoms are often incidentally controlled by pesticides being used for one of the other major fungal pathogens otherwise only the careful physical removal of the fungal growth is available as a control..

8.10.2.7 Bacterial Blotch

Blotch symptoms caused by Pseudomonas tolaasii can result in large crop loss due to staining of mushrooms and spoilage.
Good environmental control will reduce the problem. The ability to achieve rapid evaporation following watering and to control humidity and temperature levels accurately, has brought about considerable advances in bacterial blotch control. However, at certain times of the year when ambient humidity’s are high, treatment of water with sodium hypochlorite is still necessary to reduce bacterial populations and disease symptoms.

Chemical Control:

Sodium hypochlorite is an approved commodity substance used to treat the water that is applied to the Mushrooms. The recommended application rate is 150 ppm available chlorine.

8.10.3 Virus disease

The only control for this potentially devastating disease is specific hygiene designed to contain Mushroom mycelium and spores within each crop. A new Virus complex, termed Mushroom Virus X (MVX) was identified in Britain in 1996 and has since devastated the viability of a number farms. MVX is much more insidious than La France virus ever was and hygiene and process control measures to control MVX need to be considerably more stringent.

These are summarised as follows:

a) It is imperative to exclude Mushroom spores and Mushroom mycelium fragments from the latter stages of Phase II by absolute filtration and from Phase III by equally effective filtration and recycling cooled air.

b) Mushroom spores and Mushroom mycelial fragments are very effective carriers of the condition and all stages where compost is handled or exposed are vulnerable e.g. filling bulk phase II or III onto shelves, casing, ruffling, venting etc.

c) Preventing early contamination of the crop is very important.

d) Preventing spores and mycelial fragments circulating from old to new crops is important in controlling the condition. Filtration of exhaust ducts from cropping houses and control of all debris emanating from mushroom crops is important.

e) The spores that are released into the farm environment when growing open mushrooms are a major hazard: distribution of these around the farm must be controlled.

f) Isolation of cropping areas from Phase II and III operations is important if physically/economically possible.

g) Effective post harvest cook-out to kill Mushroom mycelium and spores is required to control outbreaks..

h) Effective sterilisation of growing containers and compost handling machinery, to eliminate cross contamination between growing houses and farms is essential.
Routine examination to monitor virus levels is advised should symptoms develop. Advice should be urgently sought if the levels do not respond to heightened hygiene methods.

8.10.4 Disinfectants

These products, used to kill both pests, diseases and Mushroom debris on Mushroom farms, form an integral part of the hygiene programmes repeatedly mentioned in this protocol.

The suppliers to the Mushroom industry have selected a range acceptable both to the crop and the operators on the farms.

These materials are not subject to the approval mechanisms of the Control of Pesticides Regulations but come under a new set of regulations, The Detergent Regulations 2005. This new legislation aims to enforce regulation 684/2004 which came into force on the 8th October 2005.

Formaldehyde is frequently used as a disinfectant on mushroom farms. This is a commodity substance. It has been supported in the fourth stage of the EU pesticide review and is currently approved for use until 31/12/2008 or until a decision is taken on whether it is to be included on the EU "Annex 1" list.

9 Harvesting and storage

The Mushroom crop is harvested by hand into the container in which it is to be sold to the consumer.

Growers should, if they have not already done so, enlist the advice of their local Environmental Health Officers on the complex requirements of the Food Safety Act and associated Regulations.

Most Mushrooms are destined for cool chain marketing. They are grown at approximately 18°C. In order to retain field quality it is strongly recommended that they should be brought down to 5°C as soon as practicable. The most desirable storage temperatures are within the range 2-4°C. High humidity storage facilities will assist in retaining quality up to the point of sale.

10 Pollution control and waste management

See Generic Standards and/or Generic Guidance Notes.

Not all comments in these documents are relevant to Mushrooms.

11 Energy efficiency

See Generic Standards and/or Generic Guidance Notes.

Although every effort has been made to ensure accuracy, Assured Produce does not accept any responsibility for errors and omissions.
Not all comments in these documents are relevant to Mushrooms.

12 Health and safety

See Generic Standards and/or Generic Guidance Notes.

Not all comments in these documents are relevant to Mushrooms.

13 Conservation

See Generic Standards and/or Generic Guidance Notes.

Not all comments in these documents are relevant to Mushrooms.
## Appendix 1 Insecticides approved for the control of mushroom flies (Sciarids and Phorids)

<table>
<thead>
<tr>
<th>Active Ingredient</th>
<th>Product Features</th>
<th>Approval Type</th>
<th>Harvest Interval(1)</th>
<th>LERAP Category</th>
<th>Hazard Rating</th>
<th>MRL (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>deltamethrin</td>
<td>Casing drench or fogging treatments</td>
<td>SOLA(2) (Decis®, Decis Protech®, Bandu®)</td>
<td>2 days (3)</td>
<td>none stated</td>
<td>Harmful</td>
<td>0.05 (LOD)</td>
</tr>
<tr>
<td>diflubenzuron</td>
<td>1 casing drench treatment at, or immediately after, casing</td>
<td>Full (Dimilin Flo®)</td>
<td>none stated</td>
<td>B</td>
<td>none stated</td>
<td>0.1</td>
</tr>
<tr>
<td>pyrethrins + resmethrin</td>
<td>Casing drench or fogging treatments</td>
<td>SOLA (Pynosect 30®)</td>
<td>recommended to be at least 7 days given the MRL</td>
<td>none stated</td>
<td>Harmful</td>
<td>0.1 for resmethrin (LOD)</td>
</tr>
<tr>
<td>pyrethrin</td>
<td>Casing drench or fogging treatments. Can be used in organic production</td>
<td>SOLA (Py Spray®)</td>
<td>none stated</td>
<td>none stated</td>
<td>Harmful</td>
<td>none set</td>
</tr>
</tbody>
</table>

**Notes:**

1. If no harvest interval is stated then the latest time of application determines the harvest interval.

2. Specific Off Label Approval (SOLA). Growers must be in possession of the SOLA before using these products.

3. Given the MRL this harvest interval may not be sufficient to prevent exceeding the MRL. Supporting data are likely to be required to retain this product through the current EU review of pesticides.


5. This formulation contains natural colour which can stain mushrooms so it should not be used when mushrooms are present.

SOLAs provide for the use of a named product in respect of crops, situations or pests other than those included on the product label. Such use is undertaken at the user's choosing and the risk is entirely theirs and /or their advisers. The off-label use may only take place if all the conditions given in the "Notice of Approval" document, the product label and/or leaflet and any additional guidance on off-label approvals have first been read and understood. The conditions of approval given in the "Notice of Approval" are statutory and supersede any on the label which would otherwise apply. All SOLAs are conditional on the extant approval of the specific product. Not all formulations of each active ingredient may be currently approved for use on Mushrooms. Check before use. Label recommendations are revised regularly, read a current label before use.
### Appendix 2 Biological control organisms for sciarid fly control

<table>
<thead>
<tr>
<th>Organism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steinernema feltiae</td>
</tr>
</tbody>
</table>

### Appendix 3 Products approved for controlling fungal diseases in Mushrooms

<table>
<thead>
<tr>
<th>Active Ingredient</th>
<th>Product Features</th>
<th>Approval Type</th>
<th>Harvest Interval&lt;sup&gt;(1)&lt;/sup&gt;</th>
<th>LERAP Category</th>
<th>Hazard Rating</th>
<th>MRL (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>carbendazim</td>
<td>casing treatment - 1 treatment per crop</td>
<td>Full (Bavistin DF&lt;sup&gt;(2)&lt;/sup&gt; Cleancrop Curve&lt;sup&gt;(3)&lt;/sup&gt;)</td>
<td>14 days</td>
<td>none stated</td>
<td>Toxic</td>
<td>1.0</td>
</tr>
<tr>
<td>carbendazim</td>
<td>spawn treatment - 1 treatment per crop</td>
<td>SOLA&lt;sup&gt;(3)&lt;/sup&gt; (Bavistin DF&lt;sup&gt;(2)&lt;/sup&gt; Cleancrop Curve&lt;sup&gt;(3)&lt;/sup&gt;)</td>
<td>none stated</td>
<td>none stated</td>
<td>Toxic</td>
<td>1.0</td>
</tr>
<tr>
<td>prochloraz</td>
<td>casing treatment</td>
<td>Full</td>
<td>4 days&lt;sup&gt;(4)&lt;/sup&gt;</td>
<td>none stated</td>
<td>Irritant</td>
<td>2.0</td>
</tr>
</tbody>
</table>

**Notes:**

<sup>(1)</sup> If no harvest interval is stated then the latest time of application determines the harvest interval.

<sup>(2)</sup> BASF has discontinued marketing Bavistin DF in the UK as of July 2004. There should be a two year use-up period. However, the future of carbendazim registrations in the UK remains unclear at this point in time. Further information will be provided when available.

<sup>(3)</sup> Specific Off Label Approval (SOLA). You must be in possession of the SOLA before you can use this product (LERAP Categories may not apply to Mushroom fungicides as they are applied to crops contained within Mushroom houses.)

<sup>(4)</sup> The harvest interval for prochloraz has been increased from 2 to 4 days. This means that mushrooms cannot be marketed if they are harvested within 4 days of an interflush application. Some interflush treatments may no longer be feasible.

SOLAs provide for the use of a named product in respect of crops, situations or pests other than those included on the product label. Such use is undertaken at the user's choosing and the risk is entirely theirs and/or their advisers. The off-label use may only take place if all the conditions given in "Notice of Approval" document, the product label and/or leaflet and any additional guidance on off-label approvals have first been read and understood. The conditions of approval given in the "Notice of Approval" are statutory and supersede any on the label which would otherwise apply. All SOLAs are conditional on the extant approval of the specific product. Not all formulations of each active ingredient may be currently approved for use on Mushrooms. Check before use. Label recommendations are revised regularly, read a current label before use.
Appendix 4 Products approved for tray dipping

<table>
<thead>
<tr>
<th>Product</th>
<th>Active Ingredient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safetray SL®</td>
<td>Azaconazole</td>
</tr>
<tr>
<td>Panacide M®</td>
<td>Dichlorophen</td>
</tr>
<tr>
<td>Fungo®</td>
<td></td>
</tr>
<tr>
<td>Brunosol®</td>
<td>sodium orthophenyl phenate tetrahydrate</td>
</tr>
</tbody>
</table>

HSE withdrew their approval for Safetray SF in March 2006, but existing stocks can be used until March 2008.

Dichlorophen and phenolics do not have PSD or HSE approval for use on wooden trays.

Appendix 5 Commodity Substances approved for use on Mushroom Crops

<table>
<thead>
<tr>
<th>Product</th>
<th>Maximum Individual Dose</th>
<th>Date of Expiry; ( unless earlier decisions are made or further prescribed extensions are granted )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formaldehyde</td>
<td>As a spray 0.5litres formalin / m²</td>
<td>31st December 2008</td>
</tr>
<tr>
<td></td>
<td>As a fumigant 400ml formalin / 100m³ or 100g of potassium permanganate added to 500ml formalin / 100m³</td>
<td>31st December 2008</td>
</tr>
<tr>
<td>Sodium Hypochlorite</td>
<td></td>
<td>31st December 2008</td>
</tr>
</tbody>
</table>
### Appendix 6  Guidelines on minimising pesticide residues

Assured produce is aware that a key area in the production of fresh produce which requires continued attention by growers and their advisers is that of keeping pesticide residues to a minimum. This issue is not just one of meeting the MRL trading standard but ensuring that any individual or multi residues are kept as low as possible below this level.

<table>
<thead>
<tr>
<th>Active ingredient</th>
<th>Target: pest, weed, disease</th>
<th>Current position</th>
<th>Suggested guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>carbendazim</td>
<td><em>Trichoderma</em></td>
<td>Residues rarely found(^{(1)}) (2) (3)</td>
<td>Current practice is satisfactory</td>
</tr>
<tr>
<td>chlormequat</td>
<td>A plant growth regulator for cereals (^{(4)})</td>
<td>Residues rarely found (^{(1)}) (2) (5)</td>
<td>Current practice is satisfactory</td>
</tr>
<tr>
<td>diazinon</td>
<td>Sciarid fly larvae</td>
<td>No residues detected (^{(1)})</td>
<td>No longer approved</td>
</tr>
<tr>
<td>diflubenzuron</td>
<td>Sciarid fly larvae</td>
<td>No residues reported (^{(3)})</td>
<td>Current practice is satisfactory</td>
</tr>
<tr>
<td>omethoate (dimethoate)</td>
<td>Insecticide and acaricide used on cereals (^{(4)})</td>
<td>Residues rarely found, (^{(1)}(2))</td>
<td>Current practice is satisfactory.</td>
</tr>
<tr>
<td>prochloraz</td>
<td><em>Verticillium Mycogone Cladobotryum</em></td>
<td>Residues rarely found (^{(1)}) (2) (3)</td>
<td>Current practice is satisfactory</td>
</tr>
</tbody>
</table>

**Notes:**

\(^{(1)}\) Pesticide Residues Commission (PRC) data for 2001

\(^{(2)}\) Residue levels between the limit of detection (LOD) and the MRL

\(^{(3)}\) Data for 2001-2004 from two commercial mushroom growers

\(^{(4)}\) Pesticides used on cereals may be present in the cereal straw and bran used in mushroom-growing substrates.

\(^{(5)}\) PRC confirm that chlormequat residues were only found on *Pleurotus* and *Shitake* mushrooms and not in *Agaricus bisporus*
### Appendix 7 Control Points: Mushrooms

<table>
<thead>
<tr>
<th>CS.22 MUSHROOMS</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS.22.1 In order to meet anti-pollution requirements, all water run-off from compost yards is contained for recycling, allowing only clean roof water into the normal drains. Protocol reference: Section 4.7.1</td>
<td>2</td>
</tr>
<tr>
<td>CS.22.2 Are run-off samples, discharged into water courses from concrete surfaces, analysed for pesticides and organic matter - Protocol reference: Section 4.7.1</td>
<td>1</td>
</tr>
<tr>
<td>CS.22.3 Is all spent compost disposed of in the most appropriate manner and one which eliminates risk of introducing disease onto the farm - Protocol reference: Section 8.10.1.4</td>
<td>1</td>
</tr>
<tr>
<td>CS.22.4 Is all waste mushroom material disposed of in the most appropriate manner and one which eliminates risk of introducing disease onto the farm - Protocol reference: Section 8.10.2.1</td>
<td>1</td>
</tr>
<tr>
<td>CS.22.5 Are steps taken to avoid anaerobic conditions in compost stacks and heaps - Protocol reference: Section 4.7.3</td>
<td>1</td>
</tr>
<tr>
<td>CS.22.6 Is the finished product analysed occasionally for contamination with E-coli - Protocol reference: Section 4.7.3</td>
<td>3</td>
</tr>
<tr>
<td>CS.22.7 Is the product cooled after harvesting to retain quality - Protocol reference: Section 9.0</td>
<td>1</td>
</tr>
<tr>
<td>CS.22.8 Where possible, are crops cooked-out on completion to eliminate the risk of introducing diseases from old into new crops. If crop is not cooked-out, are crops sprayed with suitable disinfectant – Protocol reference: Section 8.1</td>
<td>1</td>
</tr>
<tr>
<td>CS.22.9 Is the finished product analysed occasionally for any pesticide residues - Protocol reference: Section 8.9 (NEW)</td>
<td>2</td>
</tr>
</tbody>
</table>