



Assured Produce

Crop Specific Protocol

TOMATOES (PROTECTED)

(CROP ID: 23)



January 2009

Acknowledgements	4
1 General introduction	5
2 Planning and records	5
3 Site selection	5
4 Site management	5
5 Variety selection	6
6 Nutrition	6
7 Irrigation	6
8 Crop protection	6
8.1 The basic approach to crop protection	6
8.2 Plant protection product choice	8
8.3 Advice on the use of pesticides	8
8.4 Application of pesticides	8
8.5 Records of application	8
8.6 Protective clothing/equipment	8
8.7 Pesticide storage	9
8.8 Empty pesticide containers	9
8.9 Pesticide residues in fresh produce	9
8.10 Tomato production	9
8.11 Disease control	12
8.12 Cherry Tomatoes	16
9 Harvesting and storage	17
10 Pollution control and waste management	17
11 Energy efficiency	17
12 Health and Safety	17
13 Conservation	17
Appendix 1 Products currently approved for use on protected Tomatoes	18
Appendix 2 Insecticide compatibility with Biological Control Organisms	19
Appendix 3 Fungicide compatibility with Biological Control Organisms	20
Appendix 4 Specific off-label approvals (SOLAs) for use on protected Tomatoes	21
Appendix 5 Guidelines for Minimising Pesticide Residues in British Protected Tomato Crops	23

Appendix 6 Control Points: Tomatoes (Protected) 26

Acknowledgements

Assured Produce. gratefully acknowledges the contribution of those consulted in the preparation of this protocol, particularly Gerry Hayman.

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 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 word "**must**" (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 "**must**" 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.

Notes:

There may be other withdrawals or revocations. Products containing substances which have been revoked are shown on the PSD website (<http://www.pesticides.gov.uk>). Growers should check with their advisers, manufacturers, the Assured Produce website 'Newsflashes', the PSD website (www.pesticides.gov.uk)

Growers should comply with the 'Use up by' dates for all pesticide products. Growers should also be aware of and comply with changes on new product labels.

There may be changes for the following reasons:

- At re-registration stage after Annex 1 listing there may be: reductions of dose rates; changes in timings and/or number of applications for some products.

In the following Appendices products and use by dates are only listed for SOLAs, and in some cases new product MAPP numbers may not be available yet.

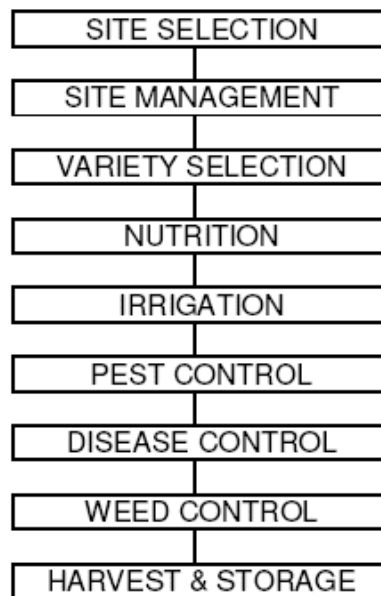
For pesticides on-label, only active substances are shown.

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. Note that the sectional layout of both this protocol and the crop specific protocols follow the same structure.



The contents of each crop specific protocol are 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.

3 Site selection

See Generic Standards and/or Generic Guidance Notes.

4 Site management

See Generic Standards and/or Generic Guidance Notes.

5 Variety selection

See Generic Standards and/or Generic Guidance Notes.

Growers should visit their propagators to inspect their plants before dispatch.

6 Nutrition

See Generic Standards and/or Generic Guidance Notes.

Growers **should** consider the recirculation of water and nutrients . If this is not a practical option for any reason., they must take steps to minimise nutrient run-off into soil and water courses.

The volume of run-off **should** be measured and samples analysed.

7 Irrigation

See Generic Standards and/or Generic Guidance Notes.

8 Crop protection

8.1 The basic approach to crop protection

Key principles of ICM for protected salad crops

- a. Biological, environmental and cultural methods of pest and disease control must be used as the first line of defence.
- b. Chemical pesticides are only to be used when biological controls are not available or shown not to be working.
- c. Crops should be monitored at least weekly and records made of pest, disease and biological control organism levels.
- d. Records should be kept of the introduction of biological control agents.
- e. Climate control computers should be used to ensure a suitable environment is maintained at all times.
- f. Records **must** be kept of all pesticide applications.

Adaptation for new pests and diseases

The occurrence of a new disease or pest problem is largely unpredictable. It may arise, for example, when a previously non-indigenous disease or pest becomes established in the UK (e.g. pepino mosaic virus, potato spindle tuber viroid, Columnea latent viroid), with a change in variety or cropping practice (e.g. switch from soil to substrate cropping) or when a pathogen/pest previously controlled by a particular pesticide develops resistance. The re-introduction of older, 'heritage' plant varieties also poses a risk in terms of the re-establishment of diseases to which more recent varieties convey resistance. In these situations it may be necessary to implement additional pesticide treatments.

A proposed schedule for controlling 'new' pest or disease problems, in order of priority, is described below.

- a. It is possible that 'new' pests and diseases may be subject to statutory action as quarantine pests or diseases. This is particularly the case with emerging virus and viroid problems, but also with pests such as tobacco whitefly (*Bemisia tabaci*). In order to protect the industry as a whole, it is essential that any suspicious cases are reported to the Plant Health & Seeds Inspectorate of Defra.
- b. The key objective is that the organism should be controlled by means of a change in glasshouse environment, crop culture, biological or other non-chemical methods. In some situations however, it is possible that additional use of pesticides may be necessary, at least in the short term or until a suitable

alternate variety with genetic resistance is available. Such new varieties should be incorporated into the cropping programme, as they become available, providing they meet the end-market specifications.

- c. The 'new' pest or disease may be controlled by selecting products already known to be compatible with the biological control measures.
- d. If none of these pesticides provide effective control, advice should be sought on a suitable alternative product, currently approved for use on the appropriate protected crop under Control of Pesticides Regulations (1986).

Training requirements

Pest and disease identification

Staff working regularly on protected tomato crops should be able to recognise the following pests and diseases, or seek immediate guidance if unsure of a diagnosis:

- Powdery mildew
- *Botrytis* (grey mould) on leaves, stems and fruit
- Various relevant virus diseases, particularly pepino mosaic virus, Columnea latent viroid and potato spindle tuber viroid.
- Aphids
- Whiteflies
- Leafhoppers
- Mealy bugs
- Spider mites and other mites
- Caterpillar damage
- Leaf miner damage
- Thrips

Staff should also be able to recognise biological control organisms being used.

Staff should know to whom to report when the above pests and diseases, or other problems regularly found on a particular nursery, are first detected during the season. Quick diagnosis and action are fundamental to effective control. Managers and supervisors should appreciate the relative risk to their crops from the relevant pests and diseases.

In service training

Training in identification of pests and diseases, their damage and their biological controls and an appreciation of the objectives of this protocol should be given to each new member of staff.

All staff working on the nursery, both regular and casual, should be instructed as necessary to satisfy COSHH requirements with respect to pesticide treatments, and to satisfy the requirements of the General Food Hygiene Regulations.

Monitoring

Regular monitoring of the biological control agents, pests and diseases is of vital importance so that quick corrective action can be taken if required. It is essential that all crops are walked at least once a week and records kept of each inspection. **All** nursery staff should be alert to fresh pest or disease symptoms or signs of imbalance with biological control mechanisms.

General requirements

Growers **should** ensure that the following standards are adhered to when growing tomatoes:

- seed should be treated with sodium hypochlorite for protection against surface borne pathogens such as pepino mosaic virus. Further seed treatments may be indicated after completion of current research work on virus and viroid transmission.
- when buying in plants, specifications for propagation, including pest and disease control measures and the conditions for the transport of plants, should be given to the propagator who, in turn, should provide the grower with documentation confirming any pesticide applications, that these meet legal requirements and that application records are held by the propagator (See Generic Standards 5.4.3)
- steps should be taken to minimise nutrient run off into soil and water courses.
- steps should be taken to minimise nitrate levels in applied nutrient solutions.
- the introduction and monitoring of biological control agents should be recorded.
- written procedures for the management and recording of incidents involving heating oil spillage **must** be in place, where oil is used on site
- written procedures for the management and recording of incidents involving breakage of glass in the glasshouse **must** be in place
- all glasshouses should have appropriate "No Smoking/No Food" signs and staff **must** be provided with a clearly defined area in which to eat and drink.
- if the crop is grown in an isolated substrate, the substrate **should**, where possible, be reused for more than one crop unless there is significant risk of carry-over of disease (See Generic Standards 4.4.2)
- where isolated substrates are reused, they **should** be sterilised between crops (See Generic Standards 4.4.3 & 4.4.4)

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.

8.9 Pesticide residues in fresh produce

See Generic Standards and/or 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 advisers is that of keeping pesticide residues to a minimum. The 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.

The key targets are:

- **Optimising late application of fungicides and insecticides to the edible part of the crop**
- **Optimising the use of post harvest treatments, though it is unlikely that any will be used on tomatoes in the U.K.**
- **Ensuring minimum harvest intervals are followed**
- **Ensuring that application equipment is applying products correctly and that any staff applying pesticides are adequately trained and qualified.**

See Appendix 6 'Guidelines on Minimising Pesticide Residues in British Protected Tomato crops.'

8.10 Tomato production

8.10.1 Specific hygiene measures

Previous crop

Every effort should be made to reduce pest numbers on previous crops before pests such as spider mites go into diapause in the autumn. High volume sprays using a short persistence insecticide may be used where there is still a pest problem after termination of cropping and prior to plant removal. Some synthetic pyrethroid products used in this way have caused persistent damage to beneficial insects however.

Equipment

The growing structures should be thoroughly cleaned in between crops to prevent carry-over of pests or diseases. Measures include:

- a. At the end of cropping, fog or fumigate the crop with a suitable disinfectant. Remove the crop, weeds and all debris within 2 days of treatment, and dispose of them by removing off site (ensure the load is covered). The plastic sheeting should be recycled where possible, but not at the risk of pest or disease carry-over by re-use on site.
- b. Wash down the glass and the structure inside the greenhouse and then treat with a suitable disinfectant

(e.g. Horticide® or Jet 5®).

- c. Specialist advice should be sought if the previous crop has been affected by virus or viroid diseases, such as pepino mosaic virus or Columnea latent viroid.

New crop establishment

For soil-grown crops, the soil should be sterilised with steam or other suitable sterilant (except for organic crops) to control weeds and root diseases. Annual treatment will generally be necessary to reduce the risk of root diseases.

Rockwool slabs intended for re-use should be sterilised with steam.

The presence of any pests in the empty glasshouse should be closely monitored prior to introduction of new plants, to assist effective and prompt control. Sticky traps should be used as part of the pest monitoring system. The traps should be replaced regularly to allow adequate identification of pests and to ensure that continuing pest presence can be distinguished from those trapped earlier.

Vehicles used to transport plants should be clean and adequately heated. Caution should be exercised where vehicles have previously been used to transport fruit and vegetables, especially tomatoes, or chemicals.

Trays containing the new season's plants should be placed only on a clean surface e.g. new polythene, disinfected and rinsed concrete. Plants should be inspected carefully on arrival and handled with the greatest of care.

Disinfectant foot dips should be used at the entrance to greenhouses as a general discipline. Currently, this is of special concern because of the risk posed by new virus diseases.

Environment

Destroy all weeds around the glasshouse before the new plants arrive and at regular intervals during the season using non-hormone weed killers of short persistence or mowing. Several common weeds (e.g. chickweed, sowthistle, dandelion) are known hosts of tomato spotted wilt virus (TSWV) and could act as a source of this virus for the tomato crop. Weeds may also be a means of carry over of other virus disease, e.g. TMV, CMV and PSTVd and of powdery mildew.

Weeds and especially tomato seedlings within the glasshouse can harbour pests such as whitefly and diseases and must be removed.

Propagation

ICM principles should be adopted from the propagation stage. Growers must formalise the supply contract with their propagators, stipulating the pesticides that can be used. Growers should ensure the supplier adheres to the contractual requirements by requesting crop treatment records and making inspection visits.

Propagators should not accept seeds of unknown provenance, such as those intended for trial purposes, because of the risk of introducing diseases to the premises and infecting otherwise healthy plants. Only properly packaged, appropriately treated and authenticated seed should be used. Due to uncertainty about the source of infection of pepino mosaic virus and Columnea latent viroid, in particular, and the possibility of their presence in or on seed, Defra now requires the treatment of all tomato seed for commercial crops with sodium hypochlorite or trisodium orthophosphate. This includes seed for organic crops. Seed treatment protocols are available from Defra Plant Health Division.

8.10.2 Pest control

Biological control

The following table lists the available biological control measures. The rates of introduction of biological control organisms should be based on recommendations of the suppliers. New biocontrol agents are also being developed.

Pest	Control	Notes
Glasshouse whitefly (<i>Trialeurodes vaporariorum</i>)	a) <i>Encarsia formosa</i> b) <i>Verticillium lecanii</i> (Mycotal®) c) <i>Macrolophus caliginosus</i> d) sticky traps	b) For corrective action. Needs high humidity to establish. c) May cause damage especially on vine harvested varieties
Sweet potato whitefly (<i>Bemisia tabaci</i>)	Statutory quarantine pest in UK. Inform PHSI. Serious virus vector.	A serious risk on imported plant material.
Spider mites (<i>Tetranychus urticae</i>) (<i>Tetranychus cinnabarinus</i>)	a) <i>Phytoseiulus persimilis</i> b) <i>Feltiella acarigusa</i> c) <i>Macrolophus caliginosus</i>	a) Better results may be obtained with strains raised on tomato plants. c) Also has activity against other pests such as whitefly and leaf miners.
Broad mite (<i>Polyphagotarsonemus latus</i>)	Remove plants. No effective biocontrol. Seek advice.	Do not introduce biocontrol agents on leaf material.
Russet mite (<i>Aculops lycopersici</i>)	<i>Amblyseius andersoni</i> suggested but does not appear well adapted to tomatoes.	Has caused serious problems on a few sites. Affects stems, lower leaves and fruit. Commercial experience has shown sprays of sulphur in a tank mix with a physical action material such as Eradicoat T® to give effective control.
Caterpillar - various species	a) Picking off b) Pheromone traps c) <i>Bacillus thuringiensis</i> d) <i>Trichogramma spp</i>	d) Egg parasite only. Use not permitted in Guernsey. <i>Macrolophus</i> is active against caterpillar eggs.
Caterpillar - (<i>Spodoptera</i> spp and <i>Heliothis</i> spp)	Statutory quarantine pest in UK. Inform PHSI	
Tomato leaf miner (<i>Liriomyza bryoniae</i>)	a) Leaflet removal plus b) and c) b) <i>Diglyphus isaea</i> c) <i>Dacnusa siberica</i>	Timing of <i>Diglyphus</i> introduction is important. <i>Macrolophus</i> active against leafminer.
American serpentine and South American leaf miners (<i>Liriomyza trifolii</i> and <i>L. huidobrensis</i>)	Statutory quarantine pests in UK. Inform PHSI	Biological control may be allowed.
Glasshouse leafhopper (<i>Hauptidia maroccana</i>)	a) Leaflet removal plus b) b) <i>Anagrus atomus</i>	<i>Macrolophus</i> is active against leaf hoppers Buprofezin used for whitefly control has some effect.
Aphids (various species)	a) <i>Aphidius colemani</i> b) <i>Aphidius ervi</i> c) <i>Verticillium lecanii</i> (Vertalec®)	Not normally serious but can cause fruit damage after feeding on flowering trusses.
Western flower thrips (<i>Frankliniella occidentalis</i>)	a) Sticky traps b) Control on other crop spp. on nursery important. c) No effective biocontrol on tomatoes.	Not usually a problem on tomatoes but may spread from adjacent susceptible crops such as cucumbers or flower crops.
Other thrips (e.g. <i>Thrips tabaci</i>)	Leaflet removal <i>Amblyseius swirskii</i> is reported to give promising results in warm climates.	Monitor closely and seek advice if numbers increase. Not usually a problem but recently so in some over-wintered, lit crops.
Mealybugs	a) Removal of colonies b) Strict hygiene e.g. irrigation lines and greenhouse structure. c) Physical barriers to re-colonisation of plants.	Buprofezin used for whitefly control has some effect but approval being revoked. Check results of ongoing research. Major problem in organic crops.

Chemical control

In some instances biological controls are not available and suitable pesticides are recommended. The chemicals listed in this section have been found to be acceptable within ICM systems.

Pest	Active Ingredients	Notes
Whitefly	a) fatty acids b) buprofezin c) pymetrozine d) spiromesifen e) thiacloprid	Spot treatment. Double <i>Encarsia</i> introductions for 2 weeks in affected areas. b) Approval revoked 30/03/09, use up by 30/03/10. c) Harmful to Macrolophus d) More information needed about effect on biocontrols.
Spider mites	a) fenbutatin oxide a) abamectin b) spiromesifen	a) Clear-up spray at end of crop - harmful to biocontrols, especially <i>Encarsia</i> . SOLA for use on cherry tomatoes. b) More information needed about effect on biocontrols.
Glasshouse leafhopper	buprofezin	When used for whitefly control, but in revocation.
Aphids	a) pirimicarb b) pymetrozine c) acetamiprid	a) widespread resistance problems b) Harmful to Macrolophus c) Harmful to beneficials.
Mealybugs	a) petroleum oil b) buprofezin c) pyrethrum	a) HV spray b) when used for whitefly control. c) approved for organic crops
Macrolophus – where causing crop damage	a) pymetrozine b) pyrethrum	b) Promising results in trials on organic crops for culling excess numbers

Notes:

Spot sprays of glucose polymer (Eradicoat® or Majestik®) may be used against aphids, spider mites, thrips and whitefly (larval and pupal stages). Polysaccharide (Agri-50E®) is also available for use against aphids and whitefly in particular. These materials act in a physical way and therefore fall outside the scope of the Control of Pesticide Regulations (1986). No harvest interval requirements therefore apply. Thorough and repeated spraying is necessary to hit the pest target and achieve control and the cost can therefore be high.

8.11 Disease control

The following approach should be adopted to control disease problems. **The steps are listed in order of priority:**

- The avoidance of the use of fungicides should be pursued through the use of good management and planning, cultural practices, and environmental manipulation, to prevent or reduce disease incidence.
- If control measures are required, biocontrols should be employed, if and when they become available.
- However, it is recognised that some fungicide treatment is likely, and the crop may be treated with the fungicides listed in the relevant disease section. Their use should be minimised through regular crop monitoring and a rapid response to whatever disease is found.
- If a problem occurs that is not controllable by biocontrol, or with those chemicals listed, the alternative chemicals listed in Appendix 5 may be used.
- If a disease problem arises that is not controllable by any of the above measures follow the procedures

outlined in Section 8.1 (Adaptation for new pests and diseases).

Disease control procedures

Certain diseases are relatively common and occur on many holdings each year. The procedure for the control of the common disease problems is given in detail, but the procedure for other diseases is given in outline only. Further technical advice should be sought as necessary.

It cannot be emphasised too strongly that regular crop monitoring with rapid and accurate disease identification and an appropriate rapid response, involving cultural changes, a glasshouse environmental change, roguing of the affected plant or a fungicide treatment, is essential to fulfil the objective of minimising fungicide use.

Crops should be thoroughly inspected for disease at least once every seven days, and staff working in the crops should be trained in disease recognition. If disease is overlooked or rapid response not taken, more fungicide applications may be required to achieve control, than where prompt action is taken.

Botrytis ⁽¹⁾

Preventative Action	Fungicide active ingredient	Notes
General		
Control humidity to below 85% RH or equivalent humidity deficit.		
Avoid plant damage. De-leaf little and often. Remove side shoots when small. Remove debris after de-leafing. Keep layered stems off the floor. Remove spent trusses. Keep foliage and floor dry. Avoid tears down stem at de-leafing. Do not de-leaf late in the day.		
On young plants		
Avoid damage at planting Avoid deep planting (soil crops)	chlorothalonil ⁽²⁾ or iprodione or pyrimethanil or fenhexamid or cyprodonil + fludioxonil (Switch®) ⁽³⁾	Alternate fungicide groups to delay resistance
In the growing crops		
If <i>Botrytis</i> is present, or humidity high, or leaf scorch present	chlorothalonil ⁽²⁾ or iprodione ⁽⁴⁾ or pyrimethanil or fenhexamid	Alternate fungicide groups to delay resistance
Ghost spotting		
Controlling humidity and avoiding rapid night to day temperature rise to avoid condensation on fruit should prevent ghost spotting.		

Notes:

⁽¹⁾ *Botrytis* and *Didymella* can be easily confused - if there is any doubt do not use a knife or handle the lesion and seek specialist laboratory confirmation of cause.

⁽²⁾ Only two applications of chlorothalonil per crop are permitted.

⁽³⁾ Note 7 day harvest interval. Consider use before commencement of harvest season.

⁽⁴⁾ Currently not approved on cherry tomatoes.

Resistance to fungicides is becoming increasingly common. Reduced disease control will occur where resistant isolates are present. Check disease isolates for resistance regularly. Alternate fungicides from different chemical groups to help avoid resistance.

Powdery Mildew

Preventative Action	Fungicide active ingredient ⁽¹⁾	Notes
General		
Control weed tomato plants. Control RH to <85% but do not over-ventilate. Inspect crops regularly, for first sign of infection.		Mildew tolerant varieties of some fruit types are available.
On finding it in your crop		
Spray immediately symptoms are seen for optimum control. Check RH control. Monitor crop closely.	sulphur ⁽²⁾ or potassium bicarbonate ⁽³⁾	Spray sulphur first as no evidence of resistance. Alternate chemical groups
Continued mildew development		
Check spray application efficiency, leaf coverage and crop penetration	sulphur or potassium bicarbonate or azoxystrobin ⁽⁴⁾	Alternate chemical groups
Severe mildew		
Seek advice		

Notes:

- ⁽¹⁾ Resistance to mildew fungicides such as fenarimol is now widespread.
- ⁽²⁾ Sulphur is more effective as a protectant than an eradicant and must be applied at the first sign of disease. Adding an approved wetter aids control. Sulphur is listed as acceptable for use in organic production (UKROFS).
- ⁽³⁾ Potassium bicarbonate (potassium hydrogen carbonate) is now approved as a Commodity Substance. Early results showed promise for powdery mildew control on a range of crops with minimal effect on biocontrol agents but results on tomato crops have been inconsistent
- ⁽⁴⁾ Where azoxystrobin is used, specific recommendations should be followed to avoid the risk of resistance occurring. These include alternation with chemicals from groups with different modes of action.

Pepino Mosaic Virus (PepMV)

This disease was seen for the first time in UK crops in 1999. It is extremely infectious and poses a serious threat to tomato crops. Growers should seek updated information on current research and the status of the disease in the country. A detailed hygiene protocol is available from the HDC. Suspect cases should be notified to the Plant Health Division of Defra and restrictions on the marketing of infected fruit may apply. A diagnostic test kit for use on site is available from the Central Science Laboratory (CSL), York, as is a facility for the non-destructive testing of seed. Recent seed tests have regularly shown evidence of this virus on seed coats. Plant Health Orders from Defra require the treatment of seed for all commercial tomato crops (including organics) with sodium hypochlorite or trisodium orthophosphate. Exceptions may be agreed where treatment of seed is not possible e.g. pelleted seed, but additional safeguards may be imposed for these exceptions e.g. leaf testing of seedlings.

Potato Spindle Tuber Viroid (PSTVd)

The first case in the UK of this potentially serious disease was recorded in 2003. It is a notifiable disease and suspect cases should be notified to the Plant Health Division of DEFRA. Growers should seek updated information on current research and the status of the disease in the country. Identification information is available from Defra Plant Health Division. Recently infections of PSTVd have been detected in ornamental plants of the Solanaceae family, such as *Solanum jasminoides* and *Brugmansia* spp. at propagation facilities in Europe. These infections may be symptomless in these species and it is strongly advised that tomato growers do not bring ornamental Solanaceous plants onto their premises. No cases were reported on UK tomatoes in 2008.

Columnnea Latent Viroid (CLVd)

Three cases of this disease were found in UK crops in 2007 and a number of crops in other countries, such as France. Like PSTVd, it may be found in ornamental species which should not be brought onto tomato production sites. Information suggests that the cases were all associated with one tomato variety and circumstantially a seed-borne infection is suspected. Current research is examining this possibility. It is not yet known whether any seed treatment would be effective if this proves to be the case. No cases were reported in the UK in 2008 but were so in southern Europe where the suspect variety continued to be grown.

In the case of both virus and viroid diseases, scrupulous hygiene should be observed on all sites, but especially those where there has been a previous outbreak. Current research suggests that thorough hygiene measures between crops are effective in removing infections. Since the original source of outbreaks is uncertain, all possible sources should be regarded with suspicion. (See requirements for seed treatment above)

Access to crops by visitors should be strictly controlled. No tomato plant material or fruits, including those in sandwiches, should be brought onto cropping sites. Particular care is required with the use of returnable crates, especially where these may have been used for imported fruit, and for the transport of young plants in vehicles which may have carried fruit .

Growers **should** seek updated information on these virus and viroid diseases.

Brown Rot (*Ralstonia solanacearum*)

This is a potentially serious bacterial disease of both potatoes and tomatoes. It is a notifiable disease and suspect cases should be notified to the Plant Health Division of DEFRA. It has been identified in UK river systems, and restrictions apply to the use of water from these areas for irrigation of both potatoes and tomatoes. As a general principle, tomato crops should not be irrigated with untreated water from rivers and streams.

Verticillium Wilt

Verticillium wilt is becoming increasingly common in crops grown in inert substrates in both Holland and the UK. Strains of the disease capable of overcoming resistance in previously resistant varieties are occurring. Scrupulous hygiene between crops is essential. Laboratory checks should be conducted on samples from crops exhibiting wilting or weak growth as diagnosis can need expert confirmation. Current advice on control of this disease and pesticide approval status should therefore be sought where it occurs. Information from the Horticultural Development Council is available to levy payers.

Less common diseases

Disease	Comment	Action
Didymella	<i>Botrytis</i> and <i>Didymella</i> can be easily confused. If there is any doubt do not use a knife or handle the lesion and seek specialist laboratory confirmation of cause. Sciarid flies can transmit <i>Didymella</i> spores.	Regular monitoring, especially of stem bases. Seek advice if confirmed.
Brown and corky root rot	Mostly affecting soil crops	Sterilise soil
Black dot (<i>Collectotrichum coccoides</i>)	Soil crops and NFT crops. Generally a weak pathogen, found when other factors are adverse	Ensure good growing conditions.
<i>Calyptella</i> root rot	Affects soil grown crops, especially in wet conditions.	Reduce irrigation
<i>Phytophthora</i> root and foot rot	Mostly affecting soil grown crops but not uncommon in rockwool and NFT	Sterilise soil. Strict hygiene e.g. irrigation lines. Avoid contamination of NFT tanks with ground water or soil. Raise rockwool slabs on polystyrene in any low-lying areas to avoid waterlogging of roots.
Black root rot (<i>Thielaviopsis</i>)	NFT crops, occasionally soil	Raise solution temperature.
<i>Fusarium</i> wilt	Now uncommon	Select resistant variety. Sterilise soil. Higher risk in organic crops.
<i>Fusarium</i> crown and root rot	Non-indigenous in the UK	Notify PHSI. Select resistant variety
Leaf mould <i>Fulvia fulvum</i> (<i>Cladosporium</i>)	Now uncommon except on old or 'heritage' varieties.	Select resistant variety. Chlorothalonil.
Blight	Uncommon in heated glasshouse crops; increased risk if near potato crop and blight present; especially in cold crops and wet summers, as in 2008.	Keep foliage dry at all times. Replace broken panes of glass quickly and keep glasshouse gutters clear to avoid water ingress in heavy rain. Azoxystrobin.
<i>Sclerotinia</i>	Increasing in spring. <i>Botrytis</i> sprays will help control.	Remove and burn diseased plants. Sterilise soil. Ensure good floor cover for NFT and rockwool crops.
Bacterial canker	Was uncommon but recent cases in Holland and two cases in the UK in 2008. Can be extremely damaging.	Use clean seed. Strict hygiene precautions. Keep foliage dry.
Pith necrosis	Occasionally in unheated crops, especially in soil.	Correct nutrition. Increase potash and avoid excess nitrogen.
<i>Pythium</i> root rot	Most risk in young plants, but becoming more common in mature crops.	Sterilise soil, heat irrigation water for NFT and rockwool (>18° c). Check drainage. Keep water tanks covered. Propamocarb hydrochloride.
Tomato mosaic virus (TMV)	Uncommon but old or 'heritage' varieties may be susceptible.	Select resistant varieties. Heat treat seed of non resistant ones.
Tomato spotted wilt virus (TSWV)	Spread by WFT.	Control WFT and weeds. Extra care if ornamental crops nearby. Remove affected plants
Cucumber mosaic virus	Occasionally recorded	Rogue plants. Control aphid vectors.

8.12 Cherry Tomatoes

Distinctions may now apply between cherry tomatoes and other tomato crops in the approval status of some pesticides. A current example is that of abamectin (Dynamec), the Approval for which excludes cherry tomatoes but for which there is a Specific Off Label Approval (SOLA). For this reason, particular care should be exercised when selecting pesticides for use on cherry tomato crops and the current approval status of pesticides should be carefully checked at the time of intended use.

9 Harvesting and storage

See Generic Standards and/or Generic Guidance Notes.

Glasshouses **must** have appropriate 'No Smoking/No Food' signs and staff should be provided with a clearly defined area to eat/drink.

10 Pollution control and waste management

See Generic Standards and/or Generic Guidance Notes.

There **must** be written procedures for the management and recording of incidents involving oil spillages.

11 Energy efficiency

See Generic Standards and/or Generic Guidance Notes.

12 Health and Safety

See Generic Standards and/or Generic Guidance Notes.

13 Conservation

See Generic Standards and/or Generic Guidance Notes.

Appendix 1 Products currently approved for use on protected Tomatoes

Active Ingredient	Target Organism	MRL (mg/kg)	Harvest Interval ⁽¹⁾
abamectin ⁽²⁾	leaf miners, spider mites, thrips	0.02	3 days
<i>Bacillus thuringiensis</i>	caterpillars	none set	zero
acetamiprid	aphids, whitefly	0.1	3 days
buprofezin ⁽⁴⁾	whitefly	1.0	3 days
chlorothalonil	<i>Botrytis</i> , blight, leaf mould	2.0	12 hours
copper oxychloride	damping off, buck-eye rot, foot rot	5.0	none stated
fatty acids	whitefly, aphids, thrips, spider mites	none set	none stated
indoxacarb	<i>caterpillars, plant bugs</i>	0.5	1 day
iprodione	<i>Botrytis</i>	5.0	1 day
maneb	blight, leaf mould	3.0	2 days
nicotine shreds	aphids, leaf hoppers, leaf miners, thrips, whitefly	none set	1 day
nicotine spray	aphids, leaf hoppers, leaf miners, thrips, whitefly	none set	2 days
pirimicarb	aphids	1.0	2 days
pirimiphos-methyl	ants, aphids, capsids, leaf miners, thrips, whitefly	1.0	none stated
potassium hydrogen carbonate ⁽³⁾	Powdery mildew	None set	None stated
propamocarb hydrochloride	root diseases e.g. Pythium	10.0 (draft).	14 days (soil crops)
sodium hypochlorite ⁽³⁾	seed treatment	None set	1 day
spinosad	thrips, caterpillars	1.0	3 days
spiromesifen	spider mites and whitefly	1.0	3 days
rotenone	aphids	0.01*	1 day
thiram	<i>Botrytis</i>	3.0 overall dithiocarbamate MRL	7 days
<i>Verticillium lecanii</i>	aphids, whitefly	none set	none stated

Notes:

(1) or latest time of application

(2) excluding cherry tomatoes, but see SOLA. Do not apply to flowering or fruiting crops between 1 November and the end of February.

(3) Commodity Substance approval

(4) Approval revoked 30 March 2009. Final use date 30 March 2010.

* Level at or about the limit of determination (LOD)

Appendix 2 Insecticide compatibility with Biological Control Organisms

Product	<i>Phytoseiulus</i>		<i>Encarsia</i>		Bumble Bees
	Eggs	Adults	Pupae	Adults	
abamectin	S	H(<21)	S	H (<21)	H
buprofezin	S	S	I (3)	S	S
fatty acids	I	H/I ?	S	H/I?	H
nicotine spray	-	H(,7)	S	H (1)	H
pymetrozine ⁽¹⁾	S	S	S	S	S
pirimicarb	I	I	S	H (<7)	H

Notes:

Key:

S Safe, but as a precaution bee hives should be covered before applications

() Number of days

I Intermediate

H Harmful. Beehives should be removed pre-application

? Not tested but suspected from practical experience

(1) Harmful to *Macrolophus*

This is based on the latest information currently available. With certain formulations and under certain circumstances the information may not be true. Always check with the supplier of the biological agents.

Appendix 3 Fungicide compatibility with Biological Control Organisms

This table is based on the latest information available. Certain formulations and circumstances may affect the position. Check with the supplier of the biological agents.

Product	<i>Phytoseiulus</i>		<i>Encarsia</i>		
	Eggs	Adults	Pupae	Adults	Bumble bees
azoxystrobin	-	S	S	S	S
chlorothalonil	S	S	S	S	S
fenarimol	S	I	S	S	S
iprodione	S	S	I	S	S
propamocarb hydrochloride	S	S	S	S	S
sulphur (Microthiol Special [®])	S	S (?)	S	H (?)	S

Notes:

Key:

S : Safe

I : Intermediate

() : Number of days

H : Harmful

- : Not tested; assume harmful unless evidence to the contrary

Appendix 4 Specific off-label approvals (SOLAs) for use on protected Tomatoes

No	Product	Active Ingredient	MRL (mg/kg)	Harvest Interval ⁽¹⁾	Expiry (information at January 2009)
0422/07	Dynamec [®]	abamectin ⁽³⁾	0.02	3 days	31/12/13
0997/07	Nimrod [®]	bupirimate	none set	2 days	31/12/13
1500/07	Switch [®]	cyprodonil/fludioxonil	1.0 cyprodonil, 1.0 fludioxonil.	7 days	31/12/13
1693/07	Decis [®]	deltamethrin	0.3	none stated	31/12/13
1650/07	Decis Protech [®]	deltamethrin	0.3	none stated	31/12/13
1633/07	Cleancrop Decathlon	deltamethrin	0.3	none stated	31/12/13
1611/07	Bandu	deltamethrin	0.3	none stated	31/12/13
1685/01	Amistar [®]	azoxystrobin	2.0	none stated	31/12/11
1533/02	Amistar [®]	azoxystrobin	2.0	none stated	31/12/11
0516/04	Scala [®]	pyrimethanil	1.0	3 days	31/12/13
3126/07	Rubigan [®]	fenarimol	0.5	2 days	30/06/09
2087/04	Teldor [®]	fenhexamid	1.0	1 day	30/11/10
0482/08	Agrovista Fenamid [®]	fenhexamid	1.0	1 day	31/05/11
0625/07	Systhane 20EW [®]	myclobutanil	0.3	3 days	31/12/13
0020/93	Vydate 10G [®]	oxamyl	0.02	14 days	31/12/13
2032/99	Filex [®]	propamocarb hydrochloride	10.0 (Draft tMRL)	2 days (substrate crops)	31/12/13

Notes:

* level set at or about the limit of determination

(1) or latest time of application

(2) maximum of two applications per crop and note resistance strategy

(3) cherry tomato only. Crops must not be treated between 1 November and the end of February.

Specific off-label approvals (SOLAs) provide for the use of the product named 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.

Specific off-label uses may only take place if all the conditions given 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 that would otherwise apply. All SOLAs are conditional on the extant approval of the specific product.

Appendix 4 Specific off-label approvals (SOLAs) for use on protected Tomatoes (Cont'd)

No	Product	Active Ingredient	MRL (mg/kg)	Harvest Interval ⁽¹⁾	Expiry (information at January 2009)
3424/07	Proplant [®]	propamocarb hydrochloride	10.0 (Draft tMRL)	2 days (substrate crops)	30/09/09
2945/07	Proplant [®]	propamocarb hydrochloride	10.0 (Draft tMRL)	2 days (substrate crops)	31/12/13
0845/03	Chess WG [®]	pymetrozine	0.5	3 days	31/10/11
0501/07	Chess WG [®]	pymetrozine	0.5	3 days	31/10/11
3652/02	Thiovit Jet [®]	sulphur	50 ⁽⁴⁾	zero	31/12/13
2024/07	Microthiol Special [®]	sulphur	50 ⁽⁴⁾	zero	31/12/13
3728/06	Calypso [®]	thiacloprid ⁽²⁾	0.5	3 days	31/12/14
0474/08	Agrovista Reggae [®]	thiacloprid	0.5	3 days	31/12/14
3103/07	Cleancrop Curve [®]	carbendazim	0.5	2 days	31/12/13
2379/06	Elvaron Multi [®]	tolyfluanid	none set	3 days	All uses suspended
3026/06	Pyrethrum 5 EC	pyrethrins	None set (Codex 0.05)	1 day	31/12/13
2119/07	Nemolt	teflubenzuron	1.0	3 days	31/12/13

Notes:

* level set at or about the limit of determination

(1) or latest time of application

(2) maximum of two applications per crop and note resistance strategy

(3) cherry tomato only. Crops must not be treated between 1 November and the end of February.

(4) currently under review as unlikely to be achievable even where sulphur has not been applied.

Specific off-label approvals (SOLAs) provide for the use of the product named 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.

Specific off-label uses may only take place if all the conditions given 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 that would otherwise apply. All SOLAs are conditional on the extant approval of the specific product.

Appendix 5 Guidelines for Minimising Pesticide Residues in British Protected Tomato Crops

These guidelines have been produced after consultation between crop stakeholders and the Assured Produce crop author. They will be developed over the coming seasons as knowledge on minimising residues develops. Growers should consult with their crop protection adviser to ensure other best practices are not compromised before considering these guidelines. Key crop problems and their implications are addressed in the following table. More detailed recommendations are available.

Targets:	Active ingredient	Suggested guidelines	Current position
Diseases			
Powdery mildew	Sulphur	Tolerant varieties. Non pesticides such as potassium bicarbonate and Agri 50E need research.	Heritage varieties a problem. Resistance to other actives, but not sulphur. Sulphur not toxic and no residue issues.
Botrytis	Iprodione Pyremethanil Chlorothalonil	Cultural control e.g. spent truss removal and environment control e.g. humidity. Biological control a future possibility but concern about registration cost of BCAs.	No varietal resistance. Alternate chemicals to avoid resistance problems. Reduce reliance on individual actives such as iprodione.
Pythium	Propamocarb hydrochloride	No other specific chemicals. Strict hygiene and water treatment. Grafting where appropriate.	No residue issues identified.
Viruses (PMV ToMV, PSTVd, CLVd)	No specific viricides available.	Seed treatment (acid extraction, sodium hypochlorite or TSOP), strict hygiene.	No residue issues.

Appendix 5 Guidelines for Minimising Pesticide Residues in British Protected Tomato Crops (Cont'd)

Target	Active ingredient	Guidelines	Current position
Pests			
Two spotted spider mite	Abamectin (Dynamec) Spiromesefin (Oberon)	Spiromesefin (Oberon) now approved but more information needed on compatibility with biocontrols. Abamectin damaging to biocontrols.. Both may have place as clean-up sprays at season end. Physical action materials.	Biocontrol not 100%. Hypernecrotic strains a problem. No apparent residue problems.
Glasshouse whitefly	Buprofezin (Applaud) Spiromesefin (Oberon)	Biocontrol with Encarsia generally effective. More experience needed with spiromesefin. Physical action sprays.	No residue issues identified. Establishment of tobacco whitefly in the UK would represent a very serious problem. Approval of buprofezin being revoked. Final use date 30 March 2010.
Leafminer	Abamectin	Biocontrol. Abamectin generally only used as end of season clean-up.	No residue issues identified. Damaging to beneficials.
Mealy bugs	Buprofezin	Biocontrol. Physical action sprays and physical barriers to re-infestation.	No residue issues identified. Biocontrol uncertain. More research needed. Problem in organics. HDC project running.
Macrolophus	Pymetrozine, but research needed. Pyrethrum	Do not introduce but overwinters on many sites. Control other pest species effectively to reduce food source and consequent breeding rate and fecundity.	No residue issues identified. Problem in some organics and speciality varieties, but not in all crops. Results in organic crops to cull excess numbers with pyrethrum look promising.
Weeds			
None	No action needed.		Not an issue in current production systems.

Background information.

1. Pesticide use on British protected tomato crops is very low.
2. No organochlorine insecticides are approved for use on British tomato crops. No organophosphates should be necessary, nor any herbicides, plant growth regulators or post harvest treatments.
3. There are no records of any pesticide residues being above MRLs or of non-approved pesticides in British-grown tomatoes in recent years, so current approaches are achieving good results.
4. Integrated Crop Management strategies for pest and disease control should continue to be the key approach to be used, with emphasis on non-pesticide strategies.
5. Virtually all UK commercial tomato crops are grown in heated glasshouses. This affords the opportunity for effective deployment of biological pest control and the prevention of disease infection by environmental manipulation.
6. Those pests and diseases for which pesticide intervention is still most likely to be required in the UK are spider mites, Botrytis and powdery mildew. The most common residues found in UK samples recently are of materials active against the first two targets, such as tetradifon (spider mites), pyrimethanil and iprodione (Botrytis). Approval of tetradifon lapsed on 31 December 2003, so this is no longer an issue. Sulphur is the most commonly used material against powdery mildew and there are no residue or risk concerns with this product, which is approved for organic production, nor would there be with potassium bicarbonate.
7. The production of 'heritage' varieties for some retailers provides particular challenges because of the limited resistance of some of these cultivars, to diseases in particular.
8. The development of biocontrol agents (BCAs) for disease control as an alternative to pesticides should be monitored. Recent results (HDC Project PC 174) have shown promise for the control of Botrytis.
9. The acceptance of materials for pest control through a physical mode of action as not being pesticides, and therefore not having to comply with pesticide legislation, should be considered. Examples are glucose polymers and polysaccharides e.g. Eradicoat, Majestik and Agri-50E respectively.

Appendix 5 Guidelines for Minimising Pesticide Residues in British Protected Tomato Crops (Cont'd)**Recommendations for minimising residues****Generic recommendations**

1. Avoid pesticide use by:

- good husbandry, including irrigation and nutrition.
- good site hygiene.
- use of clean plant material and resistant cultivars.
- use of biocontrol agents for pest control, and when available, disease control.
- use of environmental manipulation.
- use of spray materials with physical modes of action (non-pesticides) where appropriate

2. Minimise pesticide use by:

- Maintaining strict routines of crop monitoring to ensure that any remedial action is taken at the first opportunity for greatest effect with least sprays.
- Ensuring adequate training in the recognition of pests, diseases and biocontrol agents by all staff, especially crop workers, to ensure rapid and appropriate response.
- Ensuring adequate training in glasshouse environment control, for disease suppression especially.
- Maintaining and calibrating sprayers with care to ensure efficient spray application. Studies on the vertical boom sprayers used in glasshouse tomato crops indicate poor and uneven application in some cases. This results in under-dosing some parts of the plant, with a consequent risk of poor control and the need for repeat sprays, and over-dosing of other parts with a risk of exceeding MRLs. Factors such as spray nozzle uniformity along the boom, nozzle spray angle and spray volume are all important.
- Ensuring correct dose rate as this may vary according to the target pest and whether on or off label.
- Choosing any pesticides with careful attention to possible side effects on biocontrol agents.

Crop specific recommendations for tomatoes

Techniques which may be used for other crops, such as increasing harvest intervals, are not generally relevant to tomatoes once harvesting has commenced since this lasts for more than 30 weeks and is carried out a number of times per week. All crops are single, long-season monocrops, not single harvest or successional short-term crops.

Appendix 6 Control Points: Tomatoes (Protected)

CS.23 TOMATOES (PROTECTED)

- CS.23.2 Water and nutrients should be re-circulated -
Protocol reference: Section 6
- CS.23.3 If not, steps should be taken to minimise nutrient run-off into soil and water courses -
Protocol reference: Section 6
- CS.23.4 The volume of run-off should be measured and samples analysed -
Protocol reference: Section 6
- CS.23.6 Growers should visit their propagator to inspect young plants -
Protocol reference: Section 5
- CS.23.7 You must have written procedures for the management and recording of incidents involving oil spillages - where fuel oil is used on site
Protocol reference: Section 10
- CS.23.8 Your glasshouses must have appropriate "No Smoking/No Food" signs and your staff provided with a clearly defined area to eat / drink -
Protocol reference: Section 9
- CS.23.9 The introduction and monitoring of biological control agents should be recorded -
Protocol reference: Section 8.11
- CS.23.12 You should seek information on Pepino Mosaic Virus and other emerging virus and viroid diseases
Protocol Reference: Section 8.11