Crop Module: Potatoes
Effective from 1st December 2017 - 31st November 2018:
version 4.0 (Crop Risk Category 3)
This crop specific module for potatoes has been written to complement and avoid duplicating the generic principles of the Red Tractor Farm Assurance Fresh Produce Scheme standards. It is advisable to read the Red Tractor Farm Assurance Fresh Produce standards before reading this crop specific module. This module is designed to stimulate thought in the mind of the reader. It contains crop specific guidance and standards, where applicable, in addition to the requirements stated in the generic Fresh Produce standards.

Within this module the important requirements outlined in the crop specific standards section will be verified during the Red Tractor Farm Assurance assessment and compliance will form a part of the certification/approval decision.

Disclaimer and trade mark acknowledgement

Although every effort has been made to ensure accuracy, Assured Food Standards does not accept any responsibility for errors and omissions. Trade names are only used in this module where use of that specific product is essential. All such products are annotated® and all trademark rights are hereby acknowledged.

Notes: Pesticide Information

The Red Tractor Fresh Produce team has been working with Fera to provide tailored access to the LIAISON database for all Red Tractor Fresh Produce members. This system allows individual growers access to all information for plant protection products approved for use under the Red Tractor Fresh Produce Scheme.

LIAISON can be accessed under the Produce tab via the “Checkers and Services” page where you will also find a user manual. Searches will be filtered specifically for the crops for which you are registered. Once you have logged onto the site and clicked on the LIAISON hyperlink you will be directed to the LIAISON home screen.

You will need a username and password and these will be sent once you have registered:

http://checkers.redtractor.org.uk/rtassurance/services.eb

General Introduction

Following a systematic approach will help growers identify and manage the risks involved in crop production. This module is based on a typical crop production process and 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 precedent over quality and environmental controls. The layout of this module follows the same structure as that used in the Red Tractor Farm Assurance Fresh Produce Standards. The content of the module is reviewed prior to the issue of updated editions. The review process considers both new developments and all relevant technology which has emerged since the last review was completed and which have been found to be both workable by the grower and beneficial to the environment. The aim is to transfer such information and technologies to growers.

Acknowledgements

Red Tractor Farm Assurance Fresh Produce gratefully acknowledges the contribution of Simon Alexander and all consultees in the preparation of this module, particularly the Potato Processors Association and David Hudson Potato Services Limited. Thanks are also due to MG Consulting, the Potato Industry CIPC Stewardship Group (for work on the use of chlorpropham in potato stores) and the Nematicide Stewardship Programme.
STANDARDS

RA.a Key
Growers must follow good hygiene practice and manage their operations in a way that controls food safety problems (or ‘hazards’). A formal risk assessment must be carried out on all crops from planting through to packing and storage and crop production processes to identify any physical, chemical, allergenic or microbiological food safety risks (hazards) (REVISED)

- If you are supplying potato processing factories your Risk Assessment considers proximity to areas such as roads, lay-bys, footpaths and golf courses, or any source of golf balls, in terms of the risk of foreign body contamination e.g. golf balls, broken glass

SC.e
Where contractors are employed to undertake work on the production of crops, a Contractors’ Commitment Document is in place which confirms that the contractor will comply with the Red Tractor Assurance for Farms - Fresh Produce Standards

- This includes any CIPC applications made by a contractor

HOW YOU WILL BE MEASURED
additional crop specific requirements

RECORDS (to be kept for 2 years)

- Risk Assessment

- Contractors’ Commitment Document
<table>
<thead>
<tr>
<th>STANDARDS</th>
<th>HOW YOU WILL BE MEASURED</th>
<th>RECORDS (to be kept for 2 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EC.g Key</strong>&lt;br&gt;PPP application must be undertaken by competent operators</td>
<td>- Nematicide granules are applied by those who hold a PA4 or PA4G certificate&lt;br&gt;- CIPC fog applied by those who hold PA1 and PA9, CIPC liquid over a roller table application by PA12 certificates&lt;br&gt;- If CIPC applications are made by a contractor they are a member of the National Association of Agricultural Contractors “Applicator Group”</td>
<td>- PA certificates&lt;br&gt;- Proof that contractors applying CIPC are a member of the NAAC “Applicator Group”</td>
</tr>
<tr>
<td><strong>EC.h</strong>&lt;br&gt;Records must be kept of all PPP applications for a minimum of three years</td>
<td>- This includes records of all CIPC applications (see the draft CIPC application record provided in Appendix 2 of the Potato Guidance Module)&lt;br&gt;- CIPC application records must contain the following:&lt;br&gt;  - The date and name of the person requesting and or formally advising CIPC application&lt;br&gt;  - The date of application of CIPC and the specific machine used in the application&lt;br&gt;  - The CIPC product name, MAPP number and dose&lt;br&gt;  - The reason/s for the timing and dose of the application&lt;br&gt;  - A declaration when the store may be re-treated with CIPC and when the crop may be moved from the store for sale or processing&lt;br&gt;  - Confirmation of recognition of the date/s of all previous applications&lt;br&gt;  - Confirmation that all application intervals have been observed&lt;br&gt;  - Any problems or irregularities that were noticed during application, e.g. excessive store leaks, temperature gradients in the store, inadequate “draw” of fog into the store, CIPC spillage, any difficulties in producing the fog&lt;br&gt;  - Batch number/s of the product/s used&lt;br&gt;  - Confirmation of the tonnage treated and volume (active substance) of CIPC used&lt;br&gt;  - Total CIPC active substance applied to each “lot” of potatoes</td>
<td>- PPP application records</td>
</tr>
<tr>
<td><strong>EC.i</strong>&lt;br&gt;All PPP application equipment must be maintained and tested</td>
<td>- This includes all CIPC application equipment&lt;br&gt;- CIPC foggers must be tested annually.</td>
<td>- NSTS certificates for CIPC application equipment</td>
</tr>
<tr>
<td><strong>HS.g</strong>&lt;br&gt;All tools, equipment, crates, boxes and transportation used in direct contact with the product during harvesting must be kept clean and routinely maintained’ and add (REVISED)</td>
<td>- This includes boxes or crates used for ware potatoes</td>
<td>- Cleaning record&lt;br&gt;- Cleaning schedules&lt;br&gt;- Maintenance schedules</td>
</tr>
</tbody>
</table>
### CROP SPECIFIC STANDARDS

<table>
<thead>
<tr>
<th>STANDARDS</th>
<th>HOW YOU WILL BE MEASURED</th>
<th>RECORDS (to be kept for 2 years)</th>
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</thead>
<tbody>
<tr>
<td>C4.47.a</td>
<td>Minimum active per ha is used to avoid drainage and runoff losses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maximum application rate 210g metaldehoy a.s/ha* For additional protection of water, suppliers/BASIS advisors may recommend rates reduced to 160g a.s/ha or less*</td>
<td></td>
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<tr>
<td></td>
<td>Maximum total dose from 1st August to 31st December: 210g metaldehyde a.s/ha* For additional protection of water, suppliers/BASIS advisors may recommend rates reduced to 160g a.s/ha or less*</td>
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<tr>
<td></td>
<td>Maximum total dose rate: 700g metaldehyde a.s/ha/calendar year*</td>
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<tr>
<td></td>
<td>No pellets are applied within 6 metres of a watercourse</td>
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<td></td>
<td>No applications made when heavy rain is forecast</td>
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<tr>
<td></td>
<td>If drains are flowing there is no application of metaldehyde based slug pellets *from any combination of metaldehyde products. 700g is also the statutory limit a.s.: active substance (or active ingredient)</td>
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<tr>
<td></td>
<td>Farm map showing areas of high pollution risk</td>
<td></td>
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<tr>
<td></td>
<td>Metaldehyde application records</td>
<td></td>
</tr>
<tr>
<td>C4.47.b</td>
<td>Potato dumps are free of green potato growth</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diary note confirming when dumps were inspected and/ or growth treated</td>
<td></td>
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<tr>
<td>C4.47.c</td>
<td>Blight sprays are applied according to crop risk (weather conditions, disease in the locality, stage of crop growth)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Records of stage of crop growth</td>
<td></td>
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<tr>
<td></td>
<td>Local blight records e.g DSS systems or Pot Council “Blight watch” records</td>
<td></td>
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<tr>
<td>C4.47.d</td>
<td>Crops are segregated by dormancy characteristics, Maleic hydrazide application, variety and duration of storage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Store plans showing varieties &amp; unloading dates</td>
<td></td>
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<tr>
<td>C4.47.e</td>
<td>A list of all the stores (owned and/ or rented) where CIPC is used must be held</td>
<td></td>
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<tr>
<td></td>
<td>List of stores where CIPC has been used</td>
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<tr>
<td>C4.47.f</td>
<td>Prevent CIPC contamination of crops other than ware potatoes by restricting the store to ware potatoes only</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hard backed sign screwed or bolted to the building</td>
<td></td>
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<tr>
<td>C4.47.g</td>
<td>Potato stores are in the appropriate state of repair</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completed CIPC Store Checklist(s) for each store &amp; each CIPC application</td>
<td></td>
</tr>
<tr>
<td>C4.47.h</td>
<td>Crops stored below 5°C are treated once only and before they are cooled below 7°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Advisers recommendation record for each CIPC application</td>
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</tbody>
</table>

*Note: CIPC stands for Carbendazim, Propiconazole, and Thiram.*
The use of healthy seed can reduce the level of pesticides applied to the subsequent ware crop. When selecting seed potatoes, growers should recognise the effect that location, health, management and handling of the seed crop have on the ware crop.

Growers should aim to purchase seed from seed producers within the Safe Haven Certification Scheme. The scheme offers strong protection from imported diseases such as ring rot.

Seed should be purchased on its quality rather than price alone.

A good relationship with the seed supplier is essential. A direct dialogue between the seed and ware growers in all matters concerning the seed crop husbandry and treatments is important. Seed should be supplied to an agreed production and tuber specification to suit to the intended ware market.

Seed suppliers should provide the following details:

- agent
- growers name and address
- date of tuber initiation
- tuber count
- date crop loaded in store
- details of all post-harvest chemicals and dates of application

Husbandry records of seed crop in field and store should be available to the ware grower on request.

Statutory seed classification can only be a very general guide to crop health. In order to ensure compliance with the certification tolerances, growers should be aware of the specifications associated with each seed grade.

All treatments should be discussed between seed producer and buyer. Fungicide use should be tailored to variety, seed health status and the intended market outlet for the subsequent ware crop. Judicious choice of fungicides for the seed crop can result in reduced need for chemical treatment of the ware crop. Fungicide treatments are not a substitute for sound husbandry.

Application of fungicides to potato tubers

Most potato fungicides only protect against or suppress the development of disease and have no curative effect. Tubers should be largely free from soil so that the fungicide is applied directly on to the skin and target organism. The entire tuber surface should be covered by fungicide for effective control of silver scurf.


Powdery scab (Spongospora subterranea)

Cultural control: The main methods of control are cultural (see Environmental Section).

Chemical control: No effective chemical controls are available. There is an EAMU recommendation for fluazinam in seed crops.
Stem canker/black scurf (*Rhizoctonia solani*)

Cultural control: Wider rotation and techniques to encourage early shoot emergence can reduce the effects of *Rhizoctonia*. See Environmental Protection Section

Chemical control: There are effective seed and soil treatments.

Dry rot (*Fusarium spp.*)

Also see Environmental Protection Section

Cultural control: Minimise tuber damage when handling and avoid excessive handling. Unfortunately, early harvesting which assists the control of other diseases can encourage *Fusarium*. Good skin set and appropriate store management will help prevent infection.

Chemical control: Seed tuber treatments can give reasonable control when they are applied at harvest. Some strains of *Fusarium* are resistant to thiabendazole.

Gangrene and skin spot (*Phoma exigua* and *Polyscytalum pustulans*)

Also see Environmental Protection Section

Cultural control: Like many seed-borne diseases, gangrene and skin spot can be controlled by an integrated seed disease management strategy which involves:

- choosing drier, warmer seed production sites
- desiccating early with a fast acting chemical
- harvesting early and carefully in dry, warm soil conditions
- handling gently
- perhaps treating with a fungicide
- drying the crop thoroughly and keeping the crop dry
- curing properly
- storing at 4°C
- cleaning the seed store and containers prior to loading

VARIETAL SUSCEPTIBILITY VARIATES AND THIS SHOULD BE CONSIDERED ON CERTAIN SEED PRODUCTION SITES.

Chemical control: Chemical treatment is a small part of an overall control strategy for gangrene and skin spot. Liquid fungicide sprays at store loading may help.

Silver scurf (*Helminthosporium solani*)

Also see Environmental Protection Section

Cultural control: Strategies to control gangrene and skin spot will also help control Silver scurf. Cool (below 4°C) storage reduces the development of silver scurf. This may conflict with the need to sprout some seed.

Chemical control: If needed fungicides can be applied to seed stocks, either as soon as possible after lifting to prevent infection, or later to suppress sporulation and infection. Some strains of silver scurf are now resistant to thiabendazole.

Black dot (*Colletotrichum coccodes*)

See Environmental Protection Section

Blackleg (*Pectobacterium spp.*)

Also see Environmental Protection Section

Cultural Control: Current varieties vary in their susceptibility to blackleg. There are no guaranteed control methods for blackleg but seed producers and ware growers can minimise the risk of infection by the adopting the following procedures:

- choose warmer, drier production sites for susceptible varieties
- stock seed (of known origin) should be stored cold and dry
- avoid poorly structured compacted growing sites
- plant in warm kind seed beds
- handle seed very gently
- fertilise correctly
- consider disease risk before deciding on whether to irrigate the most susceptible varieties and desiccate early and completely, ensuring a quick haulm kill to reduce bacterial spread
- harvest early on dry days and in good soil conditions
- positively dry the crop at store loading
- keep the crop cold and dry after curing, during transit and in store on the ware farm
- representative seed samples can be tested for blackleg bacterial loading. This test gives an indication of blackleg risk in the growing crop at the time of the test. Bacterial levels on seed can change very quickly, reduced by good practice and increased by poor practice
- scheduling of seed deliveries onto farm to ensure that it is inspected, handled and managed in a timely manner to preserve seed quality
Blackleg caused by Dickeya species

A new bacterial pathogen, Dickeya solani has emerged in Europe. It is a more aggressive but close relative of Dickeya dianthicola (used to be called Erwinia chrysanthemi). Seed stocks in Holland have been badly affected.

Specific control measures are yet to be developed but the controls listed above for Pectobacterium are appropriate for Dickeya. Seed is the most important source of infection and so careful seed sourcing is vital. The Safe Haven seed certification scheme will help growers avoid this new potato disease.

Viruses in seed crops

Virus diseases have to be kept at very low levels in seed crops. Virus control in seed crops involves isolation, roguing, aphid protection and early burn off. Aphicides are less effective in controlling non-persistent viruses like Potato virus Y than persistent viruses such as Potato Leaf Roll Virus. Use of certified seed helps minimise virus levels in the ware crop.

CHEMICAL CONTAMINATION OF SEED

Glyphosate contamination of seed potato crops

Contamination with glyphosate (eg. Roundup) by drift from neighbouring crops and via inadequately cleaned sprayer tanks can have a significant impact on seed viability and vigour. Seed producers should have a management plan to avoid this damaging problem. See Potato Council, “Glyphosate damage in seed potatoes” 2008 and additional guidance leaflets and stickers in 2011.

SEED HANDLING AND STORAGE

Grading facilities

At dressing out time it should be possible to size grade the seed crop and where necessary spray the various fractions in a single operation. Careful handling of warm (8-10°C) seed will prevent damage and disease.

Harvesting dates

Early desiccation and harvest will significantly reduce the incidence of bacterial, fungal and viral disease.

Inspection procedures

Official inspection of seed crops is mandatory but ware producers are encouraged to look at the growing crop and or stored seed crop themselves prior to delivery where possible.

Storage of the seed crop

Many potato storage problems are the result of poor store management techniques. Good store management with close store monitoring will reduce the need for post-harvest storage chemicals and ensure high storage out turns.

Good potato store managers will:

- only store potatoes which have adequately set skins, are relatively soil and damage free, have not been rained on and are unaffected by blight or blackleg
- monitor the store regularly, and record store temperatures and fan run hours from the date of loading
- dry and cure the crop as soon as it is loaded into store
- keep the crop at a steady holding temperature
- never tolerate condensation
- only handle potatoes at temperatures of at least 8°C and handle carefully at all times
- only store the crop in clean buildings and containers

SEED DELIVERY PRE PLANTING

Pre delivery

Before each load of seed is delivered the grower should have the following information:

- Variety
- Certification Grade
- Size grade (size split where applicable)
- Tonnes (total and tonnage of each size split where applicable)
- Size grade (split where split grade)
- Delivery date and estimated time
- Haulier contact details

At delivery

All seed should be examined on delivery to ensure that it matches the order documents and is of the quality expected. If the seed is not up to standard it is important that you contact your supplier immediately. Each bag should have an official label with details matching the variety, grade and size ordered and notified pre delivery. There should also be an official seal which is intact on delivery to seal the bag or box holding the seed.
Post delivery

Management of the delivered consignment very much depends on interval between delivery and planting. Jumbo bags are primarily a transport device and not designed for storage. There are currently efforts to make them more suited to short/medium term storage of seed but currently this is not the case.

Where seed is being planted within a few days it may be acceptable to leave the seed in bags but they must be given adequate space between them to ensure air circulation, ideally 15-30cm gap. Air movement can be either natural or assisted by fans.

Where seed is to be held for 1-2 weeks it should ideally be decanted from bags to boxes. If it is to be left in bags the management needs to considered and the seed given due attention to ensure it does not sweat or sprout. The same comments as above on airflow apply. With more time in bags the risk of the middle of the bag condensating becomes greater and this is associated with the risk of increased bacterial levels.

If the seed is to be on farm for more than 2 weeks after delivery the bags should be decanted into boxes and not left in bags. In boxes it should be cured and dried and then ideally placed in a seed store and temperatures stabilized, bringing the crop down to approximately 3°C if storage will be long term. If designated seed storage is not available, in order to minimise the risk of condensation and sprouting, temporary systems can be considered. Temporary plenums etc. can be used to help maintain seed quality and have some temperature regulation effect. These simple temporary systems, combined with regular inspections of the seed condition and temperature can do an adequate job for approximately 3-4 weeks.

Further information is available from the AHDB "PCL Technical note TN03 Best practice for seed handling and storage” 2013.

Home-saved seed

Saving “seed” from ware crops with appropriate management and storage facilities can produce suitable quality seed. Growers using home saved seed should be aware that the aphicide application rates will vary according to whether the crop is a seed or ware crop. Many ware potato buyers will not accept the routine use of aphicides to protect ware crops from virus.

Seed can carry and therefore spread nematode cysts. Growers using their own “seed” ensure that they comprehensively test the field for PCN prior to planting. If any PCN are found there is a risk of the seed spreading the pest. Certified seed is only produced on land tested to be free of potato cyst nematode.

SITE AND SOIL MANAGEMENT

SITE SELECTION

Perfect potato sites and soils are rare and in practice a wide range of soils are capable of growing good crops of potatoes using appropriate management techniques such as cultivation to suit the soil type and condition, de-stoning and de-clodding.

Field selection procedure should involve a written assessment of the risk of hazardous foreign objects in the soil as well as an assessment of previous potato cropping, soil borne pests and diseases and weeds.

Free draining soils make management easier, alleviating planting and harvesting problems. Physical or chemical soil pans should be rectified to avoid rooting depth restriction.

Effective drainage systems and high soil organic matter will improve soil structure.

Environmental considerations

Sites for potato production should not harm the local environment. Potato cropping should be compatible with the existing conservation interest of the site particularly in the case of unimproved or semi-natural habitats.

Potato crops should not damage sites of archaeological interest.

Landowners have a statutory obligation under the Ancient Monument and Archaeological Areas Act 1979 to protect scheduled Ancient Monuments and Historic Buildings on their property.

CROP ROTATIONS

Pest and disease considerations: wide rotations (at least 1 in 6 and preferably wider) are desirable. Close rotations increase the risk of potato cyst nematode (PCN) and other soil-borne problems such as Rhizoctonia and Black Dot, which reduce yield and tuber quality.

Double and continuous cropping: double cropping and rotations closer than 1 in 5 will rapidly build-up potato cyst nematodes, Rhizoctonia and volunteers. Other soil-borne problems (Black dot, powdery scab and Verticillium spp.) will also become a nuisance.

Weed considerations

Most annual weed problems can be dealt with within the potato crop. Perennial weeds are difficult to control in potatoes and can have detrimental effects on both yield and efficiency of harvesting. Perennial weeds should be controlled through the preceeding rotation.
Volunteer considerations

Close potato rotations increase the risk of volunteer problems. Volunteer potatoes can act as carry-over hosts for many potato pests and diseases.

Volunteer potato control strategy

Volunteer potatoes are very difficult to control in any crop but an integrated control strategy will help contain this problem:

- grow potatoes in as wide a rotation as possible;
- lift potato crop early in kind soil conditions;
- leave as few small or waste potatoes in fields after harvest as possible;
- avoid or delay ploughing after potatoes;
- use glyphosate pre or post-harvest in cereal crops, ensuring optimal timing in stubbles as applications made too early will only kill haulm and not daughter tubers that will have already formed;
- consider volunteer potato control, when planning broad leaved weed in all crops in the rotation i.e. spring herbicides in cereals to target the volunteers;
- maleic hydrazide should only be used where market outlets permit and only if application conditions are ideal (this product leaves permissible residues in the tuber even when used according to the label);

Specific scientific predictive tests

See the Environmental Protection Section: Potato cyst nematode (PCN), free living nematodes (FLN), Spraing (Tobacco rattle virus), Spraing (Potato mop top virus) and Wireworm. Soil tests are now available for Black dot and Rhizoctonia.

SOIL MANAGEMENT AT PLANTING

Aim for a tilth as free of large clods as possible. Excessive and or over deep cultivation is expensive, time consuming, damages soil structure and reduces yield. Current potato harvesters extract smaller clods and stones effectively.


ENVIRONMENTAL PROTECTION & CONTAMINATION CONTROL

THE BASIC APPROACH TO CROP PROTECTION

INTEGRATED CROP MANAGEMENT

Preparation of seed for planting

The use of healthy seed will improve yield and crop quality and reduce the need for pesticide applications to the growing and stored ware crop.

Production systems for healthy seed combine the following good potato husbandry points:

- in general select light soils in relatively warm, dry locations
- plant high quality stock seed into “kind” seedbeds
- destroy haulm early, ensuring as quick a kill as possible to reduce the risk of disease spread
- harvest gently in good soil conditions
- consider fungicide use at store loading
- once in store, dry the crop with forced ventilation
- cure the crop thoroughly
- store at a constant temperature avoiding condensation
- store in clean buildings and containers. Stores should be swept and ideally hoovered to remove all dust. When necessary fumigate with approved products. Wash and disinfect boxes as necessary
- handle crop at temperatures over 8°C

Physiological and chronological age of the planted seed

The optimum physiological and chronological age for seed will depend on variety, planting and harvest dates and intended market.

All seed should have open eyes at planting and should be cooler than the soil temperature. Avoid damage to the eyes (sprouts). Many seed handling systems will not be gentle enough to preserve sprouted seed so aim for seed to be no more sprouted than the planter and handling system can cope with.
Storage of seed on the ware growing farm

The principles of seed acceptance and post-delivery handling are the same for ware and seed growers. Refer to the earlier section on “Seed delivery pre planting”.

Lighting

For seed sprouted in trays or crates adequate light is required for the production of strong green chits. Inadequate lighting will result in white, weak and elongated sprouts that are likely to be knocked off at planting.

Fungicides

Fungicides to control seed-borne diseases can be applied by the ware grower pre-sprouting, as a liquid over a roller table or as dusts on the planter. All seed fungicides can sometimes, for unknown reasons, have phytotoxic effects. Follow label instructions very carefully.

Choice of product, if any, depends on the intended market, previous products applied, the diseases found and likely problems.

Residues of seed fungicides are appearing in routine ware potato residue testing programmes. This may be due to “contamination” of potato boxes whilst in use as seed containers. Don’t use seed boxes for ware potatoes and always inspect ware boxes prior to filling. Contaminated or dirty boxes have to be cleaned before they are used for ware potatoes.

PEST, DISEASE, PHYSIOLOGICAL DISORDERS AND WEED CONTROL IN WARE CROPS

PEST CONTROL

Integrated pest control systems ensure that chemical treatments are only used when absolutely necessary. Pesticide choice should be based on:

- identification of the pest and estimate of its likely damage
- use of non-chemical control methods
- level of known resistance to specific chemicals by pest in the region
- level of known resistance and tolerance in the variety
- prevention of resistance build up
- level of control required
- harvest date/interval
- previous chemical applications

Potato cyst nematode (PCN)

PCN is the most important and most widely distributed pest of potatoes in the UK, affecting both yield and quality of potatoes.

Tolerance vs Resistance

Tolerance – the ability of the host (potato variety) to withstand or recover from damage by the pathogen and produce a yield.

Resistance – the ability of the host (potato variety) to prevent or restrict multiplication of the pathogen.

PLANT PROTECTION PRODUCT CHOICE

APPROVED USES NOT INCLUDED ON THE PRODUCT LABEL

Product labels, particularly for minor crops, do not include all of the approved uses. Growers can check the approval notice of a particular product using the LIAISON® search accessible via their RED TRACTOR Farm Assurance home page after logging in.

A search on the ‘Extension of Authorisation for Minor Use’ (EAMU) page of LIAISON® by crop or product name should yield a results page. A click on the product name should link to a summary of the approval information. Near the bottom of the summary is the specific off-label number (e.g. 0246/09) and this link will open up a pdf of the current EAMU document giving details of the extension of use.
Site selection

Wherever there is potential for PCN presence, fields to be cropped with potatoes need to be soil sampled and when possible the PCN species identified. Decisions about rotations, varieties and the need for chemical treatment can only be made on the basis of soil sampling and previous records.

Soil sampling should be undertaken according to the best practice outlined by the product manufacturers.

Interpretation of soil sampling results

Soil sample results must be interpreted by a BASIS qualified advisor who is on the Professional Register who will take into account the following factors amongst others

- soil type
- variety tolerance / resistance
- length of growing season
- resource protection

before deciding on whether any treatment will be necessary.

Integrated control

PCN is most effectively managed by integrating rotation length, chemical control and where appropriate, use of resistant varieties.

In the absence of potatoes PCN levels will decline but the actual decline rate has been found to be very variable. This rate of decline may be even less where potato volunteers are a problem (see Site and Soil Management).

In order to ensure that PCN populations are kept to a manageable level crop rotation is a very important part of the cultural control strategy. Although the use of nematicides and the increased use of resistant varieties plays a significant part, rotations closer than 1 in 6 would be viewed as against best practice and avoided as much as possible.

Resistant varieties

Many commercial varieties have resistance to *Globodera rostochiensis*. Where such varieties have been repeatedly grown there has been a build-up of *G. pallida*. *G. pallida* is more difficult to control due to its slower rate of population decline and its extended hatching period. Varieties should be chosen to avoid *G. pallida* becoming the dominant species.

There are no varieties with complete resistance to *G. pallida* but several have extremely good "partial" resistance. It should be borne in mind that the tolerance of these “resistant” varieties is very variable so the use of nematicides may be necessary for yield protection at levels which may affect the plant. A BASIS qualified advisor will be able to assess this situation.

Using potato varieties with high PCN tolerance such as Cara, but little or no resistance will build up PCN populations very quickly.

Trap cropping and biofumigation.

Both of the following PCN control strategies can be very useful in the management and control of PCN. They should be backed up with the use of nematicides and resistant varieties when growing the crop.

Trap cropping with *Solanum sisymbriifolium* (Sticky nightshade).

This relative of the potato has roots that stimulate the hatch but prevent the development of potato nematode cysts. *S sisymbriifolium* can be very difficult to establish as it requires warm, moist conditions to germinate so timing of drilling is very important to aid this. Breeding work is ongoing to improve varieties for the UK climate. It has been shown to be effective at reducing levels of PCN if the crop can be established and grown well, producing an ample root system.
Glucosinolate rich bio-fumigants (mustards and radishes)

The production of glucosinolate rich brassica crops has been shown to have a bio-fumigation effect on PCN when managed in the correct way. Free living nematode numbers have also been reduced with the use of bio fumigants.

It does require the crop to be grown, from seed selection through to incorporation, with as much thought and consideration as for any other commercial crop and not treated as just another cover crop of mustard.

Chemical control: Economic potato production will often require chemical control as part of an integrated control programme. Nematicide use depends on PCN numbers and species present, potato variety chosen, soil type and length of rotation. This information will be used by a BASIS qualified advisor to decide whether the field will need to be treated with a nematicide or not. When considering whether to use nematicides the growing period length must be considered to ensure harvest interval compliance.

Nematicide Stewardship

Accurate and complete incorporation of nematicide granules is vital. By March 2017 all staff applying nematicides must have attended the Industry Stewardship Training Module. The training certificate does not have an expiry date. Further training will only be required when best practice modules change.

Growers must be aware of and follow guidance in the new “Nematicide Application Module” (see Appendix)

In order to apply nematicides, the operator must hold a PA1 certificate and either a PA(SC) for on planter applications or a PA4/PA4G for on planter and other methods of application. The PA4 is an older qualification that qualifies the operator but the PA4G is more specific to granule application. All nematicide applicators must be members of NRoSO. Any operator passing their PA2 pre 1994 is also covered to apply nematicides.

Where a nematicide has been used, there must be a system in place to ensure that the field is checked within 24-48 hours for bird or mammal carcasses. Any suspect carcasses found need to be reported to the Wildlife Incident Investigation Scheme on their freephone number 0800 321600 and further advice taken from them.

Spraying (Tobacco Rattle Virus)

The virus is restricted mainly to light sandy soils in which the free-living nematode vectors (stubby-root nematodes) are common. In some seasons susceptible varieties can be severely affected, with tubers being unacceptable for sale yet impossible to grade out.

Correct identification of “damage” is important. Tobacco Rattle Virus can be confused with Mop Top Virus and Internal Rust Spot. Reliable laboratory tests are available.

Site selection

Soil sampling for the nematode vectors and previous experience of problems can give a guide to likely problems but laboratory soil tests can now identify the virus and provide a better assessment of risk. The ideal density of testing is uncertain due to the very patchy nature of the virus. Fields with high populations of virus infected stubby-root nematode should only be cropped after careful choice of variety. Knowledge of the history of symptoms seen in previous potato crops will be an extremely useful indicator in the risk for the coming crop.

Resistant varieties

Varieties are known as “Spraying resistant varieties” (rarely infected and show no symptoms) “Spraying sensitive” varieties (show symptoms) and “Spraying susceptible” varieties (which may not show symptoms but can carry the virus). Resistant varieties can be useful on problem sites.

Cultural control: As the Spraying virus infects many common weeds, such as fat hen, knotgrass, bindweed and field pansy, good weed control between potato crops may be helpful. Good machinery hygiene is important as the virus can be transmitted in a small proportion of weed seeds. Soil movement is thought to have little impact on virus spread from field to field. Growing barley in rotation with potatoes on fields with a history of Spraying may also help to reduce virus incidence. Once TRV is present in the soil it will be very difficult to remove. Choose seed and seed sources with care especially from sandy soils. A seed test on susceptible varieties could identify the virus and prevent its introduction to “clean” fields. As the free living nematodes move more freely the wetter the soil, ensure that irrigation is scheduled to avoid over irrigation.

Chemical control: In fields with a known history of Spraying, where nematode levels are high and the TRV virus has been identified do not crop with a “Spraying sensitive” variety even with chemical treatment. Nematicides only give a reduction in Spraying symptoms with “Spraying sensitive” varieties

Poorly managed “in furrow” application of granular nematicide may be a cause of tuber residues of nematicide and result in poor control of spraying. Not all nematicides have an “in furrow” recommendation so check the label prior to application.

Growers should follow guidance in the new “Nematicide Application Module” (see Appendix)
Slugs

Crops grown on heavy, cloddy soils or fields with a history of previous damage are most at risk from slug damage. Slug damage is often difficult to predict or reduce. The pest is starting to become more common on land that would not have historically been considered ‘sluggy’ land due to oilseed rape being in the rotation. For further information see AHDB Information sheet no 2 – Integrated Slug Control (2015).

Varetal susceptibility
Select less susceptible varieties on slug prone sites.

Cultural control: Rotation, rainfall, variety, incorporation of organic matter, soil type and trash carry over from the previous crop all affect slug populations. The production of a fine soil tilth will suppress slug activity. Damage can be limited by lifting the crop as early as possible.

Parasitic nematodes are now commercially available as biological control but their efficacy on slugs in potatoes is not proven.

Chemical control: Whilst test baiting can give an indication of activity of slugs on the soil surface and may assist in accurate timing of application of slug pellets. Prophylactic treatment in high-risk situations may be appropriate.

Follow the Metaldehyde Stewardship Group Best Practice Guidelines to avoid contaminating ground water (www.getpelletwise.co.uk).

Wireworms

Large wireworm populations occur only in permanent grassland but commercially significant wireworm damage is not unusual in crops grown on old arable soils.

Site selection: There is a high risk of wireworm damage to potatoes grown immediately after grass which has been down for 5 or more years; even in the 2nd, 3rd and sometimes 4th year after grass, wireworms can still be a problem. As chemical controls are only partially effective, cropping with potatoes after grass should be avoided.

Fellow the Metaldehyde Stewardship Group Best Practice Guidelines to avoid contaminating ground water (www.getpelletwise.co.uk).

Wireworm attack is also affected by bulk density and sand content of the soil, grass species diversity of the old sward and field aspect. However these relationships are not reliable enough to predict damaging populations.

Cultural control: The control of wireworms by cultural methods cannot be relied upon to prevent damage to potatoes grown soon after ploughing-in old grassland. However, once in an arable rotation, wireworm populations decline over a period of 3 to 4 years. Early harvesting may avoid some damage as the longer the crop is in the ground the worse the damage becomes. There are no resistant varieties but early bulking varieties may be ready to harvest before wireworm attack, usually in the late summer.

Buried, fresh carrot traps in the crop prior to potatoes may give an indication of likely wireworm problems in the potato crop.

Pheromone trapping of adult beetles in the field in the year prior to planting potatoes has unfortunately not proved to be a reliable indicator of tuber damage.

Intensive crop husbandry (lots of cultivation and generous use of crop protection products) in other crops in rotation with potatoes is often most effective in reducing and keeping wireworm populations down.

Chemical control: Soil sampling for wireworm larvae can be a guide to likely damage but it is certainly not reliable. Specially baited traps using germinating cereals in the ploughed land may help guide the need for chemical treatment as long as soil conditions allow for wireworm activity. Local knowledge and chemical control in crops previous to potatoes are important.

The approved products (nematicide / insecticide granules) can give a reduction in wireworm damage, not control.

For further information see the Grower Advice – Wireworm factsheet (2011)

Growers should follow guidance in the new “Nematicide Application Module” (see Appendix)

Cutworms

Cutworm attacks can be severe, if somewhat sporadic. Serious damage is usually confined to un-irrigated, light land crops in Eastern England in long, hot, dry summers.

Forecasting cutworm attacks

Pheromone traps may be used to catch moths, but moth numbers are not a direct guide to correct spray timing. Spray timings should be based on dynamic models of egg and larval development (see the Horticultural Development Council www.horticulture.ahdb.org.uk). A minimum of 10 mm irrigation or rain, correctly timed, can give effective control of young cutworm larvae, and reduce the need for chemical treatment.

Cultural control: Backward (open canopy) crops are more prone to cutworm damage. Early planting and rapid establishment of a complete canopy minimise the risk of damage. Because young cutworms cannot survive
in wet soil, frequent irrigation will help to prevent the development of damaging infestations. Irrigation can be timed to coincide with the presence of larvae in their first or second instar.

**Chemical control:** If a crop is considered to be at risk and irrigation or rain is not timely an insecticide should be applied according to local spray warnings.

See Horticultural Development Council (www.horticulture.ahdb.org.uk)

**Aphids**

In most years control of aphids in ware potato crops is unnecessary. However in some years heavy aphid feeding on the haulm can reduce yield and in a few varieties virus spread may be a problem.

**Cultural control:** Planting healthy, virus free seed from either classified seed crops or crops on which a virus test has been conducted will reduce the risk of virus spread in the ware crop.

**Crop monitoring**

Monitor ware crops regularly from May to July. Spraying will only be worthwhile if aphid numbers start to increase rapidly before end of July and if hot dry weather is forecast. Varieties susceptible to direct feeding damage may need to be sprayed a little earlier.

**Chemical control:** before resorting to chemical control, take into consideration:

- location of crop
- over-wintering of aphid
- time of year
- aphid species and numbers present
- presence of aphid predators
- presence of bees especially when the crop has flowers or weeds in a crop flower
- recent weather patterns and weather forecast
- susceptibility of variety to aphid feeding damage
- importance of prevention of virus spread
- tolerance and resistance of variety to virus infection
- aphid resistance to chemicals

Feeding damage is less of a problem than is generally been assumed. The established threshold for feeding damage of 3 to 5 aphids per true potato leaf may be conservative for most varieties.

**Aphid resistance and aphicide choice in ware crops**

The Peach potato aphid, *Myzus persicae* can now be found with three different types of insecticide resistance. It is possible for some strains of *M. persicae* to have all three types of resistance which makes them immune to organophosphate, pirimicarb and pyrethroid insecticides. Organophosphate aphicides (and pirimicarb from 31/07/2017) are no longer approved for potatoes.

The three types of resistance are esterase or E4, “Mace” and knockdown or kdr. The resistance mechanisms prevent certain insecticides from affecting the aphid.

There are newer insecticides that have no resistance problems yet acetamiprid (InSyst), flonicamid (Teppeki), pymetrozine (Plenum), thiacloprid (Biscaya) and thiamethoxam (Actara). Where an aphicide has to be used the choice should be based on:

- environmental considerations, including the aphid predators present
- aphid species in the crop and persistence of the chemical
- level and type of *M. persicae* resistance in the region if known
- prevention of resistance build up
- only one neonicotinoid product permitted on ware crops
- where applicable the type of insecticide used for cutworm control in the potato crop and in other crops near the potatoes

Pyrethroid products kill more beneficial predators than aphicides from other chemical groups. *M persicae* and grain aphids are now commonly resistant to pyrethroid insecticides. Pyrethroid products are best avoided on ware crops.

Where a population of predators is present or can be established, one well-timed application of acetamiprid, flonicamid, pymetrozine, thiacloprid or thiamethoxam could allow natural predators to keep aphids below economic thresholds. Pirimicarb insecticides give no control of Mace resistant aphids or *Aphis gossypii* the Melon Cotton Aphid. If a second aphicide application is necessary, use a material with a different mode of action.
### Potato aphicides and their modes of action

<table>
<thead>
<tr>
<th>Trade name</th>
<th>Active ingredient</th>
<th>Chemical group</th>
<th>Mode of action</th>
<th>Resistance problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aphox &amp; Phantom</td>
<td>Pirimicarb</td>
<td>Dimethyl carbamate</td>
<td>Acetylcholinesterase inhibitor</td>
<td>Mace &amp; some E4</td>
</tr>
<tr>
<td>Actara</td>
<td>Thiamethoxam</td>
<td>Nicotinoids</td>
<td>Acetylcholine receptor agonist</td>
<td>None yet</td>
</tr>
<tr>
<td>InSyst</td>
<td>Acetamiprid</td>
<td>Nicotinoids</td>
<td>Acetylcholine receptor agonist</td>
<td>None yet</td>
</tr>
<tr>
<td>Biscaya</td>
<td>Thiacloprid</td>
<td>Nicotinoids</td>
<td>Acetylcholine receptor agonist</td>
<td>None yet</td>
</tr>
<tr>
<td>Hallmark</td>
<td>Lambda cyhalothrin</td>
<td>Pyrethroid</td>
<td>sodium channel modulator</td>
<td>Kdr &amp; some E4</td>
</tr>
<tr>
<td>Plenum</td>
<td>pymetrozine</td>
<td>Pyrimidine</td>
<td>selective feeding blocker</td>
<td>None yet</td>
</tr>
<tr>
<td>Teppeki</td>
<td>fionicamid</td>
<td>Pyridine</td>
<td>feeding inhibitor</td>
<td>None yet</td>
</tr>
</tbody>
</table>

See: Potato Council “Guidelines for preventing and managing insecticide resistance in aphids in potatoes” and also advice from the Insecticide Resistance Action Committee (IRAC) [http://www.irac-online.org](http://www.irac-online.org)

Growers should be aware that the number of repeat applications of aphicide products varies between seed and ware crops. Check the label before application.

### DISEASE CONTROL

#### Introduction

Always try to control disease by using resistant varieties and cultural methods. Chemical seed treatments can reduce disease incidence in the ware crop. If required, the choice of chemical to protect the ware crop should be based on:

- identification of the disease and estimate of likely damage
- environmental considerations
- persistence of the chemical
- level of known pesticide resistance in the region
- prevention of resistance build up
- level of control required
- harvest date/interval
- previous chemical applications
- varietal susceptibility
- market requirements

### The role of potato volunteers or ground keepers

Volunteer potatoes can act as a host for a number of potato diseases and pests. Every effort should be made to control ground keepers (see Site and Soil Management) at every opportunity in the rotation.

### Intensity of rotation and previous cropping

Increasing the frequency of potato cropping, particularly for main crop or longer season varieties, will increase the risk from stem canker, black scurf, black dot, powdery scab and Verticillium wilt.

### Cultivations

Over deep cultivation in wetter soil conditions impedes drainage encouraging bacterial rotting and powdery scab. Very deep planting in difficult soil conditions may increase the incidence of stem canker and encourage blackleg.

### Irrigation

Irrigation applied at tuber initiation and for a further 4 weeks can reduce the severity of common scab. Excessive irrigation increases the risk from powdery scab, blackleg, black dot, pink rot, and creates conditions more favourable to late blight.

### Harvesting

Early harvesting in good soil conditions is the most important cultural means of disease and quality control in the crop.

Early lifting of tubers with set skins reduces the incidence of silver scurf, skin spot, black dot, black scurf and bacterial rots. Late lifting increases the risk of tuber damage and poor fry quality. Avoid lifting tubers for storage with obviously scuffed skins.
Storage

Storage regimes are dictated by market outlet. Very low store temperatures (2 to 3°C) and inadequate curing increase the risk of skin spot and gangrene in susceptible varieties. Higher temperature (8°C+) storage favours the development of silver scurf, back dot, dry rot and bacterial soft rots.

CONTROL OF MAJOR DISEASES IN WARE CROPS

Operators applying crop protection pesticides (soil, tuber or foliar applied) to the crop must hold the appropriate NPTC PA qualifications.

Common scab (Streptomyces spp.)

Molecular testing techniques are confirming the presence of several different scab species or strains. Some of these scabs are not controlled by irrigation and thrive in acid soils.

Cultural control:

- Resistant varieties should be used when possible.
- Common scab is especially prevalent on light sandy soils, after old grassland and sometimes after heavy applications of lime.
- Carefully scheduled irrigation at and after tuber-initiation can reduce common scab on most varieties and soil types.

For further information see the AHDB Potatoes publication – Early Season Irrigation for Scab Control.

Chemical control: None is available.

Late blight (Phytophthora infestans)

Late blight is the most important fungal disease of potatoes. Blight in the crop canopy can spread to the tubers resulting in marketing and storage problems. The blight fungus is changing genetically and current strains in UK are very aggressive and spread very quickly in crops not protected by fungicide.

Several of the newer potato varieties are very susceptible to foliar and tuber blight.

Cultural control:

Choose the most resistant varieties available where possible.

- Haulm growth on potato dumps should be destroyed with chemical desiccant or contained with black plastic sheeting.
- Volunteers / ground keepers should be controlled throughout the rotation.

Seeds stocks should be blight-free.

Depth of planting and ridge building should provide sufficient soil cover to minimise the risk of tuber infection from spores washing down from infected haulm.

Crops that are to be lifted green top are particularly vulnerable to tuber blight even if little foliar blight is visible.

Crops with blight in the canopy should be desiccated and lifting delayed until at least 14 days after complete haulm death.

Blight forecasting techniques (Decision Support Systems) and electronic monitors can be used to determine optimum spray timings and appropriate fungicide type.

Chemical control:

- Blight cannot be eradicated so fungicide sprays have to be prophylactic.
- Decision support systems can accurately predict blight spray timing and often reduce the number of sprays needed over a season.
- Prophylactic spray programmes should start no later than when the plants begin to meet along the rows. If weather conditions are conducive before the plants meet along the row, spraying should begin sooner. If weather conditions are not conducive to blight development, delaying spraying may be an option.
- Subsequent spray timings are dictated by crop risk and disease pressure. These will be determined by locality, local blight pressure, weather conditions, cultural practice, variety and planting date.
- Potato blight spray programmes should use the minimum number of sprays necessary for good blight control.
- Blight spray programmes should be managed until the haulm is completely dead.
- Blight spray programmes should contain a number of different active ingredients with different activity to minimise risk of resistance and to effectively protect the crop from blight.

When blight is established in the crop it is important to follow the instructions on the fungicide label and adhere to good agricultural practice.

There are industry accepted phenylamide, Qol and Qil resistance strategies. Refer to the Fungicide Resistance Action Committee (FRAC) guidelines www.frac.info and product labels for specific details.
**Powdery scab (Spongospora subterranea)**  
Also see Choice of Variety Section.

The disease is both seed and soil-borne. Spores of the fungus persist in the soil for many years. The fungus causes skin blemishes, or gross tuber distortion and it is a vector for potato mop-top virus.

**Cultural control:**
- Powdery scab is often more serious when the soil moisture level fluctuates through the growing season.
- Compaction, poor drainage and cooler temperatures favour the disease.
- The disease risk is high on heavily irrigated light sandy soils. Irrigate with a scheduling scheme to avoid over-watering.
- Select a resistant variety on "problem" sites.
- Avoid obviously infected seed, although the relationship between disease levels on the seed and that on the ware crop is not straightforward.

**Chemical control:** No reliable chemical control is available.

**Stem canker/black scurf (Rhizoctonia solani)**

Stem canker can be damaging in early crops where vigorous, early growth is needed for early bulking of the tubers. In main crops stem canker has a variable effect, according to the ability of the crop to compensate. Some varieties such as Markies react badly and do not compensate to stolon pruning by stem canker. Stem canker can have a significant effect on the root system as well as stolon pruning.

Black scurf on the tubers spoils the appearance of the skin. This is an obvious problem for packing crops but less so for processing crops that will be peeled.

Soil borne inoculum seems to be an increasing problem.

**Cultural control:**
- The fungus is seed and soil-borne.
  - Short rotations should be avoided to prevent a build-up of *Rhizoctonia* in the soil.
- Plant seed free of black scurf if possible.
- Planting seed in good conditions and not too deep will encourage rapid plant emergence and reduce the incidence of stem canker.

**Chemical control:**
- Wash up a sample of every batch of seed to determine macroscopic levels of the disease and seed with obvious black scurf may benefit from fungicide treatment.
- Consider varietal reaction to stem canker and treat if severe and any black scurf is found on the seed.
- Fields with known *Rhizoctonia* risk can be treated with a soil fungicide.
- Eye plug testing of seed and soil tests for *Rhizoctonia solani* may help determine the need for fungicide application.

**Dry rot (Fusarium spp.)**

Also see Choice of Variety Section.

**Cultural control:**
- Good skin set, gentle handling and rapid temperature pull down after curing should reduce incidence of dry rot.
- Very early harvesting in dry, warm soils is conducive to dry rot.

**Chemical control:**
- Fungicides applied at store loading can be effective but thiabendazole resistant strains of *Fusarium* spp. are known to exist.
  - Permissible Thiabendazole and or Imazalil residues can be detected in potatoes that have been correctly treated with these fungicides. Some markets will not use potatoes treated with Thiabendazole or Imazalil.

**Silver scurf (Helminthosporium solani)**

Silver scurf is found on most seed tubers. It is an important skin blemish of stored potatoes for washing and pre-packing.

**Cultural control:**
- Crops should be desiccated early, lifted promptly, dry cured once in store, and then rapidly cooled and stored below 4°C.
- Low temperature storage increases reducing sugar levels in the tubers which may affect their suitability for certain markets.
- Stored crops should be inspected regularly for disease development.
- The disease seems to develop slowly on some varieties.
Chemical control:
- Seed treatments, in conjunction with cultural measures, can help control the disease.

Ware crops may be treated with Thiabendazole and or Imazalil at lifting but control may be disappointing if spray application is uneven or if Thiabendazole resistant strains are present. Permissible residues of Thiabendazole and Imazalil can be detected in potatoes that have been correctly treated. Some markets will not use potatoes treated with Thiabendazole or Imazalil.

Black dot (Colletotrichum coccodes)
Black dot is primarily a soil-borne disease that frequently develops on stems bases and roots. More worrying and costly however is the appearance of black dot on tubers destined for washing and pre-packing.

Cultural control:
- Choose less susceptible varieties.
- Avoid fields which have had a long history of potatoes whenever possible.
- Early lifting, dry curing and rapid cooling to 3°C can reduce black dot development.
- The disease is a particular problem on irrigated peaty soils.
- Close rotations encourage black dot.
- Avoid obviously infected seed.

Chemical control:
- Fungicide soil and seed treatments can be used in conjunction with cultural control methods to avoid black dot on pre-packing potatoes.
- Soil testing for Black dot is now available and may help assess the need for fungicide use.

Operators applying seed and or soil fungicides should have the NPTC PA qualification.

Skin spot (Polyscytalum pustulans)
Also see Choice of Variety Section.

Skin spot is primarily a seed-borne disease but can survive in the soil and on plant debris. Infected tubers can be unsuitable for pre-packing or give peeling problems to potato processors. The disease can also cause stolon and root pruning, symptoms similar to stem canker.

Cultural control:
- Use skin spot free seed from a known source.
- Lift crops early, dry cure and ensure complete healing of wounds.
- Do not apply chlorpropham (CIPC) before the crop is properly cured.
- Stores should be monitored frequently and if the disease is found, the crop should be marketed promptly.
- Low temperature storage and CIPC treatment may exacerbate the disease.

Chemical control:
- Fungicides applied at lifting may help control skin spot. Thiabendazole resistance has been found but its effect on control is not known.

Permissible residues of Thiabendazole and or Imazalil can be detected on correctly treated tubers. Some markets will not use potatoes treated with Thiabendazole or Imazalil.

Blackleg (Erwinia now Pectobacterium spp.)
Blackleg in ware crops is related to:
- initial bacterial loading of seed
- varietal susceptibility
- seed storage conditions on seed and ware farms
- soil conditions and temperatures at and after planting.
- high physiological age
- very early planting in poor soil conditions
- handling damage to both seed tubers and chits

Other black leg species:
Erwinia chrysanthemi (now called Dickeya dianthicola) another type of black leg has been seen in recent years.

Dickeya solani another new bacterial pathogen, has emerged in Europe. It is more aggressive but close relative of Dickeya dianthicola. Seed stocks in Holland have been badly affected and downgraded. Most D. solani infections in the UK seem to be associated with imported seed. Control measures for Dickeya are the same as those for black leg. A lab test is required to tell the difference between Pectobacterium ssp. and Dickeya ssp.

Cultural control:
- Blackleg control in ware crops follows the guidelines given in the Choice of Variety Section.
The Safe Haven seed certification scheme will help growers avoid *Dickeya solani*.

Bacterial loading tests of seed tubers can be a guide to possible problems in the ware crop.

For further information see the PCL publication – Managing the risk of blackleg and soft rots.

**Chemical control:** None is available.

## OTHER BACTERIAL SOFT ROTS IN STORE

These rots frequently develop after late, wet, cold harvests especially if tubers are badly damaged. Tubers lifted with (often unnoticed) infections of some soil-borne fungi or tuber blight usually develop soft rots.

Some varieties are more susceptible to soft rots and particular care should be taken at harvest.

**Cultural control:**

- Harvest early in good soil conditions.
- Don’t long term store “rained on” loads or crops with tuber blight or other soil-borne fungi. Suspect crops should not be cured but thoroughly dried, cooled quickly if possible (may not be appropriate for processing crops) and sold early.
- Avoid condensation on tubers in the store.
- Close store monitoring will identify the development of soft rots.

**Chemical control:** None is available.

### Aphid-borne viruses

See Choice of Variety Sections.

### Spraing (*Mop Top Virus*)

*Potato Mop Top virus* is carried by the powdery scab fungus. Damage by *Mop-Top Virus* is unusual. Control is difficult but some varieties are tolerant of the virus. The *Mop-Top Virus* “Spraing symptoms” in the tuber are similar to damage caused by *Tobacco Rattle Virus* and internal rust spot. A tuber laboratory test is available that can confirm the precise cause of the damage. The test results ensure appropriate management of the disease.

### Pink rot (*Phytophthora erythroseptica*)

Pink rot is a soil-borne fungal disease that is usually “overtaken” by secondary bacterial soft rots.

**Cultural control:** Pink rot is favoured by wet soil conditions at the end of a hot dry summer.

- Over-irrigation, poor drainage and soil compaction are also implicated.

**Avoid growing potatoes in fields where pink rot has occurred.**

**Chemical control:** None is available.

### Verticillium wilt

This is a common soil-borne disease that is not fully understood. In some seasons its presence accelerates crop senescence. The combined effects of PCN damage and *Verticillium* spp. are reported to be serious.

**Cultural control:**

- Varieties that are susceptible to stress may be more sensitive to *Verticillium* attack.
- wider rotation
- avoid poor soil structure
- avoid high levels of PCN
- avoid water stress
- avoid *Verticillium* susceptible crops such as peas, linseed or strawberries in the rotation.

**Chemical control:** None is available.

### Watery wound rot, violet root rot and rubbery rot

All these diseases are soil-borne fungi and their incidence is sporadic and not usually important.

**Cultural control (Watery Wound Rot):**

The *watery wound rot fungus* enters wounds made at harvest. Cool dry storage with little curing can suppress the disease in store if the problem is identified soon enough.

**Cultural control (Violet Root Rot):**

Violet root rot also affects carrots and sugar beet. Avoid fields where severe attacks have occurred in the past.

**Cultural control (Rubbery Rot):**

Rubbery rot can be a problem after over-irrigation or heavy rainfall on poorly structured soil.

**Chemical control:** None is available.

### Botrytis rot

This fungus may invade senescing or damaged haulm, especially during wet weather at the end of the season. On rare occasions tubers can be infected and a firm, dry rot develops during storage. **Chemical control:** None is available.
Early blight (Alternaria ssp.)

Early blight is becoming a more common problem, and the symptoms are caused predominantly by the pathogens Alternaria alternata and A solani but other Alternaria ssp have been implicated. These pathogens can only be differentiated using microscopic investigation. To date there is no accurate model for the prediction of disease development.

For further information look at AHDB Potatoes publication 'Managing the risk of Early Blight'.

Chemical control: Fungicide activity is variable between the two main species, with limited chemical control of A. alternata and variable control of A solani. Chemical control is mainly protectant but there is currently little understanding of when any programme should start to offer optimal protection. Many blight products have no control of A solani.

Cultural control: Cultural control requires the crop to be under minimum stress as disease development is slower with healthy and vigorous crops so optimise irrigation and nutrition, especially nitrogen, and reducing compaction. Disease symptoms can be found first in the field in poorer fertilised areas such as field edges, or in stressed waterlogged areas or PCN affected areas. There is no current reliable variety susceptibility information and the best option to date is to rely on local knowledge. Some varieties are known to be more susceptible such as Markies and Vivaldi, with other varieties showing severe symptoms in some seasons such as Fontane, Hermes, M Piper and Russet Burbank.

Sclerotinia stalk break

Sclerotinia is a fungus that attacks a wide range of arable crops. Infection of potatoes used to be predominantly seen in wetter seasons especially in Northern Scotland but is becoming more common further south, possibly related to the increase in oilseed rape and carrots, especially over wintering the latter, in the rotations.

Cultural control: none available

Chemical control: There are a couple of biological fungicides, soil applied that claim activity against Sclerotinia. There is some activity of foliar applied Fluazinam on Sclerotinia but timings are uncertain

Glycoalkaloid accumulation

To prevent high levels of these naturally occurring, poisonous compounds developing in the tubers avoid over exposure to light or stress. For example, ensure good ridges are formed in the field; at lifting potatoes should be removed from the field as soon as possible and damage kept to a minimum. During storage and grading potatoes should not be left exposed to light for unnecessarily long periods.

Pit rot

Pit rot is a poorly understood but sometimes quite serious disorder of tuber lenticels. Stores should be kept dry and well ventilated to prevent pit rot.

Chilling injury

To avoid the possibility of internal flesh or vascular discolouration potatoes should not be stored below 0°C. Temperatures below -2°C will freeze potatoes.

Blackheart

Black heart can be a significant problem in late stored pre-packing potatoes. The causes are not fully understood.

Problems can occur in well-sealed or infrequently fresh air ventilated refrigerated stores. It is suspected that low oxygen levels for whatever reason induce black heart.

Growth cracks, secondary growth, hollow heart, internal browning and misshapen tubers:

Also see the Irrigation Section.

Cultural control:

Crops with steady tuber growth rates are usually free of these problems. A regular and even water supply is thought to be important in avoiding these disorders. Varietal susceptibility to each of these faults varies and choice of variety should be carefully matched to the site.

Crop desiccation in relation to rainfall following a drought can sometimes be timed to avoid the development of second growth in the tubers.

Correct seed spacing and timely haulm destruction will reduce oversized, cracked and hollow-hearted tubers

The causes of internal browning are not understood.

Enlarged and “star-cracked” lenticels

Also see Irrigation Section.

Cultural control:

- Carefully managed irrigation and cultivation will help avoid enlarged lenticels but very wet soils late in the season do induce the problem.
- Some varieties are known to be susceptible.
Jelly end rot
Scheduled irrigation will help control jelly end rot.

WEED CONTROL
Effective weed control protects yield, eases harvesting and minimises tuber damage.

Cultural control:
Herbicide programmes have largely superseded traditional inter-row cultivations. Cultivations can damage the growing crop and may create clods. However well-timed shallow cultivations are commonly and successfully used on organic soils and those which have not been stone/clod separated.

An integrated weed control strategy involves:
- careful seedbed preparation, residual herbicides don’t work well on cloddy soil
- ridging and inter-row cultivations where and when appropriate
- choice of appropriate herbicide
- planting healthy seed in good soil conditions to speed the development of a full canopy
- maintaining a complete crop cover for as long as possible to out compete weed growth, especially towards the latter end of the season
- controlling perennial weeds in previous crops especially the broad leaved ones. More reliable options exist for grass weed control.

Choice of herbicides
The factors to be considered when selecting a potato herbicide are:
- weed spectrum
- soil type
- variety
- previously applied herbicides
- following crop considerations and requirements
- crop growth stage and choice of follow up chemical treatment

Chemical haulm desiccation
Desiccating haulm speeds tuber skin set, prevents disease spread from the haulm to tubers, eases mechanical harvesting and controls tuber size. Chemicals vary in the speed with which they kill the haulm but speed of skin set is similar for all correctly used desiccants. The crop needs to be protected against blight until the haulm is completely killed. It is essential that the canopy is killed quickly to reduce the risk of disease spread, especially blackleg.

Mechanical haulm removal
Careful crop flailing can reduce the use of chemical desiccants. Mechanical haulm destruction techniques were thought to spread diseases within the crop canopy but this does not appear to be a problem. Haulm re-growth may be a nuisance but is easily managed.

Application of a low rate of Diquat pre flail can aid desiccation by reducing volume of material the flail has to handle, helping to keep target clear for following desiccant.

NUTRITION
Fertiliser application should be based on:
- soil analysis
- anticipated soil nitrogen availability
- potato crop response to individual elements
- variety
- time and duration of crop growth
- contribution made to nutrient requirement by organic manure application
- market outlet requirements (e.g. dry matter or cooking quality)
- crop off-take information

Fertiliser recommendations and organic manure values are given in Potato Council (AHDB) “Crop nutrition for potatoes 2013” and DEFRA RB209 Fertiliser Recommendations 8th edition 2010.

Nitrogen
Excessive amounts and ill-timed applications of nitrogen can adversely affect crop performance and quality and may be leached from the soil.

Organic manures and composts
Applications should be made in accordance with the DEFRA “Protecting our Water, Soil and Air, A Code of Good Agricultural Practice for farmers growers and land managers” and the requirements in Nitrate Vulnerable Zones. For further information on the requirements for nitrogen applications within an NVZ go to www.gov.uk/guidance/using-nitrogen-fertilisers-in-nitrate-vulnerable-zones
The nutrient content of any organic manure applied must be taken into account in deciding inorganic fertiliser policy for the field. Standard figures are available in RB209 but where possible sample the organic manures on farm when calculating crop requirements.

See "Making the most of organic manures for optimum results and cost savings" BPC 2000. "PAS 100:2011 Specifications for composted materials" and “Quality compost: benefits to potato production and soil quality” both at www.wrap.org.uk

The use of any domestic or industrial wastes as nutrients or soil conditioners should be discussed with end users of the crop.

See ADAS and SAC’s “Safe Sludge Matrix” provides guidelines on the use of sewage sludge.

**IRRIGATION**

**PREDICTING WATER REQUIREMENT**

Irrigation of potatoes has a great influence on tuber yield and quality. Accurate irrigation scheduling, in conjunction with weather forecasts, is essential to achieve the yield and quality the market demands, conserve water and to avoid disease and soil structure problems.

**Irrigation method**

Water is a valuable resource and should be treated as such. All efforts should be made to use it in the most efficient way possible. Growers should consider physical factors such as field slope when deciding which way to plant a field. Planted ridge shape should be considered in conjunction with soil type, using beds or a lazy ‘M’ ridge shape to conserve moisture if possible. Water runoff can lead to diffuse pollution as well as loss of crop due to localised waterlogging and increased disease risk so should be avoided.

Scheduling of irrigation is essential in ensuring optimal water use, with various options available based on balance sheet type or direct soil water measurement.

The most common method of application is still the raingun. This can often be adversely effected by wind unless set up correctly and the performance monitored. Systems such as booms and trickle can offer a more even application but with an increased financial cost.

Infrastructure should be maintained to minimise the risk of water loss through leaks.

For further information on water management see www.ukia.org and for yield and quality issues see AHDB publication - Irrigation and water use best practice guide for potatoes.

**Water quality and supply**

Where the annual irrigation water risk assessment indicates a risk of impurities in irrigation water, samples should be analysed for these contaminants

**QUALITY ASPECTS OF IRRIGATION:**

**Common scab**

Common scab may be controlled by keeping soil around the developing tubers near to field capacity for 4 weeks after tubers begin to form. Maintaining such low soil moisture deficits (SMDs) requires frequent applications of small amounts of irrigation.

**Powdery scab**

Irrigation regimes to minimise common scab increase the risk of powdery scab. Fields with a history of powdery scab should be irrigated very carefully and should be planted with a resistant variety (see Environmental Protection Section).

**Potato blight**

Irrigated crops have to be considered vulnerable to potato blight and fungicide protection programmes should be planned accordingly (see Environmental Protection Section).

**Blackleg**

Irrigation can create soil conditions favourable for the development of blackleg. Irrigation scheduling systems will help reduce these risks.

**Tuber quality parameters**

Well-planned irrigation improves skin texture and "bloom", tuber size and shape by avoiding large fluctuations in soil moisture. Careful irrigation management should reduce bruising, growth cracking, secondary growth, hollow heart, enlarged lenticels and jelly end rot.

**Irrigation stop dates**

Irrigation stop dates will depend on crop cover, tuber size, maturity, soil type and moisture content, disease levels and the weather forecast.
Harvest and Storage

Time of Harvest

Late harvesting is one of the biggest causes of loss of tuber quality. High quality crops that store well need to be lifted before soils become too wet and cold. For processing crops tuber dry matter and sugar levels will determine desiccation dates.

Staff Motivation and Careful Tuber Handling

Poor harvesting and handling techniques cause bruised and damaged tubers that are the commonest quality problems in the industry. All growers should ensure that personnel and equipment involved in harvesting and handling the crop operate to the highest standard possible.

Sophisticated potato handling equipment needs sensitive, properly trained and well-motivated operators. Through their training and management all staff will appreciate the nature and implications of potato damage and bruising.

Training

a. The entire potato harvesting and handling staff should be trained or briefed annually on the importance of damage and how they can affect it.

b. Operators should receive specialist training on their machine, its correct operation and various adjustments.

c. All training should be undertaken in a language that can be easily understood by the employee. This is more pertinent at harvest when grading lines are predominantly manned by foreign labour.

Machinery

Despite the excellent design of modern potato equipment, potatoes will still be damaged if the machinery is not operated correctly. One of the most common points of damage in a harvesting system is the harvester/trailer transfer. Trailer drivers are often casual staff so their training and education on the issues related to potato bruising are very important (such as how to layer a trailer when filling it). To keep damage to an absolute minimum the following points should be followed closely:

- constant monitoring of machine settings and tuber damage to ensure optimum performance in the prevailing conditions.
- regular maintenance to ensure any potentially damaging features are eliminated.
- all machinery used needs to be compatible

Potato Damage Monitoring Techniques

Regular damage monitoring and use of electronic potatoes will help reduce damage and reinforce staff commitment to careful crop handling. Monitoring should include sample washing to assess skin set and tuber surface damage as well as hot boxing and peeling to check for bruising.

Growers should be going into stores about 3 days after loading to check the bruising levels tie up with what was found out of the hot box, especially at the start of the season. This will give confidence that the hot box is working correctly.

Hygiene

Members should ensure their potato crops are handled and stored to avoid contamination, damage or exposure to anything likely to affect their food quality.

Risk Assessment Controls Includes Records Of:

- harvesting trailer cleaning
- potato store maintenance and cleaning
- where appropriate potato box checking, maintenance and where necessary cleaning
- potato grading staff briefings on hygiene standards and security of their personal belongings
- daily glass, grading equipment and plastics check
- pre-harvest potato field risk assessments

See appendices for examples of supporting documents for the above requirements/records.

Post-Harvest Treatments

Store Management

The crop owner is expected to have final responsibility for the management of the store and any pesticide application to the stored crop.

Where third party storage is used a formal agreement should be in place describing storage requirements.

Also see the Choice of Variety Section.
Curing

Curing to suberize or heal wounds reduces disease development and dehydration. Temperature and humidity affect the rate of curing. “Dry curing” can reduce skin diseases and rots. It involves keeping the potatoes at about 12°C for about 10 days and ventilating each day with “dry” air for several hours to reduce humidity in the store.

Wet tubers and those suspected to be infected by blight and or blackleg are a special storage risk and need to be thoroughly dried, monitored closely and sold early.

Storage temperature

Optimum crop storage temperature depends on market outlet. Lower temperatures minimise silver scurf and sprout development but may encourage some diseases and can spoil fry quality.

Storage chemicals

The application of storage chemicals can be minimised or even avoided by use of an integrated seed, harvest and store management strategy. The use of chemicals for disease or sprout control will depend on the crop’s growing conditions, storage regime, disease risk and time of store unloading.

Treatment with some potato storage chemicals is unacceptable to certain market outlets. Growers should check that their market will accept treated potatoes before treatment. All storage chemicals when applied correctly will leave detectable residues well within maximum residue limits. However some potato buyers prefer potatoes with very low or no detectable pesticide residues.

The use of chemical suppressants in many potato stores is still necessary. Current processing potato varieties cannot be stored at low temperatures or treated with ethylene and then fry or cook acceptably.

Some non-processing potato crops can be stored for long periods without suppressants, using low temperatures. It will depend on variety and one notable exception to this would be King Edwards.

Ethylene and crop oil treatments are now available for controlling sprout growth in low temperature non-processing stores. They should be considered to reduce the risk of CIPC exceedences in certain store types and the appropriate conditions.

Application of storage chemicals

All storage chemicals must be used according to the instructions on the label and as recommended in Defra’s “Code of practice for using plant protection products”. The Potato Industry CIPC Stewardship Group’s “Be CIPC Compliant” web site (www.cipccompliant.co.uk) gives practical guidance on CIPC use on potatoes.

CIPC (CHLORPROPHAM)

APPLICATION OF CIPC

CIPC should only be applied once the crop has been properly dried and cured but before any sprouting begins. The first treatment timing is recommended to be within 3 weeks after store loading completed but it is far more important to ensure that the crop is dry and cured. In a wet season this may take longer so the first treatment has to be delayed until then.

Advice on the need for CIPC

Any advice to use CIPC on stored potatoes must (like any other crop protection product) come from a BASIS qualified adviser who is also a member of the BASIS Professional Register and has read the Scheme standards and agrees to advise on pesticide use in compliance with the scheme standards. The BASIS adviser must always have inspected the crop before issuing a recommendation for application of CIPC. It is recommended that all BASIS qualified advisors who are recommending the use of CIPC in potato stores have successfully completed the BASIS Stored Potatoes course.

Guidelines for the use of CIPC in potato stores

CIPC is a very important post-harvest product for sprout suppression in potatoes that is frequently found as a tuber residue in fresh market and potatoes for processing. These residues are usually low, within the MRL and are no risk to consumer health. To ensure safe and effective use of CIPC, crop owners and their CIPC contractors or farm application operatives should be able to demonstrate responsible and minimum use of this product.

For crops stored below 5°C the number of applications permitted may vary depending on product label. The first application has to be made before the crop is below 7°C.

To achieve safe, even and effective application of CIPC, the following points and procedures should be implemented:

- Store managers should plan their storage to ensure that only crops that need CIPC are treated and that only crops that need multiple treatments are treated as such. For example stored crops should, whenever possible, be segregated by dormancy characteristics, variety, Maleic hydrazide treatment and duration of storage to avoid any unnecessary CIPC applications.
CIPC applications must only be carried out by specialist contractors who are members of the National Association of Agricultural Contractors “Applicator Group” or fully trained, qualified and experienced farm staff using appropriate equipment.

Whether applications are carried out by farm staff or specialist contractors, documentation must be available showing complete traceability of all aspects of each CIPC application. See appendices for an example of a CIPC application record sheet.

Whether applications are carried out by farm staff or specialist contractors the operators must be experienced, trained fully qualified (PA1 and PA9) and registered with NRoSO with records to prove this.

The CIPC application equipment must have a valid test certificate from an independent sprayer certification scheme such as NSTS. Certification, service and calibration records must be available for inspection. Contact the National Sprayer Testing Scheme (NSTS) for current information on CIPC application equipment testing.

Where CIPC is applied by contractor the store manager/ crop owner must have an appropriately signed Contractors Commitment Document.

Store managers must keep a current list of all their stores (owned and or rented) where CIPC is used.

CIPC treated buildings must be clearly labelled with a hard backed permanent sign that is either screwed or bolted to the outside of the store indicating CIPC has been used.

Each store must have a signed and satisfactorily completed “CIPC Store Checklist” accompanying the most recent CIPC application. The checklist must be signed and dated by both the BASIS qualified advisor and the CIPC applicator to confirm that it has been seen. See The potato industry CIPC Stewardship Group’s “Be CIPC Compliant” web site (www.cipccompliant.co.uk)

Completed Store Check lists and BASIS adviser’s recommendation sheets must be made available to the CIPC applicator.

Store Check list should be countersigned by the applicator to confirm that it has been seen (not that the contractor has completed it).

Only UK approved formulations of CIPC can be used.

Statutory guidance, label instructions, withholding intervals and company advisory information must be adhered to.

Full safety equipment should be on hand during CIPC application.

The interval between consecutive CIPC treatments and period post application before store re-entry varies according to product. The product label must be consulted to confirm requirements of the specific product used. The store manager/owner must ensure that systems are in place to train appropriate staff to ensure compliance.

CIPC application techniques

The following CIPC application techniques can help to improve CIPC distribution and may therefore reduce the quantity of CIPC required which in turn ensures that the minimum amount of CIPC is used for effective long term control.

1. Active recirculation

New controls planned by CIPC approval holders, and backed by Industry Stewardship, will mean all CIPC applications from the 2017 harvest are made using ‘active recirculation’

‘Active recirculation’ is the new industry agreed term to describe the recirculation of air (containing CIPC fog) by fans. Research conducted by AHDB and others within the industry has shown that the correct use of fans can significantly improve the uniformity of CIPC distribution, reducing the risk of maximum residue level exceedance. See sections 5&6 below for specific information on box and bulk stores.

‘Active Recirculation’ - for application of chlorpropham (CIPC) to stored potatoes is defined as “the active, even movement and recirculation of airflow, through stored potatoes, during and after chlorpropham application (until the fog has cleared) accomplished via any suitable mechanical means in order to improve application uniformity and maximise product efficacy.”

2. Application and where necessary re-application timing

Once properly cured, refrigerated stores (target holding temperature below 5°C) should be treated BEFORE they reach 7.0°C. Advice on further applications in a cold store can be found on the product label and CIPC best practice.

CIPC applications should be supported with a formal recommendation from an appropriately qualified (BASIS) adviser who has inspected the crop.

Once crops are dry and cured, do not delay the first CIPC application as it may result in extra, unnecessary CIPC applications.

The need for and timing of a second and subsequent applications of CIPC requires careful observation of the suspected sprout re-growth. The store manager and BASIS qualified adviser should be certain that retreatment is essential. Re-application should be considered very carefully, in some instances potatoes show signs of fresh sprouts, which then do not develop for a number of weeks. Fresh sprouts are more effective at absorbing CIPC and so may be maintained for a longer period.
3. **Product selection and dose rates applied**

Store managers, crop owners and their qualified advisers are responsible for selecting and following the label dose rates. There are many occasions where the rate of CIPC applied is below the maximum recommended rate for a single or total application as shown on the product label. The rate applied will depend on a number of factors such as storage period, variety, end use, storage temperature, growing season. These and other factors need to be taken into account to ensure that the minimum effective rate possible for adequate sprout control is used.

Note the different maximum dose rates of CIPC for fresh and processed crops (from any label, or any combination of labels). These total rates are currently being reduced on an annual basis so those involved in recommending CIPC application need to ensure that they have the most recent total dose figures. Always comply with the label and see [www.cipccompliant.co.uk](http://www.cipccompliant.co.uk) for best practice guidance.

The total quantity of active CIPC applied to any lot of potatoes and the last date of application and total product rate should be declared at the point of sale to ensure maximum rates are not exceeded and should be recorded on the dispatch note accompanying the load from the store.

4. **Crop temperatures and condensation**

Close crop temperature control and keeping the crop at its minimum holding temperature will improve sprout control and reduce the number of CIPC applications.

Using the recirculation fans prior to CIPC application will even out crop temperatures in the store and improve distribution of the sprout suppressant. Where wide temperature variations exist within a store due to the ventilation system, the store may not be balanced, and ‘dead’ areas may exist. This could cause a build-up of condensation which will cause sprout control to be significantly reduced. Chemical residues may also become an issue.

In stores where insulating materials such as straw or quilts are used to maintain crop temperatures the crop touching such materials must be checked prior to gassing to confirm that it is dry. If there are issues, the materials should be removed to allow the crop to dry prior to application with CIPC.

Do not raise the temperature of refrigerated stores prior to application of CIPC. But turn off the fridge plant and leave the re-circulation fans running for 6 to 12 hours PRIOR to CIPC application.

5. **Box stacking patterns and CIPC application ports.**

Box layouts for best air circulation will improve CIPC distribution. Pallet apertures should be aligned and open; they should never be stacked tight to walls. Stacking patterns around the store door should allow air to return through the crop to the recirculation louvres or fridge unit.

For best practice advice see [www.cipccompliant.co.uk](http://www.cipccompliant.co.uk)

Store managers should discuss box layout and positioning of application ports with their CIPC contractor or operator and store designer.

CIPC fog should be delivered into the store unhindered and never be directed at the crop, boxes or walls. CIPC should be delivered into the store in such a way to prevent the fog rising to the roof space and falling directly on to the top boxes. CIPC applications are more even in the more positively ventilated box stores, such as suction wall or open suction systems. Store owners should consider this when considering store updates or new builds with box stores.

The provision of ‘active recirculation’ in box stores may consist of a mechanical ventilation system capable of even airflow recirculation. This may consist of a permanent / purpose-built ventilation system or a temporary ventilation system utilising auxiliary fans, plenums, or other means to allow for uniform airflow and recirculation; unmodified overhead throw systems will not be acceptable. For further information see ‘CIPC Application: A store owner’s guide. Essential information for making potato stores CIPC compliant from the 2017/18 season’ which can be downloaded from [www.cipccompliant.co.uk](http://www.cipccompliant.co.uk)

6. **Bulk stores**

In bulk potato stores, provision for ‘active recirculation’ may consist of a mechanical ventilation system with under-floor ducts, under-pile ducts, or other means of even, through-pile airflow and recirculation. Typically, reducing airflow velocity is recommended and can be accomplished via the use of variable frequency drives (VFDs or Inverters), or other suitable means.

7. **Part filled stores**

Avoid treating part filled stores. Failing this try to contain the part store in a lesser air space (see the CIPC store check list “Empty air space in stores”)

8. **Store leakage**

Leaky stores produce unwanted “fog drift” resulting in reduced doses, unnecessary repeat applications and environmental contamination.

The CIPC applicator should alert the store manager/ crop owner to issues with leaking stores and repairs should be made before another application. (See the CIPC store check list “store integrity”) Failure to do so may result in the applicator refusing to treat the store.

9. **Application equipment and fog quality**

The CIPC fogging equipment should be set to produce a dry fog. There should be no evidence of CIPC puddles.
or heavy crystalline deposits in the store. These are indicators of inadequate application technique.

10. **CIPC residue testing**

Owners of CIPC treated crops should test their own crops for CIPC residues. Recognised sampling procedures should be adopted (see Potato Industry Stewardship Group “Guidelines for obtaining a potato sample for CIPC residue testing”).

**Records of each CIPC application**

Store managers must be able to provide records for each CIPC application to all treated stores, which contain the following information:

- The date and name of the person requesting and or formally advising CIPC application
- The CIPC product name, MAPP number and batch number of the product(s) used.
- The reason/s for the timing and dose of the application
- A declaration when the store may be re-treated with CIPC and when the crop may be moved from the store for sale or processing
- Confirmation of recognition of the date/s of all previous applications
- Confirmation that all application intervals have been observed
- Any problems or irregularities that were noticed during application, for example, excessive store leaks, temperature gradients in the store, any CIPC spillage, and any difficulties in producing the fog
- Confirmation of the tonnage treated and amount (active substance) of CIPC used
- Crop owners / store managers must be able to produce a record of the total CIPC active substance applied to each “lot” of potatoes on hand and at the point of sale
- Where CIPC applications exceed the maximum rate of active ingredient for fresh potatoes, crop owners must point out to buyers that the potatoes can only be used for commercial processing

See appendix for an example of a suitable record sheet.

**Storage of crops other than ware potatoes in CIPC treated buildings**

Buildings in which CIPC has been applied or that have contained CIPC treated potatoes for any length of time will contain CIPC deposits on or in their fabric. These deposits are impossible to remove completely. Other food crops stored in these buildings are likely to “pick up” CIPC residues, and as such will be over the MRL for that crop, which will be the level of detection. These crops will, therefore, be legally un-saleable.

If the earlier use of any building is unknown it is possible to test fabric from these buildings for CIPC.

Buildings that have been CIPC treated or where CIPC can be detected in the structure MUST NOT be used to store crops other than ware potatoes.

Growers should also be aware that stores that have ever been treated with CIPC should not be used for storing seed for any crop as there is a risk to germination/normal development. Where treated stores are adjacent to general storage areas, growers should ensure that there is no risk of contamination to these areas during gassing of the potato store. These areas may also present a risk to seed.

**RESIDUES AND CONTAMINANTS**

Growers and advisers must keep tuber residues to a minimum. This issue is not simply meeting the MRL trading standard but ensuring that any individual or multi-residues are kept as low as possible.

**The key targets are:**

- Optimising late applications of crop protection products to the tuber
- Optimising the use of all post-harvest treatments
- Ensuring minimum harvest intervals are followed
- Ensuring application equipment is working correctly and that application techniques follow product label directions.

The commonest pesticide residues found in potato tubers are: CIPC (chlorpropham), maleic hydrazide and propamocarb hydrochloride (found in Consento, Infinito, and Proxanil). Recently residues of azoxystrobin (Amistar), fosthiaze (Nemathorin), oxamyl (Vydate), pencuricon (Monceren), flutolanil (Rhino), fonicamid (Teppiki) and fluopicolide (part of Infinito) and have been discovered. These residues are virtually always below the MRL.

Reducing the dose and or widening the harvest interval with these products may reduce the residue level but it could also result in reduced product performance and therefore sub optimal levels of control. Where possible, especially with blight control products, consider alternating active ingredients and not relying on one active ingredient.‘.

Tecnazene, which is no longer approved on potatoes, is occasionally found but this is usually a result of past contamination of storage containers or buildings.
GUIDELINES ON MINIMISING PESTICIDE RESIDUES

These guidelines have been produced after consultation between crop stakeholders and the RT Fresh Produce crop author. They will be updated 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. The table below lists the active ingredients that may give rise to crop residues and details alternative strategies.

<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>azoxystrobin</td>
<td>Black dot and black scurf</td>
<td>Occasional residues but none close to the MRL 7 ppm</td>
<td>Ensure that application equipment is calibrated and working correctly (NSTS) and operators qualified with PA/SC or PA2 and on NRoSO. Consider targeted pathogen and rate required for control</td>
</tr>
<tr>
<td>chlorpropham</td>
<td>tuber sprouting in store</td>
<td>Residues below 5ppm are common MRL of 10.0ppm</td>
<td>Avoid mixing varieties of differing sprout growth in the same store. Ensure uniform store temperatures, ideal box layouts and suitable wind conditions at application time. Use a qualified and experienced CIPC applier with calibrated machine. Correct timing of initial treatment essential as this may result in increased applications initial treatment as this results in increased applications. Use “balanced” air system with active airflow in bulk stores. Apply CIPC during “pull down” in cold stores above 7°C. Ensure any re-treatment is absolutely necessary. There are no proven differences in tuber residue levels between any of the currently approved formulations of chlorpropham</td>
</tr>
<tr>
<td>dithiocarbamates (e.g. maneb &amp; mancozeb)</td>
<td>late blight</td>
<td>very occasional residues of this non systemic fungicide are detected MRL 0.3 ppm</td>
<td>Residues are suspected to be direct contact of the fungicide spray with exposed tubers in cracked ridges. Minimise cracking of ridges during growth (water, soil conditions)</td>
</tr>
<tr>
<td>fosthiazate</td>
<td>nematodes and wireworm</td>
<td>MRL 0.02 ppm</td>
<td>Do not use in furrow, follow Nematicide application module on incorporation very carefully. Operators should hold PA4/PA4G and attend stewardship workshop</td>
</tr>
<tr>
<td>imazalil</td>
<td>fungal diseases in stored tubers</td>
<td>very low residues well within the MRL are found after application MRL 3 ppm</td>
<td>Try not to use imazalil but ensure earlier harvesting, better management of store temperature and tuber drying. Refrigeration</td>
</tr>
<tr>
<td>maleic hydrazide</td>
<td>volunteer potato suppression and sprouting in store</td>
<td>tuber residues well within the MRL are always detected after application MRL 50 ppm</td>
<td>Avoid leaving potatoes on the field at harvest. Do not plough after potatoes. Grow “smothering” crops after potatoes. Use appropriate herbicides in set aside and other crops. Do not use MH unless spray conditions and crop growth are ideal</td>
</tr>
<tr>
<td>Chemical</td>
<td>Usage</td>
<td>MRL</td>
<td>Notes</td>
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</tr>
<tr>
<td>oxymyl</td>
<td>nematodes</td>
<td>0.01 ppm</td>
<td>Follow Nematicide application module on placement and incorporation of granules very carefully. Operators should hold PA4/PA4G (or PA/SC) if in furrow application and attend stewardship workshop.</td>
</tr>
<tr>
<td>pencycuron</td>
<td>seed dressing for black scurf and stem canker control</td>
<td>0.1 ppm</td>
<td>Residues in ware may be the result of contamination of ware boxes by treated seed or close contact of daughter tubers with treated seed tubers. Keep seed boxes separate or inspect and clean all boxes prior to ware harvest. Operators should be trained and hold a PA(SC) if applying using an applicator on planter.</td>
</tr>
<tr>
<td>propamocarb</td>
<td>fungicide for late blight control</td>
<td>0.3 ppm</td>
<td>Investigations into the reasons for recent residue finds (even though well within the MRL) are not conclusive, but often seen where the grower is using too many products containing that active. Alternate different actives in the blight programme.</td>
</tr>
<tr>
<td>tecnazene</td>
<td>tecnazene is not now approved for use on potatoes but previous applications continue to contaminate stored tubers</td>
<td>very low residues are very occasionally detected. These are “carry over residues” from store treatment several years previously</td>
<td>Ventilate empty stores and boxes suspected to be contaminated. Test store structure for active before loading with potatoes again.</td>
</tr>
<tr>
<td>thiacarbazole</td>
<td>fungal diseases in stored tubers</td>
<td>imazalil</td>
<td>As fungal resistance to thiabendazole is common, review continued use. Suggestions under imazalil apply.</td>
</tr>
<tr>
<td>flutolanil</td>
<td>seed dressing for black scurf and stem canker control</td>
<td>0.1 ppm</td>
<td>Residues in ware may be the result of contamination of ware boxes by treated seed or close contact of daughter tubers with treated seed tubers. Keep seed boxes separate or inspect and clean all boxes prior to ware harvest. Operators should be trained and hold a PA(SC) if applying using an applicator on planter.</td>
</tr>
<tr>
<td>fluopicolide</td>
<td>As propamocarb</td>
<td>As propamocarb</td>
<td>As propamocarb</td>
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</table>
APPENDIX 1: PPA HACCP STANDARD - REVISED 18TH JANUARY 2012

SPECIAL NOTE FOR GROWERS SUPPLYING POTATO PROCESSING FACTORIES: (PPA “bolt on” HACCP module) Most potato processing factories and certainly those represented by the Potato Processors Association (PPA) will expect growers delivering potatoes to comply with and have completed the following HACCP documentation. PPA HACCP STANDARD documentation (PPA ‘bolt on’ HACCP module).

<table>
<thead>
<tr>
<th>Section</th>
<th>Ref No</th>
<th>Requirement</th>
<th>Priority</th>
<th>Examples of Records</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0. Traceability</td>
<td>1.1</td>
<td>Through the use of relevant records (such as seed potato records, field diary, store diary etc.), it must be possible to trace any load of potatoes delivered to the customer back to the farm, store, field and seed lot</td>
<td>Key</td>
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<tr>
<td>2.0. HACCP</td>
<td>2.1</td>
<td>The producer must hold a written HACCP based risk assessment of their potato supply operation, which is specific to that producer, considers all appropriate hazards within an accurate flow diagram and has been reviewed within the last 12 months</td>
<td>Normal</td>
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<tr>
<td>3.0. Site Selection</td>
<td>3.1</td>
<td>For each field of potato production, a recorded foreign object and industrial pollution risk assessment must have been carried out as part of site selection, which takes into account stone content, proximity of any golf course, public footpaths, houses, roads, recreational areas or activities (e.g. shooting), industrial premises nearby and any other potential sources of contamination likely to affect the growing crop</td>
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<td></td>
<td>3.2</td>
<td>Records must be available to show that if fields selected for production have been determined as having potential hazards, corrective actions have been taken and/or controls are in place</td>
<td>Normal</td>
<td>3.2.1 Staff Foreign Object Awareness Record</td>
</tr>
<tr>
<td>4.0. Crop Management</td>
<td>4.1</td>
<td>A written risk assessment must be carried out that has considered the risks of foreign objects, including wood, metal, plastic, glass, weed seeds etc. by the use of organic manure</td>
<td>Normal</td>
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<td>5.0. Equipment Maintenance</td>
<td>5.1</td>
<td>Records must be completed to demonstrate that equipment (e.g. planters, tractors, harvesters, vehicles, stores and grading equipment) have been inspected, repaired (if necessary) and cleaned before use</td>
<td>Normal</td>
<td>5.1.1 Equipment and Building Maintenance Record</td>
</tr>
<tr>
<td>6.0. Pest Control</td>
<td>6.1</td>
<td>There must be a named person(s) responsible for managing pest control on site, who either manages the pest control personally or is the direct contact for the contractor and who ensures that all corrective actions are followed up in a timely manner</td>
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<td>6.2</td>
<td>Pest control practices are only to be undertaken by a contractor able to demonstrate approval by a National Pest Control Body or a person able to produce a copy of their training certificate from a recognized course</td>
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<td>6.3</td>
<td>Up to date copies of COSHH sheets for all pest control products must be held</td>
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<td>Section</td>
<td>Ref No</td>
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<td>6.4</td>
<td>All bait stations must be numbered and included on an accurate, dated site plan of the premises</td>
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<td>6.5</td>
<td>All internal and external bait boxes must be locked, clearly labelled and secured in place. The nature and location of the bait stations must not pose any risk of contamination of the potatoes</td>
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<td>6.6</td>
<td>Records of inspections and follow-up visits must be able to demonstrate that pest activity is being adequately controlled</td>
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<td>6.7</td>
<td>There must be adequate external bait stations to give effective control of rodents</td>
<td>Normal</td>
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<td>6.8</td>
<td>Clear, unobstructed inspection corridors must be maintained around the exterior and interior of the store to enable easy access to bait stations</td>
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<td>6.9</td>
<td>The position of the baits must not pose a risk of contamination to potatoes</td>
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<td></td>
<td>6.10</td>
<td>Granular bait is not permitted</td>
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<td>7.0.</td>
<td>7.1</td>
<td>Recorded daily glass and hard plastic checks must be completed during store loading and unloading</td>
<td>Key</td>
<td>7.1.1 High Risk Glass and Hard Plastic Record</td>
</tr>
<tr>
<td>Glass Control</td>
<td>7.2</td>
<td>Recorded annual pre-storage glass checks for windows in neighbouring buildings and chitting stores must be completed</td>
<td>Key</td>
<td>7.2.1 Low Risk Glass and Hard Plastic Record</td>
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<td>7.3</td>
<td>Lights in storage and grading areas must be protected</td>
<td>Key</td>
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<td>7.4</td>
<td>Procedures must be in place to control broken or unprotected glass (lights / thermometers)</td>
<td>Key</td>
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<td>7.5</td>
<td>All glass breakages must be cleared up immediately and placed in controlled waste/dedicated glass containers. Records of all incidents must be held</td>
<td>Key</td>
<td>7.5.1 Glass and Hard Plastic Breakage &amp; Clean Up Record</td>
</tr>
<tr>
<td>8.0.</td>
<td>8.1</td>
<td>The potential for foreign object contamination must be effectively managed through maintaining a sound store structure, with adequate pest proofing and hygienic working practices. Stores must be thoroughly cleaned prior to the storage season and records kept</td>
<td>Normal</td>
<td>8.1.1 Storage Food Safety and Hygiene Check Record 8.1.2 Store Cleaning Record</td>
</tr>
<tr>
<td>Storage</td>
<td>8.2</td>
<td>Louvres must be designed and constructed in order to protect the crop from exposure to light when open</td>
<td>Normal</td>
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<td>8.3</td>
<td>Procedures must be in place to prevent foreign material contaminating potato boxes</td>
<td>Normal</td>
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<td>8.4</td>
<td>Recorded checks must be completed to demonstrate that all boxes have been cleaned and are in a sound condition prior to filing</td>
<td>Normal</td>
<td>8.4.1 Box Check Record</td>
</tr>
<tr>
<td></td>
<td>8.5</td>
<td>All potato stores must be locked when not in use</td>
<td>Normal</td>
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<tr>
<td>Section</td>
<td>Ref No</td>
<td>Requirement</td>
<td>Priority</td>
<td>Examples of Records</td>
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<tr>
<td>9.0. Grading</td>
<td>9.1</td>
<td>The potential for foreign object contamination must be effectively managed through maintaining all grading and associated equipment in sound condition, avoiding unsuitable temporary repairs, minimising metal-to-metal contact and by use of suitable materials for belts, cushioning etc.</td>
<td>Normal</td>
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<td>9.2</td>
<td>The producer must complete daily, recorded checks to show that the grader and associated equipment such as lights and belts etc. will not pose a risk of contamination to the graded potatoes</td>
<td>Key</td>
<td>9.2.1 Grader Daily Check Record</td>
</tr>
<tr>
<td></td>
<td>9.3</td>
<td>A signed glove register which covers all grading staff must be in place</td>
<td>Key</td>
<td>9.3.1 Grader Personnel Check Record</td>
</tr>
<tr>
<td></td>
<td>9.4</td>
<td>The full width of the inspection belt must be within easy reach of the inspectors and the potatoes must pass in front of the inspectors in a single layer</td>
<td>Normal</td>
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<td></td>
<td>9.5</td>
<td>The producer must provide suitable facilities for grading to be carried out in bad weather</td>
<td>Normal</td>
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</tr>
<tr>
<td>10. Hygiene</td>
<td>10.1</td>
<td>The producers must hold a hygiene policy on site, clearly stating eating, drinking, smoking and jewellery restrictions. The policy must be signed by all employees</td>
<td>Key</td>
<td>10.1.2 Hygiene Policy</td>
</tr>
<tr>
<td></td>
<td>10.2</td>
<td>There must be appropriate and sufficient signs in place around the site in order to re-enforce the smoking policy</td>
<td>Normal</td>
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</tr>
<tr>
<td>11.0 Transport</td>
<td>11.1</td>
<td>Maintenance and cleaning records must be available to show all internal maintenance work carried out on bulkers and trailers used for transporting potatoes to the customer</td>
<td>Key</td>
<td>11.2.1 Trailer Check Record</td>
</tr>
<tr>
<td></td>
<td>11.2</td>
<td>All bulkers and trailers are to be inspected for cleanliness and absence of foreign object contamination prior to loading to the customer. The checks must be recorded</td>
<td>Key</td>
<td></td>
</tr>
<tr>
<td>12.0 Training</td>
<td>12.1</td>
<td>Annual training on quality, food safety and hygiene must take place for all relevant staff (field operators, storage and grading). Signed training records must be held</td>
<td>Key</td>
<td>12.1.1 Operator Training Record</td>
</tr>
<tr>
<td>13.0 Incident Handling</td>
<td>13.1</td>
<td>The producer must be able to provide evidence that actions are taken following a customer complaint, in order to prevent re-occurrence of the issue</td>
<td>Normal</td>
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<td></td>
<td>13.2</td>
<td>There must be a procedure in place (site or customer specific) to isolate stock and notify the customer should potatoes become contaminated with glass, pesticides, oil diesel etc</td>
<td>Normal</td>
<td>13.2.1 Potato Contamination Record</td>
</tr>
</tbody>
</table>
### Examples of Record Documents for PPA HACCP

#### Grading Line Staff Foreign Object Awareness Record No: 3.2.1

Foreign object awareness information from the pre-planting and pre-harvest risk assessment record

<table>
<thead>
<tr>
<th>Date</th>
<th>Store/Lot/Field</th>
<th>Where Documented</th>
<th>Graders Informed</th>
<th>Signed</th>
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<tbody>
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</table>

#### Equipment & Building Maintenance Record No: 5.1.1

Tick as appropriate

<table>
<thead>
<tr>
<th>Cultivation Equipment</th>
<th>Stone Separator</th>
<th>Trailer</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washed</td>
<td></td>
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<tr>
<td>Ridger/Bed Former</td>
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<tr>
<td>Forklift/Teleporter</td>
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<tr>
<td>Grading Line</td>
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<tr>
<td>Fertiliser Applicator</td>
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<td>Harvester</td>
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<tr>
<td>Pesticide Applicator</td>
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<tr>
<td>Potato Planter</td>
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<td></td>
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<tr>
<td>Potato Store</td>
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</tr>
</tbody>
</table>

Farm Name:  

Producer Ref:  

All maintenance & calibration pre-use and during use to be recorded detailing all work done and spare parts used

Machine:  

Identification Number / Mark:  

Maintenance Undertaken

<table>
<thead>
<tr>
<th>Date</th>
<th>Problem/Reason</th>
<th>Maintenance/Calibration Undertaken</th>
<th>Next Due Date</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
### Storage Food Safety & Hygiene Check Record No: 8.1.1

#### Store / Building Identification No/Mark:

<table>
<thead>
<tr>
<th>Store structure</th>
<th>Wood</th>
<th>Lights</th>
<th>Rodent presence</th>
<th>Action taken</th>
<th>Signed</th>
</tr>
</thead>
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</table>

- The store is checked monthly during storage and daily during grading / unloading.
- Any problems are noted and communicated to grading staff using the staff awareness sheet.
- Rodent presence is recorded.
- Any rodent presence is recorded.
- The store is cleaned and any loose wood is removed.
- Any rodent presence is recorded.

Date:_________
## Store Cleaning Record (Bulk Store / Box Stores) Record No: 8.1.2

### Store / Building Identification No/Mark:

- Floors to be swept of all debris
- Floors and walls are washed with pressure washer where applicable
- Ceiling, laterals and main ducts cleaned of all dirt where applicable
- Fan house, ventilation corridors and control shed are swept of all debris in all stores
- Sign off box when relevant action undertaken

### Week Number (delete as necessary)

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- Store Swept
- Washed Out Store
- Ceiling Cleaned
- Laterals Cleaned
- Fan House Swept
- Ventilation corridor swept
- Control Shed Swept
Box Check Record No: 8.4.1

Summary:
- All boxes checked pre-filling for damage - discarded or repaired as necessary
- All boxes checked post-filling for damage - action taken where necessary
- All boxes checked once in store for damage - action taken where necessary

<table>
<thead>
<tr>
<th>Date</th>
<th>Store</th>
<th>Checked Pre-Filling</th>
<th>Checked Post Filling</th>
<th>Checked In Store</th>
<th>Signed</th>
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</table>
- Clean all adhering soil off grading line equipment (including spirals and stars)
- Clean soil and dirt from around the grading line
- Clear all loose potatoes from the area around the grading line
- Check all elevators and hopper for loose and broken parts
- All repairs to machinery undertaken must be completed with care and attention to avoid risk of foreign object contamination and must be recorded on Equipment Maintenance Record
- All tools, spare parts etc must be stored in a safe place to avoid risk of foreign object contamination

<table>
<thead>
<tr>
<th>Date</th>
<th>Check and lubricate chains</th>
<th>Check Web and Belts</th>
<th>Check for worn / broken parts / temporary repairs</th>
<th>Lights in grading / washing area</th>
<th>Grader cleaned</th>
<th>Hopper</th>
<th>Elevator 1</th>
<th>Elevator 2</th>
<th>Checked by</th>
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</table>
### Personnel Check Record No: 9.3.1

**To include all potential personnel foreign object contaminants e.g. all personal protective clothing, gloves, plasters, tools, cleaning items etc.**

<table>
<thead>
<tr>
<th>Name</th>
<th>Initials</th>
<th>Date</th>
<th>Details of Item</th>
<th>Check / Issue In</th>
<th>Check / Return Out</th>
<th>Initials</th>
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<tbody>
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<tr>
<td>Date</td>
<td>Hopper</td>
<td>Coils/Screen</td>
<td>Stars</td>
<td>Elevator</td>
<td>Trailer</td>
<td>Store Grade Lights</td>
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<tr>
<td>Date</td>
<td>Location</td>
<td>Details</td>
<td>Tractor/Trailer Reg if Applicable</td>
<td>Cleaning Method</td>
<td>Area and Operators Clothes &amp; Shoes Inspected</td>
<td>Broken Pieces Disposed of in a Designated Container</td>
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## Low Risk – Annual Glass & Hard Plastics Record No: 7.2.1

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Items Checked</th>
<th>Corrective Action</th>
<th>Signed Off</th>
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<tr>
<td>Date of Incident</td>
<td>Location of Incident</td>
<td>Details of Incident</td>
<td>Potatoes Isolated</td>
<td>Potatoes Labelled ‘Not for Use’</td>
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## Trailer Check Record No: 11.2.1

<table>
<thead>
<tr>
<th>Date of Incident</th>
<th>Trailer No:</th>
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<tbody>
<tr>
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<td>Seal No:</td>
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<table>
<thead>
<tr>
<th>Supplier Grower/Store:</th>
<th>Haulier Vehicle Reg:</th>
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<table>
<thead>
<tr>
<th>Loading Site:</th>
<th>Date on Farm:</th>
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<table>
<thead>
<tr>
<th>Delivery Site:</th>
<th>Date at Factory:</th>
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</table>

**Prior to Loading drivers must inspect the trailer internally and externally and ensure it is free from contamination risks and foreign objects**

<table>
<thead>
<tr>
<th>Internal Inspection</th>
<th>Tick if OK</th>
<th>External Inspection</th>
<th>Tick if OK</th>
<th>Description of Fault/Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal lights not broken and covered</td>
<td></td>
<td>Lights and lenses intact</td>
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<tr>
<td>Rivets/screws/bolts not loose</td>
<td></td>
<td>No rust by unloading area</td>
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<tr>
<td>Seals/mastic intact, not loose</td>
<td></td>
<td>No external damage</td>
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<tr>
<td>Free of contamination &amp; foreign objects</td>
<td></td>
<td>Door seals not damaged</td>
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<tr>
<td>No strong smell</td>
<td></td>
<td>Number plate fixings</td>
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<tr>
<td>No pallets/wood chips/splinters/nails</td>
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<td>No rust/flaking paint</td>
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<td>No pests, insects or vermin</td>
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<td>Free of old crop</td>
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</table>
What was the previous load?

<table>
<thead>
<tr>
<th>Scheduled loading time at farm</th>
<th>Actual time arrived at farm</th>
<th>Actual time departed from farm</th>
<th>Scheduled delivery time at factory</th>
<th>Actual time arrived at factory</th>
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<table>
<thead>
<tr>
<th>Print Name</th>
<th>Signature</th>
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<tbody>
<tr>
<td>Driver:</td>
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<tr>
<td>Supplier/Grower:</td>
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</tbody>
</table>

Please leave in your cab **ALL LOOSE** objects and any items liable to contaminate your load i.e. cigarettes, food, pens, jewellery, watches, mobile phones etc.
Operator Training Record No: 12.1.1

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<tr>
<th>Date:</th>
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<tbody>
<tr>
<td>Training Subject:</td>
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<tr>
<td>Trainer:</td>
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<tr>
<td>Content of Training:</td>
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<table>
<thead>
<tr>
<th>Name of Attendee:</th>
<th>Signature:</th>
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Operator Hygiene Policy No: 10.1.2

- Smoking, eating, drinking and chewing are not permitted in the grader or potato store
- Smoking, eating and drinking is only permitted in designated areas
- The wearing of jewellery (to include sleeper earrings, rings and watches) is not permitted whilst working on the grader
- Personal items e.g. mobile phones, car keys, money, must be left in a secure place and not taken into the grader

I have read and understood the requirements:

Date:

Name:

Signature:

Potato Council Technical Publications

Copies of various publications on potato production, storage and marketing are available to levy payers and corporate members of the P.C. from:

AHDB Potato Council
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

Tel: 02476 692 051
Website: www.potato.org.uk

Free publications can be ordered through the publications line (number above) or by email: publications@potato.org.uk. Some reports are available to download from the website: www.potato.org.uk/about-us/knowledge-transfer

Technical publications specific to Scotland

SRUC – Scotland’s Rural College – SAC Consulting – Crop publications

www.sruc.ac.uk/downloads/120312/crop_publications
### APPENDIX 2: DRAFT CIPC APPLICATION RECORD BY COURTESY OF AND THANKS TO AJAY JINA

<table>
<thead>
<tr>
<th>CIPC APPLICATION RECORD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business name:</td>
</tr>
<tr>
<td>Store name:</td>
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<tr>
<td>Variety/Varieties:</td>
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<tr>
<td>Intended market: and storage temperature</td>
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<thead>
<tr>
<th>Requested by:</th>
<th>Date:</th>
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<tr>
<th>Confirmed by:</th>
<th>Date:</th>
<th>BASIS No:</th>
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<tr>
<th>Reason for Application:</th>
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<table>
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<tr>
<th>Application date:</th>
<th>Date and dose of all previous applications:</th>
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<tr>
<th>Dose and name of product used:</th>
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</thead>
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<table>
<thead>
<tr>
<th>Store contents</th>
<th>Number of boxes</th>
<th>Total weight Potatoes (t)</th>
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</table>
### APPENDIX 2: DRAFT CIPC APPLICATION RECORD BY COURTESY OF AND THANKS TO AJAY JINA (CONTINUED)

<table>
<thead>
<tr>
<th>Formulation:</th>
<th>Batch Number:</th>
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**Comments:**

(i.e. weather/wind conditions, problems during application, precautions taken, operator comments, condition of crop and or store fabric ...)

**Signed:**

**Date:**
APPENDIX 3: NEMATICIDE APPLICATION MODULE

(Code of good practice for the application of nematicides)

Professional advice

Growers should always seek advice from a BASIS qualified agronomist prior to the purchase and use of a nematicide. Recommendation sheets should be available for each treated field.

Operator requirements

Operators have been qualified to apply nematicides (NPTC PA (SC), PA4 or PA4G, PA2 pre 1994) and members of NRoSO.

By March 2017 staff applying nematicides must have completed the Industry Stewardship Training module.

Machinery details

Growers should be able to demonstrate that the granule applicator has been calibrated before use. It should ideally be inspected and certified annually by NSTS but the interval between certifications must be no more than 2 years.

Rotors or cassettes must be appropriate for the nematicide.

When applying nematicide growers should keep records to demonstrate that:

- The applicator is checked prior to each work day, ensuring all pipework is correctly fitted, the hopper bungs are in place and the hopper lids are secure.
- The applicator is calibrated each week
- The area treated and the product volume used match for each field

Protecting the environment – preventing granule spills

Nematicides should be applied and incorporated within a single pass. Applicators with a working width wider than the incorporation equipment should not be used.

By March 2017 all applicators must be fitted with a device in cab that allows the operator to shut off nematicide granule flow at least 3 meters from the end of each row. For those applicators fitted with a hydraulic or electric motor this should already be possible. For those applicators driven by a land or spider wheel an electronic clutch can be fitted to the applicator drive shaft to enable remote shut off. [http://www.cropsprayers.com/Horstine/]

After planting growers should cultivate headlands to ensure no granules left on the soil surface.

Growers should use designated filling sites for filling hoppers in each field, which can easily be checked for spillages.

Small spillages should be buried immediately ensuring no granules are left on the surface.

In the case of a larger spillage growers should put emergency procedures in place and make sure those dealing with the spillage wear appropriate PPE, as stated on the product label. Ensure operators have appropriate emergency equipment such as spill kit and decontamination equipment for skin and eyes, emergency details for the products being used; and a list of emergency contact details for the environment agencies and medical services.

Transfer the granules to the original container or an empty container that originally held the same product. The container should be in good condition and with an undamaged label. Access the container by removing the valve and undoing the clamp (or tie seals) around the neck.

If an original product container is not available, transfer the spilled granules into a suitable, larger container clearly labeled with the product name and the hazard classification and risk and safety phrases shown on the product label.

Operator exposure

Operators are required to use correct PPE in line with product labels and COSHH

A stable filling platform should be available for safe lifting and emptying of the nematicide containers

Operators and field supervisors should be aware of the procedures required in the case of an accidental exposure to a member of staff.

Post Application wildlife monitoring

Growers should check treated fields 24 hours post application for any bird or animal carcasses. Any carcasses found may indicate poor incorporation of granules. If granules are seen on the surface they should be incorporated immediately. Remove and cover the carcass, then contact the Wildlife Incident and Investigation (WIIIS) using the UK free-phone number 0800 321600. Also, the granule manufacturer.

Vydate call DuPont 01438 734450
Nemathorin call Syngenta 0800 1696058
Mocap call Certis 01223 894261
Standing together for British agriculture

Our standards start with the consumer. We monitor what they value the most about their food and understand what they expect from farmers. These values are translated into practical on-farm standards so Red Tractor farmers can demonstrate they are producing what consumers want.
Certification Bodies

Your routine point of contact with the Scheme is through your Certification Body.

Certification Bodies are licensed by Red Tractor to manage membership applications and to carry out assessment and certification against the Standards. The table below shows which Certification Bodies apply to each enterprise.

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**NSF Certification**
Hanborough Business Park, Long Hanborough, Oxford OX29 8SJ
Tel: 01993 885739 Email: agriculture@nsf.org Web: www.nsf-foodeurope.com

**SAI Global Assurance Services Ltd**
PO Box 6236, Milton Keynes MK1 9ES
Tel: 01908 249973 Email: agrifood@saiglobal.com Web: www.saiglobal.com/assurance

**Acoura**
Acoura Certification Ltd, 6 Redheughs Rigg, South Gyle, Edinburgh, Scotland EH12 9DQ
Tel: 0131 335 6643 Email: redtractor@acoura.com Web: www.acoura.com

**NIFCC [Northern Ireland]**
1A Lissue Walk, Lissue Industrial Estate (East), Lisburn, Northern Ireland BT28 2LU
Tel: 028 9263 3017 Email: info@nifcc.co.uk Web: www.nifcc.co.uk

**QWFC [Wales]**
PO Box 8, Gorseland, North Road, Aberystwyth SY23 2WB
Tel: 01970 636688 Email: info@wlbp.co.uk Web: www.wlbp.co.uk

T: 0203 617 3670
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www.redtractorassurance.org.uk