



Assured Produce

Crop Specific Protocol

CARROTS

(CROP ID: 57)



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Acknowledgements	4
1 General introduction	5
2 Planning and records	5
3 Site Selection	5
3.1 Site history	5
3.2 Crop rotation	6
4 Site management	6
4.1 Soil mapping	6
4.2 Soil management	6
4.3 Soil fumigation	6
4.4 Substrates	6
4.5 Drilling and transplanting	7
4.6 Growing systems	7
5 Varieties	7
6 Crop nutrition	8
6.1 Nutrient requirement	8
7 Irrigation	8
8 Crop Protection	9
8.1 The basic approach to crop protection	9
8.2 Plant protection product choice	10
8.3 Advice on the use of pesticides	10
8.4 Application of pesticides	10
8.5 Records of application	10
8.6 Protective clothing/equipment	10
8.7 Pesticide storage	11
8.8 Empty pesticide containers	11
8.9 Pesticide residues in fresh produce	11
8.10 Pest, disease and weed control	11
9 Harvesting and storage	17
9.1 Hygiene	17
9.2 Post harvest treatments	18
9.3 Post harvest washing	18

9.4 Storage	19
9.5 Harvesting	20
10 Pollution control and waste management	21
11 Energy efficiency	21
12 Health & Safety	21
13 Conservation issues	21
Appendix 1 Typical application rates for nutrients	22
Appendix 2 Insecticides currently approved for use on Carrots	23
Appendix 3 Fungicides currently approved for use on Carrots	25
Appendix 4 Herbicides currently approved for use on Carrots	26
Appendix 5 Seed treatments currently approved for use on Carrots	28
Appendix 6 Pest control currently approved for use on Carrots	29
Appendix 7 Growth suppressant currently approved for use on Carrots	30
Appendix 8 Guidelines on minimising pesticide residues	31
Appendix 9 Control Points: Carrots	32

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Preface

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

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

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

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

All statements in this protocol containing the words "**must**" (in bold type) will be verified during the Assured Produce assessment and their 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 Produce does not accept any responsibility for errors and omissions.

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

Notes:

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

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

There may be changes for the following reasons:

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

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

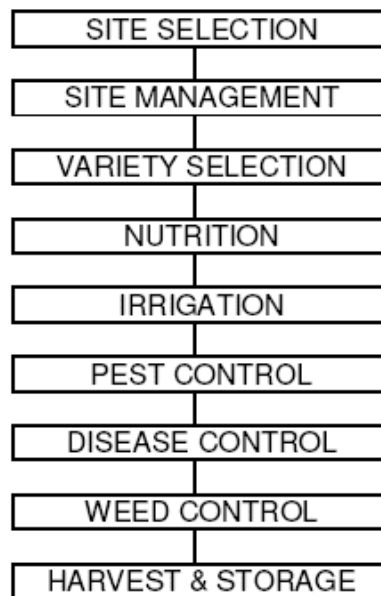
For pesticides on-label, only active substances are shown.

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

1 General introduction

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

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



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

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

2 Planning and records

See Generic Standards and/or Generic Guidance Notes

3 Site Selection

3.1 Site history

See Generic Standards and/or Generic Guidance Notes.

(Revised) 3.2 Crop rotation

Crops must be rotated to produce a balanced economic and environmental system of farming and to limit the build up of specific pests, diseases and disorders that adversely affect yield, quality and sustainability.

In planning crop rotations for carrots it is important to recognise that parsnips, celery and umbelliferous herbs such as Parsley also encourage many of the pests and diseases that affect carrots. Sugar beet and potatoes are also important hosts to Violet Root Rot that can seriously affect carrots and parsnips.

To avoid further build up of Violet Root Rot in root crop rotations the practice of growing sugar beet one year in three or four should be avoided whenever possible.

Crop maturing is closely associated with the incidence of disease. Growers should align drilling periods to intended harvest periods so as to minimise the harvesting of over mature roots that undoubtedly degrade more rapidly and increase the soil pathogen inoculum levels.

A continuing policy of sound rotation is essential for the future of carrots and other vegetable and arable root crops.

4 Site management

4.1 Soil mapping

See Generic Standards and/or Generic Guidance Notes

4.2 Soil management

Soil type

Choice of suitable soil texture is an essential requirement for the production of good quality carrots. Long, well-shaped roots will only be obtained if they are able to grow and develop without restriction.

Suitable soils are sandy in texture and range in lightness from pure blowing sand to sandy loams. Silt soils can produce good quality crops but access for harvesting without serious soil structural damage and effective soil separation can be extremely difficult in wet conditions. For this reason only the lightest silts should be cropped with carrots. Organic soils need to be carefully selected to avoid the production of shorter, more wrinkled roots and the occurrence of persistent soil diseases that reduce marketable yield.

Stones are a common feature in sandy soils. Mechanical stone separation and burying techniques maybe employed to minimise root damage from stones. Soils with a high content of gravel, which cannot be machine separated effectively, are not suitable for production of smooth straight roots.

4.3 Soil fumigation

See Generic Standards and/or Generic Guidance Notes.

4.4 Substrates

See Generic Standards and/or Generic Guidance Notes.

4.5 Drilling and transplanting

See Generic Standards and/or Generic Guidance Notes.

4.6 Growing systems

4.6.1 Early crops

Early crops of carrots for harvesting in June and July are grown in specific production areas where irrigation can be used in dry periods. Crops are seeded in the late autumn or winter at low density and the beds are covered in clear film plastic or non-woven fleece covers to warm the soil. The covers are removed when seedlings are well developed during April or May. The crop should be encouraged to grow quickly through the application of water and nutrients, thereby avoiding any checks to growth.

The drilling population must reflect the variety, seed quality, soil-type, aspect, potential field loss and harvest period.

Yields reflect both population and market specification. October-drilled crops tend to have inferior skin colour and may have proportionally more root fanging (due to frost lift) than winter or early spring drilling.

Early crops require little or no protection from Carrot Fly and foliar diseases and are, therefore, grown with minimal pesticide input.

All polythene and fleece crop covers used in early production must be salvaged, cleaned and recycled wherever possible.

4.6.2 Main season and late crops

Crops for harvesting from August to May are normally sown during the period February to May; the later sowings being used for spring lifting. Graded natural seed is preferred over pelleted seed due to its ability to germinate better under drying conditions. The introduction of modern vacuum seeders, together with improved seedbed preparation, has led to greater precision of seeding and consistency of carrot size and quality. Options to prime seed are now readily available. This technique can improve crop uniformity and assist in early weed control.

During their growth and development, main season crops are exposed to all normal pest and disease pressures. Regular inspections, combined with appropriate trapping and forecasting techniques, must be used to guide the crop protection programme.

Crops reach marketable size in succession according to variety, drilling date, plant population, site and management approach. Once mature, crops are machine lifted, washed, packed and marketed. Frosts that will damage Carrots are commonly experienced in most areas of the UK from November or December onwards. For winter production, therefore, some form of field storage is employed. A satisfactory system of crop monitoring must be undertaken throughout the field storage period. Carrots required for marketing through winter and spring must be protected from severe weather conditions and spring re-growth suppressed so that roots maintain good texture and flavour. Systems used include earthing over, strawing (with or without polythene film), short-term controlled-environment storage and use of frost resistant varieties.

(Revised) 5 Varieties

In choosing varieties of carrots, due regard must be paid to the following characteristics:

- Strength and resistance to splitting is preferred in all varieties to reduce the potential wastage of raw

material.

- Tolerance to root and foliar diseases. Varieties of known susceptibility to Cavity Spot must only be used when there are no acceptable alternatives, or the location historically has little or no incidence of the disease. Varieties exhibiting strong healthy foliage are preferred.
- Selected varieties must match intended soil types as soil texture has a direct effect on skin finish and carrot length.
- Only varieties of known frost tolerance should be grown for late open lifting without straw or soil protection.
- Skin and crown quality.
- Seed health status.

6 Crop nutrition

6.1 Nutrient requirement

Major nutrients

Prior to cropping, the field nutrient status must be determined by sampling and analysis. Analysis is required for each field as fertiliser application must be in accordance with crop need and soil reserves.

A blended phosphate, potash, sodium and magnesium base fertiliser is normally applied to the soil prior to ploughing, stone separation or bed making. Where the soil pH is low it may be necessary to apply a liming material. Where potash requirements exceed 150 kg/ha, the excess should be applied as a top dressing at 2 - 4 true leaves.

- a. Almost all carrot production areas are within the revised Nitrate Vulnerable Zones (NVZ) published. Carrot crops are low N users but it is nevertheless important that nitrogen applied is in accordance with crop requirements and large single or excess applications are avoided.
- b. Growers are encouraged to more fully understand crop off-take on their soil types so as to provide evidence in support of total nitrogen applied.

Carrot crops are particularly effective at taking up residual soil nitrogen and can play a valuable part in the reduction of nitrate losses from the soil.

Examples of typical fertiliser recommendations may be found in Appendix 1.

Trace elements

Many sandy soils, particularly where the pH is high, are deficient in available trace elements. Deficiencies of manganese and copper are common and are best corrected using specific inorganic trace element foliar sprays. To correct a low soil boron status it is convenient to apply a boronated base fertiliser if the soil pH is below 7 or foliar spray if the soil pH is above 7.

The crop nutrient status can be readily checked during growth using leaf tissue analysis. This can be a useful guide to the need, or otherwise, of trace element treatments.

Where trace element and multi-nutrient foliar feeds are used routinely, there is a need to demonstrate that such treatments are justified through tissue or other appropriate analysis.

All unnecessary fertiliser and trace element treatments must be identified and avoided.

7 Irrigation

Irrigation response

Adequate soil moisture at seed depth is essential to give satisfactory plant establishment. Conservation of moisture during land preparation and at drilling is, therefore, essential. Irrigation has proven very beneficial in dry spring conditions as an aid in crop establishment. Accurate timing of irrigation for establishment is essential.

Many of the soils used for carrot production contain only small amounts of available water for growth and development. Typical moisture holding values for a loamy sand soil are 130 mm per metre depth, sufficient in mid season to satisfy the transpiration demand of main crop carrots for about three weeks. Such soils often overlay moisture bearing chalk or loamy subsoil and as the crop is deep rooting it can often exploit these reserves to maintain some condition until rain returns. However, for consistent quality combined with commercially worthwhile yields, adequate irrigation is essential.

Early crops by definition do not have time to rely solely on natural moisture so they must be watered to maintain a high growth rate and to achieve a good skin quality. Irrigation is sometimes used to freshen a summer crop before lifting and to maintain skin finish and achieve a turgid product.

Irrigation scheduling

Scheduling systems help forecast the timing of irrigation and the priority order. A field inspection to examine the soil profile is essential to confirm when the profile is becoming dry and to check on the success of the applied irrigation. Capacitance/neutron probes and other soil moisture sensor techniques that give a direct measure of soil water are becoming more widely available and their use is encouraged to maximise irrigation efficiency.

Irrigation water is a scarce resource and it must only be applied in accordance with need.

8 Crop Protection

8.1 The basic approach to crop protection

The guiding principle is that pesticide use should be minimised. An integrated approach should be adopted to achieve this involving the following management steps.

Planning

- *sensible crop rotations to avoid build-up of problems.*
- *careful site selection to avoid potential or previous problems thereby enhancing crop health and cleanliness.*
- *use of resistant varieties that exhibit the required quality characteristics.*
- *adopt appropriate target populations to avoid over maturity prior to harvest.*

Cultural preventative techniques

- *sound crop and field hygiene.*
- *promoting crop health by ensuring effective nutrient availability through soil analysis and accurate application of fertilisers and trace elements.*
- *utilising available irrigation to promote healthy growth and to control susceptible pests.*
- *exploit drilling periods that minimise pest risk.*
- *consider crop covers to minimise pest attack.*
- *avoid growing crops adjacent to late harvested crops of the previous season.*
- *formulate an anti resistance strategy wherever approvals allow.*
- *volunteer carrots and parsnips on "Set Aside" and waste ground provide a dangerous source of pest and diseases and must be effectively controlled.*

Corrective action

Where corrective or protective action is necessary the following approach must be adopted.

- a. The need to take corrective or protective action must be established by regular monitoring and reference to established thresholds. The effect of prevailing and predicted weather conditions on the need for treatments must be considered.
- b. The availability and use of biological and natural methods of pest and disease control must be reviewed and applied if appropriate.
- c. Where chemical control is essential:
 - o Select the least toxic and persistent product which will provide control with due regard to its efficiency and ecotoxicity.
 - o Use the minimum effective dose.
 - o Use an appropriate application method with effectively maintained equipment.
 - o Use selective and spot treatments whenever appropriate.
 - o Time the treatment accurately.

Spray applications, which are not totally justifiable, must be avoided.

8.2 Plant protection product choice

See Generic Standards and/or Generic Guidance Notes.

Approved uses not included on the product label

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

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

In the case of products with older approval an electronic approval may not be available. In these cases growers should contact the PSD Information Services Branch for details of the approved conditions of use.

Contact details are: information@psd.hse.gsi.gov.uk tel. 01904 455 775

8.3 Advice on the use of pesticides

See Generic Standards and/or Generic Guidance Notes.

8.4 Application of pesticides

See Generic Standards and/or Generic Guidance Notes.

8.5 Records of application

See Generic Standards and/or Generic Guidance Notes.

8.6 Protective clothing/equipment

See Generic Standards and/or Generic Guidance Notes.

8.7 Pesticide storage

See Generic Standards and/or Generic Guidance Notes.

8.8 Empty pesticide containers

See Generic Standards and/or Generic Guidance Notes.

8.9 Pesticide residues in fresh produce

See Generic Standards and/or Generic Guidance Notes.

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

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

The key targets are:

- **Utilising combinations of reduced rate pre-emergent herbicides. With the loss of key herbicides at the end of 2007-this may not always be possible**
- **Optimising late application of fungicides to the edible part of the crop**
- **Optimising the use of post harvest treatments**
- **Ensuring minimum harvest intervals are followed**
- **Ensuring that application equipment is applying products correctly**

See Appendix 8 for the pesticide targets and guidelines on this crop.

8.10 Pest, disease and weed control

8.10.1 Pest control

8.10.1.1 Nematodes

Soil migratory nematodes are widely distributed in sandy soils and can cause severe economic damage to carrot crops through direct injury to the seedling taproot, causing "fanging" and/or root knots or lesions. For this reason, most carrot crops have been traditionally treated with nematicide at drilling. Other historical reasons for fanging include leaching of pesticides or damage occurred by poor distribution of manure.

Where sampling is undertaken and nematicide justified, a reference untreated area should be left to allow evaluation of the threshold that presently exists. The nematicides currently recommended for use in carrots are listed in Appendix 2.

8.10.1.2 Carrot Fly

Carrot Fly is a widely distributed and serious pest of carrots and treatments for its control account for most of the insecticide applied in this crop. The main problem is larval mining of the swollen taproots, especially in late-lifted crops. The severity of damage increases from November onwards.

The following can be effective in reducing the intensity of attack:

- i. *Do not site new crops adjacent to or following over-wintered carrot or parsnip crops.*
- ii. *Do not site carrots next to last year's celery crop, as celery is very attractive to carrot fly.*
- iii. *Choose large open/exposed fields (>20Ha) to grow maincrop and over-wintered crops.*
- iv. *Over-wintered crops should avoid small fields (<10Ha), sheltered fields with boundaries of trees, hedgerows and nettle beds.*
- v. *Separate early and late crops (including parsnips, celery and parsley). A separation between late and early crops of 2km or more would be ideal.*
- vi. *Harvest early crops and the headlands of storage crops promptly.*
- vii. *Aim for a minimum of 5-year rotation.*

Carrot fly forecasting and monitoring

The HDC-funded carrot fly activity forecast is available by subscription to all levy payers and can give useful guidance on regional root fly activity. Field traps are an effective way of monitoring local activity and are more appropriate to individual circumstances. Both systems combined with local knowledge can be applied usefully to assist in the correct use of carrot fly control measures. Professional help is readily available in setting up trapping schemes and in recording and interpretation of results.

Chemical control of first generation

It is important to achieve good control of first generation carrot fly as this lessens the second-generation attack and minimises summer damage.

To achieve this, first early (autumn/winter sown under polythene film) crops can be harvested before the carrot fly develops to the root penetration stage, which can occur from early August.

On second early (first open sown) crops a spray treatment for first generation control may be required. This must be timed to coincide with adult carrot fly activity.

For maincrops, from emergence, during the period of detected first generation carrot fly activity, a timely application of a lambda-cyhalothrin insecticide will be required to prevent attack to and loss of seedlings.

Alternatively, tefluthrin (Force®) seed treatment can be used for crops drilled from mid-March and harvested before mid-August. Earlier use of Force® seed treatment is not justified as the tefluthrin persistence would be inadequate to cover the first generation risk period, traditionally from weeks 15 to 27 (subject to area).

The following factors need to be considered in choosing an insecticide for first generation carrot fly:

- a. The pest spectrum, e.g. aphids, cutworm.
- b. The option to adopt tefluthrin seed treatment.
- c. A full COSHH assessment.

Chemical control of second generation

Correct timing, particularly of the first treatment of the second generation programme is crucial. This is best determined by carrot fly trapping and may be assisted by the HDC carrot fly forecast.

A full programme of treatments is only required for crops grown in high-pressure carrot fly areas. In all other circumstances a reduced programme of treatments must be used.

Crops that do not require treatment for second-generation carrot fly are those harvested before the end of August.

In some seasons, the second generation may extend beyond early October, or even a third generation may

appear. Commercial experience suggests that NO treatment for carrot fly is justified from mid-October.

Recommended application rates and number of applications must not be exceeded. Insecticides are to be applied at the appropriate volume as indicated on respective approvals.

Currently approved insecticides for carrot fly control are listed in Appendix 2.

Reducing pesticide usage

Non-chemical solutions to carrot fly control in the form of crop covers are available although cost is likely to limit use.

Intensive chemical programmes are not needed where there is little pest activity. Correctly sited and managed orange sticky carrot fly traps will provide individual field guidance on incidence levels. Spray programmes should start only at the beginning of carrot fly activity. Where there is little pest pressure, regular sprays to the outer 24 metres of the crop supplemented with peak activity full field sprays will often provide a satisfactory level of control.

Avoid cropped headlands as these attract the most pests or, in the case of storage crop headlands, harvest these early. Regular monitoring of all crops will provide information that can be used to limit the damage from pest attack.

8.10.1.3 Aphids

Carrots are hosts to Willow Carrot Aphids that can transmit serious virus diseases. Migration from winter hosts starts in May to early June to the new season's crops. Other aphid species commonly infest carrots and, if they are forming active and damaging colonies, treatments will need to be applied. CSL can provide a useful aphid monitoring service for grower groups/regions. *Unless aphids are found to be present in crops, aphicide sprays must not be applied.*

Chemical control

A list of currently approved aphicides appears in Appendix 2.

8.10.1.4 Cutworm

Cutworm attacks are common every year but larval survival and economic damage is mostly confined to light soils and dry seasons. Cutworms may reduce yield on late-drilled crops by severing seedling plants from their taproots but the most serious effect is on the loss of quality caused when cutworm larvae mine into maturing carrots.

Cutworm monitoring

It is not practical to monitor turnip moth eggs or juvenile cutworms on foliage, as they are just 1.2-1.3 mm long when they burrow underground.

Monitoring systems for turnip moth (adult cutworm) activity are well developed but turnip moth monitoring alone will not give a guide to correct spray date; that is related to the development of the larvae. Spray warnings are based on dynamic models that will show when sensitive crops should be treated.

Routine treatment can be unnecessary or wrongly timed. Regularly irrigated crops often do not require treatment. Producers are urged to seek professional advice in this area.

Chemical and biological control

A list of insecticides currently approved for control of cutworms in carrots is given in Appendix 2.

8.10.1.5 Other pests

Chafers, wireworms, silver Y moth, springtails and bean seed fly can all on occasion cause crop damage

8.10.2 Disease control

8.10.2.1 Seedling diseases

Alternaria species, which can adversely affect establishment, may be carried on seed and commercial seed lots are routinely treated with fungicide to control these pathogens. Some soil borne diseases can also be suppressed by fungicide seed treatments.

Seed treatments are relatively cheap, effective and the most desirable method of seedling disease control. Seed known to carry a high Alternaria count should not be sown.

8.10.2.2 Root diseases

Cavity spot (*Pythium violae*/*P. sulcatum*)

Cavity spot remains a major problem in many carrot-growing areas, particularly in late lifted crops and in wet seasons. Infection pressure appears to increase with frequency of cropping. It can occur on soils not previously cropped with Carrots or related crops so previous cropping is not an infallible guide to risk.

Cultivars differ in susceptibility, so varieties with lower susceptibility should be selected particularly for later lifted crops and higher risk sites.

Partial control of *P. violae* is possible with metalaxyl-M applied as a soil fungicide at drilling or within six weeks of sowing. Commercial experience indicates application at 1 TL for optimum efficacy.

A soil ELISA test can provide an indication of site cavity spot risk both before and during the growing season. This test is available commercially and producers are urged to continue to evaluate the usefulness of this test in their own circumstances and to monitor and record the incidence and control of cavity spot in fields in which the soil test has been used.

The incidence of cavity spot increases in lower pH soils, on land recently manured, in wet growing seasons and in over-mature crops. Grower experience indicates that parsley grown within the rotation may significantly increase the risk of cavity spot. Work carried out at HRI Wellesbourne suggested that free Ca²⁺, applied at drilling, significantly reduces the incidence of cavity spot. This has not been fully validated and growers must be aware that any calcium product that increases localised soil pH will also increase the risk of scab!

Crown Rot

Crown Rot is a particular problem in the cooler and wetter growing areas and is also occasionally observed in East Anglia. The symptoms of darkening and breakdown of internal tissues from the crown of the mature root frequently follow autumn foliage die-back. Studies of the fungal pathogens found *Alternaria*, *Fusarium* and *Itersonilia* to be interacting, giving a complex symptom. There appear to be no distinct varietal differences in susceptibility between currently used cultivars.

Reassess root and foliage quality to evaluate harvest sequence so as not to waste late applications on potentially problematic fields.

Various approved fungicides will assist in the control of Crown Rot (ref Appendix 3). However, growers may minimise the risk by arresting excessive foliage development by timely nitrogen and irrigation applications.

Violet Root Rot (*Helicobasidium purpureum*)

Incidences where Violet Root Rot is causing economic damage to Carrots appear to be increasing. It is particularly prevalent following warm summers. Long rotations and avoidance of sites where there is any history of Violet Root Rot is the only control measure currently available. Carrots and many arable root crops are susceptible.

Common scab (*Streptomyces scabies*)

Scab is prevalent on Carrots grown on coarse sandy soils of high pH but also occurs on other soil types in seasons when the early summer period is dry. The root appears susceptible to infection at the seedling stage and well-timed light irrigation can provide some control. Scab lesions darken and enlarge with age and can become infected with secondary bacteria. Severe scab causes wastage and must be avoided.

Liquorice rot (*Mycocentrospora acerina*) and *Fusarium* species

These soil pathogens cause dark lesions on the crown and shank of the root. They may occur where carrots are affected by scab but this is not always the case. Irrigation to limit the incidence of scab may reduce the incidence of these pathogens.

Acrothecium carotae

This pathogen has caused severe problems in long-term cold stored carrots in Denmark, Sweden, Norway and Holland. The disease has also been noted in strawed down field-stored carrots in Denmark and in the East Midlands. The disease causes dark brown to black lesions, which are moist, mostly circular spots 0.5-1.2cm in diameter distributed haphazardly on the root. The disease tends to express itself from February onwards. Low pH soils may exacerbate this disease.

Chalara elegans

This soil borne pathogen (or the closely related *Chalara thielavioides*) causes surface blackening (caused by production of spores) of washed carrot roots. The pathogen is widely distributed in soils throughout much of the world. There are no field control measures and no resistant varieties. The disease expresses itself during warm, humid summer and early autumn periods, especially if the product has been pre-packed. Cold storage inhibits development and the disease often develops in retail stores which sell the carrots at ambient temperatures. Control measures in the washing and packing facility include use of good factory hygiene, very clean water and multiple fresh water rinses, which are more effective with the addition of food-approved surfactant and biocidal rinsing aids.

8.10.2.3 Foliar diseases

Currently approved fungicides are listed in Appendix 3.

Alternaria (*Alternaria dauci*/*A. radicinum*)

Alternaria blight can reduce plant populations and damage foliage. *Alternaria radicinum* may invade roots during storage causing dark lesions on root shoulders. Seed treatments containing fungicides help control the seed-borne phase of the disease and infected seed should always be treated. Good field hygiene and crop separation will limit the spread of *Alternaria* between crops. A number of fungicides are available that have good protectant activity against *Alternaria*. An application of iprodione plus thiophanate methyl for control of

crown rot will give useful control of *Alternaria* foliage blight and suppression of *Sclerotinia*.

Many varieties now exhibit improved Alternaria tolerance. These should be used in high-risk situations. Timing of foliage fungicides may now reflect risk periods and commercial Decision Support Systems (DSS) are available.

Crop monitoring systems, which utilise spore traps and microscopic examination of the leaves can be extremely effective in evaluating the need for fungicides for control of Alternaria

Crop prediction (DSS) and/or crop monitoring systems must be evaluated in those areas where *Alternaria* poses a crop risk.

Powdery mildew (*Erysiphe heraclei*)

Powdery mildew develops as a grey mycelium on the upper leaf surface. Yield may be reduced following early severe attack, which is more likely in warm dry seasons. Fungicides are best applied at the first sign of mildew attack when lesions can be clearly identified. Repeat treatments may be necessary on late crops and on bunching carrots. Routine treatments must be avoided.

Avoidance of moisture stress will minimise the crop susceptibility to mildew.

***Sclerotinia* (*Sclerotinia sclerotiorum*)**

Sclerotinia will attack carrot foliage and can progress into the crown of the root to cause a root rot. Crops which have very vigorous foliage are the most susceptible to attack. Avoiding the conditions that lead to excessive foliage growth will limit the incidence of the disease.

***Cercospora* (*Cercospora carotae*)**

Cercospora is an occasional disease of UK carrot crops. Like *Alternaria*, it causes a leaf blight which can seriously affect yield. Key differences between *Cercospora* and *Alternaria* are - *Cercospora* tends to attack younger leaves and *Alternaria* attacks older leaves first, and *Cercospora* is more active during warmer, earlier periods of the season.

8.10.2.4 Cool storage diseases

Various fungal and bacterial pathogens can develop on stored roots particularly those that have been damaged during harvesting operations or have been badly handled.

Only roots that are free of disease symptoms should be cool stored. The lifting and handling system needs to be carefully designed and managed to eliminate as far as possible all sources of damage. Once roots are in the store the temperature must be reduced rapidly to avoid the development of bacterial rotting. All stored crops must be monitored regularly to detect the development of any storage problem so that appropriate action can be taken to reduce potential crop wastage.

Good husbandry and handling together with the maintenance of the correct storage environment will assist in lowering the incidence of fungal and bacterial rots.

8.10.2.5 Other diseases

Carrot Motley Dwarf Virus

The willow-carrot aphid spreads carrot motley dwarf virus. Infected plants are stunted with yellow crinkled and mottled foliage and fail to develop normal roots. Good control of the aphid vector will limit the spread of

virus within and between crops.

Infection pressure can be reduced by good hygiene with respect to residues of old carrot and parsnip crops.

Parsnip Yellow Fleck Virus

Like the carrot motley dwarf virus the parsnip yellow fleck virus is spread by aphid activity within the crop. Unlike carrot motley dwarf virus however, infestations are not localised but spread sporadically throughout the field

Infected plants wither and centre leaves rapidly turn brown/black

The carrot crown develops brown staining within the tissue - a symptom not dissimilar to crown rot.

With the loss of O.P. insecticides aphids are more commonly colonising in crops and therefore routine field inspections and prompt treatment are essential.

8.10.3 Weed control

Following the loss of a number of important herbicides as a result of the Pesticide Review, growers are encouraged to adopt and perfect more cultural methods of weed control, to include timely inter-row cultivation and use of selective herbicide treatments where possible.

Whilst herbicides are available, a balance between herbicide efficacy and persistence must be considered. Repeat 'low-dose' programs and tank mixes are often necessary in order to cover the complete weed spectrum. Later drillings may have the opportunity (depending on soil type and weather) to adopt stale seedbed techniques to minimise the weed pressure.

With the recent development of sophisticated hoes mechanical weeding is not only an option but has a definite place within the control strategies. Timings need perfecting so as not to stimulate excessive weed finishing prior to canopy closure. This is particularly effective for the control of Fool's Parsley and Mignonette.

Certain weeds are so closely related to Carrots that selective chemical control is impossible. Examples such as hemlock and wild carrot can be particularly problematic and must be avoided. Fields containing significant proportions of these weeds must not be cropped with early polythene-covered Carrots, as mechanical control methods are not possible while the crop is covered.

All such weeds emerging through the crop and producing viable flowering shoots must be machine topped, weed wiped or hand pulled to prevent the production of seed and further contamination.

Where weed pressure is low but the species present are important (e.g. volunteer potatoes) hand weeding, or selective glyphosate dabbing, should be considered as a priority over spray applications. Where the weeds present occupy distinct areas of the field or the sides of the beds, only selective or directed treatment is necessary.

Carrots are generally grown on soils prone to leaching, therefore care must be taken that no herbicides appear as major pollutants of ground water. (Refer to respective LERAP status in Appendix 4.)

Currently approved herbicides are listed in Appendix 4.

9 Harvesting and storage

9.1 Hygiene

See Generic Standards and/or Generic Guidance Notes.

9.2 Post harvest treatments

See Generic Standards and/or Generic Guidance Notes.

9.3 Post harvest washing

Washing

The crop is mostly fresh washed as required for production and sales. If holding or buffer storage is essential then the incoming produce must be kept cool and moist.

It is essential that the washing area allows an efficient and rapid throughput of raw material in order to maintain quality in the final product. The washing area must be separated from the packing area so that clean and dirty areas are distinct.

All equipment must be well designed and manufactured for minimal damage and ease of cleaning. This is particularly important for helping to control *Chalara elegans/thielavioides* infestation. An efficient in-line hydro-cooler will remove much of the field heat and assist in the preservation of freshness and shelf life.

Carrots are commonly size graded over diverging or drop roller graders. The larger grades are presented loose and the smaller sizes are tray and pre-packed.

All roots to be marketed must be inspected on a well-lit belt or roller table where defective roots can be removed from the sample.

Water supply

Water can be drawn from any source providing its quality is satisfactory as per the Water Supply [Water Quality] Regulations, 2000. Microbiologists can advise on suitability and treatment of water supplies. Routine checking of non-mains supplies should be carried out. A final rinse with clean water is essential.

Efficient soil extraction on harvesters and at the washer intake will reduce the volume of wash water required and help conserve supplies.

Waste water disposal

Disposal systems must cope with:

- a. the volume of liquid waste and its fluctuation
- b. the quantity of solids therein, and
- c. the polluting nature of dissolved organic matter.

Large seasonal and day-to-day variations of quantities are normal and adequate provision should be allowed for these and for rainfall.

There are statutory powers to prevent the pollution of underground water by discharge of effluent. Underground pollution can be traced to land used for disposal of solid or liquid wastes and great care is needed to prevent this. Pollution of streams and water supplies derived from wells, springs and boreholes can lead to action by the local water authority (Environment Agency/water company). Screening and sedimentation techniques must be used to separate solids from water.

Every discharge (except clean roof water), reaching certain tidal and all non-tidal rivers requires the prior

approval of the Environment Agency.

Waste solids disposal

Waste vegetable material and soil often contains significant levels of persistent pests and diseases.

Particular attention must be given to the disposal of infected carrot waste, as this can be a major source of Violet Root Rot and other important root crop diseases. Wherever possible, waste must be composted on land that will not be used for crop production. It is essential that solid pack-house and washer waste is not returned to land that is likely to be cropped with roots.

The sale of infected stock-feed roots could lead to further spread of persistent diseases and customers should be made aware of the risks of feeding infected roots to livestock on fields which will be cropped with roots.

Water recycling

There must be an adequate cleaning and conservation policy for water used for washing (See Generic Standards 9.3.1).

Wherever possible, water for washing should be reused. Effective screening, sedimentation and storage are required. A standard practice is to use fresh potable water for the final rinse which feeds back to the hydro-cooler; the hydro-cooler water feeds back to the washers; the washer water feeds back to the pre-cleaners; the pre-cleaner water is discharged to the appropriate effluent treatment system. A chlorinating plant or other effective purification treatment will be necessary if recycled water is to be used for final wash and rinse purposes.

9.4 Storage

9.4.1 Earthing over

Earthing over is mostly suitable for crops grown on organic soils where the peaty soil texture can give some insulation against frosting. It is a low cost technique but there can be a yield penalty, as the row configuration for earthing up does not make full use of the available space. This system is also not totally secure against frosting. The crown of the carrot needs to be well covered, as well as the shoulders of the ridge. A layer of black polythene film secured over the ridge can give improvements in frost protection.

9.4.2 Strawing

Straw covering offers good frost protection but is an expensive technique and it requires large amounts of energy to bale, move, spread and dispose of straw residues. Crops can be lifted from under straw during periods when open soil is frozen. Spring re-growth can be suppressed when large volumes of straw are used.

Straw disposal can be a major problem. For effective incorporation, straw should be thoroughly chopped and premixed before ploughing in. Coincident removal and chopping can reduce subsequent energy requirement for incorporation. The industry needs to further develop techniques to reduce the energy requirement of straw incorporation. A newly published DEFRA/ADAS booklet (Carrot Storage - A guide to crop management for in-field storage and the disposal of straw and plastic) is available FOC.

Currently the burning of carrot straw is permitted. The following minimum legislation must be observed: (other guidelines or legislation may also apply):

The Clean Air Act 1993 (dark smoke)

The Health and Safety at Work Act 1974 (worker safety)

The Highways Act 1980 (1986) (safety of road users)

The Environmental Protection Act 1990 (statutory nuisance)

As burning is only partially effective and a potential nuisance the trend is towards its avoidance through improved mixing techniques.

9.4.3 Polythene and straw

Improved frost protection is given by storing Carrots in the field underneath a layer of black polythene with straw spread over the top. This insulates against wind frost and, providing the straw layer is sufficiently deep and remains intact, limits the effect of warming spring temperatures on re-growth. Spring re-growth of carrots is light dependant; thus the use of black polythene helps retard this.

Strawing-down + black polythene is the standard storage technique in the UK of carrot crops for winter and spring lifting

Following lifting, all polythene fragments must be collected and disposed of effectively, and that in the continued absence of economic cleaning and recycling schemes, the material is best buried safely at registered landfill sites.

9.4.4 Cool storage

Cool storage in wet air systems is an established technique for buffering supplies from the field to the pack-house or for short-term storage of packed product. Historically long-term cool storage has not been used in the UK as carrot skin quality deteriorated during storage and the resultant product did not appeal to the main fresh market customers. However, with the introduction of 'polishing' washers in many packing stations, which can restore the skin finish of stored carrots to 'fresh lifted' appearance, this option may become viable. Soil type, root health and maturity, degree of root damage, harvest temperature, cooling stage and storage temperature and humidity can all affect ability of the crop to store long-term.

Vegetable crops must not be stored in the same chamber as fruit or other ethylene-producing crops as physiological damage to the vegetables can rapidly occur.

9.5 Harvesting

Specialised top lifting machines are used for harvesting in the early season when carrot foliage is strong. Where crops are particularly lush the foliage is often cut between the rows prior to top lifting. As foliar strength declines share lifters are used.

Carrot roots are very susceptible to mechanical damage and care is needed to ensure damage is minimised during all harvesting and handling operations. Damage from breakage and fresh splitting are major causes of wastage in fresh Carrots.

Breakage and splitting are believed to be related to cultivar, crop moisture status and season of harvesting with the most susceptible varieties proving practically impossible to handle without losses during the autumn and winter. In recent years work by the NIAB, commercial farmers and by plant breeders has led to the identification and use of stronger varieties and this type of damage has been reduced.

Brittle varieties must be avoided whenever stronger alternatives of equivalent quality are available.

It is vital that harvesting and handling systems are well designed, maintained and managed to reduce

the incidence of crop loss through mechanical damage.

Measures must be taken to avoid deterioration and damage of the product during harvesting, washing and storage.

10 Pollution control and waste management

See Generic Standards and/or Generic Guidance Notes.

11 Energy efficiency

See Generic Standards and/or Generic Guidance Notes.

12 Health & Safety

See Generic Standards and/or Generic Guidance Notes.

13 Conservation issues

See Generic Standards and/or Generic Guidance Notes.

Appendix 1 Typical application rates for nutrients

Major nutrient requirements (kg/ha)

(Extracted from RB209)

Nutrient (kg/ha)	SNS, P, K or Mg Index						
	0	1	2	3	4	5	6
Nitrogen (N) - all soil types	110	60	20	0 ^a	0 ^a	0 ^a	0 ^a
Phosphorus (P ₂ O ₅) (all soils)	200	150	100	50M	nil	nil	nil
Potassium (K ₂ O) (all soils)	275	225	175 (2-) 125M (2+)	35	nil	nil	nil
Magnesium (MgO) (all soils)	150	100	nil	nil	nil	nil	nil
Sodium (NaCl)	On sandy soils apply agricultural salt at 375kg/ha (200kg/ha Na ₂ O) and deeply cultivate the application into the soil before drilling.						

^(a) A small amount of nitrogen may be needed if SMN levels are low in the 0-30cm of soil

M : Maintenance

Nitrogen – Apply no more than 100kg/ha N in the seedbed. The remainder should be applied as a topdressing when the crop is fully established.

Appendix 2 Insecticides currently approved for use on Carrots

Active Ingredient (2)	Approved Use	Product Feature	Approval Type	Harvest Interval (1)	LERAP Category	Expiry Date (3)	Hazard Rating	MRL (mg/kg)
Bacillus thuringiensis var Kurstaki	cutworms	Insecticidal bacterium	SOLA 0433/07 Dipel® DF	none	none	31.08.12	Not classified as hazardous	0.01
cypermethrin	cutworms	contact, stomach acting pyrethroid insecticide	SOLA 0637/08 Toppel 100 ECâ	none	A	28.02.11	Harmful Flammable Irritant	0.05
deltamethrin	insecticide	contact and residual acting Pyrethroid insecticide	SOLA 1696/07Decis ® SOLA 1158/07 & 1652/07 Decis Protech ® SOLA 1659/07 & 1662/07 & 1659/07 Pearl Micro ® SOLA 1610/07 Bandu® SOLA 1634/07 Cleancrop Decathlon®	21 days	A	31.12.13 ^a	Harmful/Toxic Flammable	0.05

Appendix 2 Insecticides currently approved for use on Carrots (cont.)

Active Ingredient	Approved Use	Product Feature	Approval Type	Harvest Interval ⁽¹⁾	LERAP Category	Expiry Date	Hazard Rating	MRL (mg/kg)
lambda cyhalothrin	cutworms carrot fly	quick acting contact and ingested pyrethroid insecticide	Label	14 days	B	MAPP 12629 31.12.11 All others 13.11.09	Harmful	0.02
Lambda-cyhalothrin	Carrot Fly	quick acting contact and ingested pyrethroid insecticide	SOLA 0201/08 Markate 50 [®]	14 days	A	28.06.11	Harmful	0.02
lambda-cyhalothrin + pirimicarb	cutworms, aphids	an insecticide mixture combining translaminar, contact, fumigant and stomach activity	Label	14 days	A	MAPP 12961 31.01.12 MAPP 12550 31.01.12 MAPP 13246 31.12.13 ^a	Harmful	0.02 (lambda-cyhalothrin) 0.5 (pirimicarb)
nicotine	aphids, caterpillars & insect pests	general purpose, non-persistent, contact alkaloid insecticide	Label	2 days	none	31.12.13 ^a	Very toxic Part II Poisons	0.01
oxamyl	nematodes	Soil applied, systemic oxime carbamate nematocide and insecticide	Label	At drilling 84 days (12 weeks)	none	31.12.13	Toxic	0.01
pirimicarb	aphids	carbamate insecticide	Label	3 days	none	MAPP 09620, 11360, 09221, 09903, 12877, 13047, 08878 30.11.09 MAPP 12910 & 13644 31.01.12	Toxic	0.5
						all others 31.12.13 ^a		

Appendix 3 Fungicides currently approved for use on Carrots

Active Ingredient	Approved Use	Product Feature	Approval Type	Harvest Interval ⁽¹⁾	LERAP Category	Expiry Date	Hazard Rating	MRL (mg/kg)
azoxystrobin	<i>Alternaria</i> ,	Systemic translaminar and protectant strobilurin fungicide	Label	10 days	B	31.12.11		0.2
Azoxystrobin + difenoconazole	<i>Alternaria</i> , <i>Powdery mildew</i>	Systemic, protective and curative fungicide	Label	14 days	none	31.12.13 ^a	Harmful	0.2 (azoxystrobin) 0.3 (difenoconazole)
boscalid + pyraclostrobin	<i>alternaria sclerotinia</i>	Protectant and systemic fungicide	Label	14 days	B	30.09.13	Harmful	1 (boscalid) 0.1 (pyraclostrobin)
fenpropimorph	Powdery mildew <i>alternaria</i> / crown rot	Contact & systemic morpholine fungicide	SOLA 3753/02 Corbel [®] SOLA 0629/04 Clean Crop Fenpropimorph [®] SOLA 3767/02 Clean Crop Fenpro [®]	28 days	none	31.12.13 ^a	Harmful	0.05
iprodione + thiophanate-methyl	<i>alternaria</i> / crown rot	Systemic and protectant fungicide	SOLA 0525/04 Compass [®]	28 days	none	MAPP 11740 31.12.13 ^a	Harmful	0.5 (iprodione) 0.1 (thiophanate-methyl)
metalaxyl-M	Cavity spot	Systemic, phenylamide fungicide	Label	42 days (6 weeks) after drilling	none	30.09.12	Harmful Irritant	0.1
tebuconazole	<i>alternaria dauci</i> , powdery mildew	Systemic conazole fungicide	Label	21 days	B	MAPP 12105 31.07.09 All others 31.12.13 ^a	Harmful Irritant	0.5
tebuconazole + trifloxystrobin	<i>Alternaria</i> , <i>Sclerotinia</i> , Powdery mildew	protectant and systemic fungicide	Label	21 days	none	31.12.13 ^a	Harmful	0.5 (tebuconazole) 0.05 (trifloxystrobin)

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

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Appendix 4 Herbicides currently approved for use on Carrots

Active Ingredient	Approved Use	Product Feature	Approval Type	Harvest Interval (I)	LERAP Category	Expiry Date	Hazard Rating	MRL (mg/kg)
chlorpropham	annual grasses broad leaved weeds	residual carbamate herbicide	Label	pre-emergence	none	MAPP 13566 31.01.10 all others 31.07.10	Harmful Flammable	0.05
clomazone	annual grasses, broad- leaved weeds	An isoxazolidinone residual herbicide (pre-emergence)	Label	pre-emergence	none	MAPP 12598 28.02.10 MAPP 13861 31.12.13 ^a		0.01
cycloxydim **	V. cereals, cover crops, perennial annual grasses	translocated post-emergence oxime herbicide	Label	42 days (6 weeks)	none	31.12.13 ^a	Harmful	0.5
fluazifop-P- butyl **	annual & perennial grass weeds	phenoxypropionic acid herbicide	Label	56 days (8 weeks)	none	31.12.13 ^a	Harmful	0.3
isoxaben	annual dicotyledons General broad leaved weed control	soil acting amide herbicide	SOLA 2209/96 Flexidor 125 [®] SOLA 0855/94 Flexidor 125 [®] SOLA 0892/05 Flexidor 125 [®] SOLA 0895/05 Flexidor 125 [®]	pre-emergence (114 days)	none	31.12.13 ^a	none stated	0.05
linuron	annual meadow grass broad leaf weeds	contact and residual urea herbicide	Label	50 days	B	14.10.12	Toxic	0.2
metribuzin	Wild Mignonette & Fools Parsley	contact and residual triazinone herbicide	SOLA 2949/06 Clean Crop Solmet B [®] SOLA 0794/08 Clean Crop Solmet B [®] SOLA 0394/03 Clean Crop Metribuzin [®] SOLA 0795/08 Clean Crop Metribuzin [®] SOLA 1887/03 Sencorex WG [®] SOLA 0589/08 Shotput [®] SOLA 0592/08 Shotput [®]	28 days	B	MAPP 12273 & 09621 30.09.09 MAPP 11960 30.09.11 MAPP 13788 30.09.12 MAPP 11304 31.12.13 ^a	Harmful	0.1

Appendix 4 Herbicides currently approved for use on Carrots (cont'd)

Active Ingredient	Approved Use	Product Feature	Approval Type	Harvest Interval (I)	LERAP Category	Expiry Date	Hazard Rating	MRL (mg/kg)
pendimethalin	annual grasses & broad leaf weeds	residual dinitroaniline herbicide	Label	1 per crop pre-emergence	B	MAPP 13816 18.11.11 all others 31.12.13 ^a	Harmful	0.2
propaquizafop **	V. cereals, Cover crops perennials/annual grasses	phenoxyalkanoic acid foliar acting grass herbicide	Label	28 days	none	MAPP 12034 31.03.09 MAPP 10763 31.05.12 All others 31.12.13 ^a	Irritant	0.1
prosulfocarb	Broad leaved weeds and grass weeds	thiocarbamate herbicide	SOLA 3774/07 Defy [®]	84 days	B	31.12.13 ^a	Irritant	0.1
tepraloxymidim **	annual grass weeds	systemic post emergence herbicide	Label	21 days	none	MAPP 14026 30.08.12 All others 31.05.15	Harmful	0.5 ^c
trifluralin	germinating broad-leaved weeds. Annual grasses	soil incorporated dinitroaniline herbicide	Label	pre-emergence	none	20.03.09	Irritant Harmful	1

Appendix 5 Seed treatments currently approved for use on Carrots

Active Ingredient	Approved Use	Product Feature	Approval Type	Harvest Interval (1)	LERAP Category	Expiry Date	Hazard Rating	MRL (mg/kg)
cymoxanil/ fludioxonil/ metalaxyl-M	seed treatment	fungicide seed dressing	SOLA 1191/02 Wakil XL [®]	Pre-drilling	none	31.12.13 ^a	none stated	0.05 (Cymoxanil) 0.05 (Fludioxonil) 0.1 (Metalaxyl-M)
thiram	seed treatment	protectant dithiocarbamate fungicide	Label	Pre-sowing	none	31.12.13 ^a	Harmful	0.1
tefluthrin	Seed treatment	soil acting pyrethroid insecticide seed treatment	SOLA 0534/04 and 0547/05 Force ST [®]	at drilling	none	31.12.13 ^a	Harmful	0.05

Appendix 6 Pest control currently approved for use on Carrots

Active ingredient	Approved Use	Product Feature	Approval Type	Harvest Interval (1)	LERAP Category	Expiry Date	Hazard Rating	MRL (mg/kg)
aluminium ammonium sulphate	birds and mammals	inorganic bird and animal repellent	Label	none stated	none	31.12.13a	none stated	0.01

Appendix 7 Growth suppressant currently approved for use on Carrots

Active Ingredient	Approved Use	Product Feature	Approval Type	Harvest Interval (1)	LERAP Category	Expiry Date	Hazard Rating	MRL (mg/kg)
maleic hydrazide	growth suppressant	A pyridazinone growth regulator	SOLA 1326/08 Fazor®	21 days	none	31.12..13a	none stated	30

Notes:

(1) or latest time of application

(2,3) not all products containing the listed active ingredients may have approval for carrots. Where it is stated in the 'expiry' column 'all others' in relation to MAPP numbers, this applies to products with approval for use on carrots

** Amendments to the Statutory Conditions of Use of Grass Weed Herbicides containing Acetyl Coenzyme A Carboxylase (ACCCase) and Acetolactate Synthase (ALS) inhibitors have been introduced to try and reduce the risk of grass weed resistance. The new restrictions came into effect from 9 October 2006 and must be observed, regardless of label conditions of use. The amendments stipulate only one application per crop of any one active substance which is an ACCCase inhibitor. Products containing an ACCCase inhibitor cannot be applied more than twice to a crop (the two products must contain a different active substance). Full details can be found on the PSD website: <http://www.pesticides.gov.uk/approvals.asp?id=1960>

Appendix 8 Guidelines on minimising pesticide residues

These guidelines have been produced after consultation between crop stakeholders and the Assured Produce crop author. They will be developed over the coming seasons as knowledge on minimising residues develops. Growers should consult with their crop protection adviser to ensure other best practices are not compromised before considering these guidelines. The table below lists the active ingredients that may give rise to crop residues and details alternative strategies.

Active Ingredient	Target: pest, weed, disease	Suggested guidelines
pendimethalin	<i>Pre-emergent weeds</i>	Use less than maximum rate and utilise additional pre-emergent herbicides in the tank mix.
azoxystrobin	<i>Alternaria</i>	Minimise exposure to seed borne <i>Alternaria</i>
iprodione	<i>Alternaria</i>	Adopt <i>Alternaria</i> resistant varieties
tebuconazole	<i>Alternaria</i>	Improve fungicide timing by adopting disease prediction (Decision Support Systems) and/or crop monitoring aids
boscalid	<i>Alternaria, Sclerotinia</i>	Use this product early in a fungicide crop protection programme
		Adopt fungicide mixtures to reduce rates of higher-risk actives. Modify husbandry to minimise disease risk: <ul style="list-style-type: none"> · Review row configurations. · Match variety, drilling and harvest period to minimise over-maturity. · Closer management of nitrogen to avoid excessive foliage development. · Closer management of irrigation to avoid excessive foliage development. · Maximise rotation interval.

The author's review of historical and potential pesticide residues in carrots identified a low risk of residue. Those identified as leaving detectable residues (all consistently below the MRLs) are pendimethalin, azoxystrobin, iprodione and tebuconazole and boscalid. These values may be further reduced through closer attention to: operator training; sprayer maintenance; calibration; and, for the fungicides, increasing respective harvest intervals etc. In the short term, growers may also wish to consider: adopting disease free seed; improved fungicide timings with disease prediction; fungicide mixes to allow reduced rates and cultural controls (i.e. choosing varieties with disease tolerances and erect foliage, reviewing row configurations, matching drilling timings with populations to minimise over maturity, and closer nitrogen and irrigation management)

Appendix 9 Control Points: Carrots

CS.57 CARROTS

- CS.57.1 You must implement a satisfactory system of crop monitoring throughout the field storage period
- Protocol reference: Section 4.6.2
- CS.57.3 You must ensure that plastic film materials used as crop covers are recovered and recycled or disposed of in an appropriate manner
- Protocol reference: Section 9.4.3
- CS.57.4 Deleted 2005
- CS.57.5 Measures must be taken to avoid deterioration and damage of the product during harvesting, washing and storage
- Protocol reference: Section 9.5
- CS.57.6 *Deleted 2007*
- CS 57.7 You must evaluate prediction and/or monitoring systems for control of *Alternaria*
- Protocol reference: Section 8.10.2.2