Assured Produce

Crop Specific Protocol

CHICORY

(CROP ID: 37)

January 2006

CONTENTS

Control Document No: 00021/06

Acknowledgements

Assured Produce gratefully acknowledges the contribution of all consultees in the preparation of this protocol, particularly Robin Buck and Julian Perowne of Jack Buck Growers.

Preface

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

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

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

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

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

Disclaimer and trade mark acknowledgement

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

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

Notes

EC Review: Major withdrawal of pesticide products
All pesticide information quoted in this Crop Specific protocol was last updated in January 2006. Please also read the accompanying Assured Produce 'Newsflash' on the website.

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

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

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

Until there are replacement approvals you can continue to use these pesticides under the LTAEU.

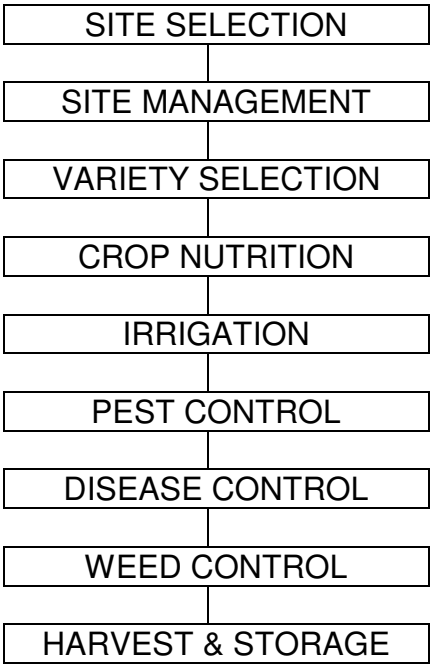
Growers should check with their advisers, manufacturers, the Assured Produce website 'Newsflashes' and the PSD website (www.pesticides.gov.uk)

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

1 General introduction

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

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



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

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

1.1 Definitions

Chicory (*Cichorium intybus* var. *sativum*), also known by its Flemish name 'witloof chicory', is grown in the field for its swollen taproot. In the dark, under controlled conditions apical buds on the taproots develop into pointed 'chicons' (a process is known as 'forcing') which are eaten raw or cooked. Radicchio is a type of salad Chicory grown for its red leaves. These, along with green leafed varieties such as Escarole and Frisee look like lettuces but have a characteristic bitter flavour. To add to the confusion, the French name for Chicory is 'endive' and for endive ' chicoree frisee'.

Witloof Chicory belongs to the Compositae family, which also includes red and green leafed Chicory, ie. radicchio (*Cichorium intybus* var. *foliosum*), endive (*Cichorium endivia*) and lettuce (*Lactuca sativa*).

2 Planning and records

See Generic Standards and/or Generic Guidance Notes.

3 Site selection

3.1 Site history

Site situation

Chicory is especially sensitive to any residue in the soil of a hormone herbicide. Such herbicides, including clopyralid, should be avoided in the previous crop. Particular care should be taken to minimise herbicide drift from neighbouring fields by careful siting and ensuring the neighbouring fields are treated in ideal conditions.

Warm south-facing fields are preferred as the optimum temperature for Chicory growth lies between 13°C and 24°C. Growth ceases if temperatures are below 7°C or above 30°C. A north-facing field should be avoided. Chicory will tolerate light frosts without damage, however, exposed sites with a history of late spring or early autumn frosts are best avoided.

3.2 Rotation

Site diseases

Certain soil-borne diseases will build up if Chicory is cropped in a close rotation, namely:

Downy mildew:	*Bremia lactucae* (Regal)
Watery soft rot:	*Sclerotinia minor* (Jagger)
	Sclerotinia sclerotiorum (Lib.) de Bary
Ringspot or Anthracnose:	*Microdochium panattonianum* (Berl.)

Bacterial Rots:	*Erwinia* spp.
	Pseudomonas spp.
	Xanthomonas spp.

The bacterial rots persist as spores in crop debris buried in soil.

The soil-borne diseases that may attack Chicory during forcing are:

Phytophthora spp., *Pythium* spp., *Erwinia chrysanthemi*, *Pseudomonas* and *Sclerotinia* spp.

All these soil-borne pathogens require host plants on which to multiply, in the absence of a host the pathogen population declines. Crop rotation, with several years between host crops, is a sustainable means of ensuring pathogen populations never build up significantly and decline in the intervening years.

A minimum rotation of one in four years should be followed if the rotation is made up from crops not susceptible to *Sclerotinia*. If *Sclerotinia*-susceptible crops are grown within the rotation, a one in six year rotation is essential provided the Chicory follows a non-susceptible crop such as cereals. Cereals are the preferred crop to precede Chicory.

Site pests

Many broad-leaved crops may host free-living nematodes of various species. If there has been a history of problems with establishment or poor crop performance caused by free-living nematodes, soil samples should be taken in the previous year. Selecting fields with minimal nematode populations is a useful cultural technique to avoid crop damage.

4 Site management

See Generic Standards and/or Generic Guidance Notes.

It is **strongly recommended** that root stocks are sampled to determine maturity and order of forcing.

5 Variety selection

See Generic Standards and/or Generic Guidance Notes.

6 Nutrition

Ensuring an adequate supply of nutrients allows crops to grow rapidly and result in high yields. Almost all plant nutrients are taken up as ions in the soil water supplied from soil reserves; therefore, careful management of soil fertility should aim to establish the correct

soil nutrient conditions before planting. While monitoring crops during subsequent growth is helpful and allows remedial applications by foliar feeds or top dressing, the penalties incurred by early nutrient shortage are rarely recovered.

6.1 Nutrient requirement

Nutrient assessment

The key factor dictating the availability of all nutrients is soil pH, monitoring and adjustment of pH is an essential first step towards good soil nutrient management. It is **strongly recommended** that macro and micronutrient needs are tested by assessing samples of soil or leaf tissue. The following table indicates which nutrients are best determined with a soil analysis and which are best determined by leaf tissue assessment:

	Soil analysis (prediction)	**Leaf tissue (confirmation)**
Soil pH	Yes	No
Nitrogen	Yes (separate testing)	Yes
Phosphate	Yes	Yes
Potassium	Yes	Yes
Magnesium	Yes	Yes
Sulphur	No	Yes (N:S ratio)
Manganese	No (use pH + texture)	Yes
Copper	Yes	Not ideal
Boron	Yes	Yes
Molybdenum	Yes	Yes

Soil samples for nutrient analysis should be taken as 25 soil subsamples (an auger sample volume is adequate for each subsample) from an area not exceeding four hectares, each to plough layer depth (usually 15 cm). Mineral nitrogen samples should be taken to 60 or 90 cm depth. The subsamples should then be thoroughly mixed (the sample should weigh approx. 1 kg) before sending to the laboratory.

Chicory will tolerate acid soil conditions (pH 5.0 to 6.8), although growth is better if pH lies between 6.0 and 6.8. Fields with a wide range of pH values can produce satisfactory crops if the cation exchange capacity (CEC) of the soil is above 10 meq/g soil. The pH effects on crop performance are more likely to be critical on low CEC soils such as light sands.

Major nutrients

Any fertiliser applications need to be made on the basis of assessment by soil or leaf tissue samples, enabling the correct nutrient to be selected and dose rates appropriately adjusted. Examples of typical fertiliser recommendations are given in Appendix 1 which originate from 'Fertiliser Recommendations Reference Book 209 (2000) 7th Edition'. It provides a sound base to guide fertiliser recommendations and applications, based on assessment of soil samples.

It is **strongly recommended** that soil nitrate sampling is undertaken and evidence held by the grower.

Micro nutrients

It is recommended that applications of micro nutrients are only made after visible leaf deficiencies or tissue analysis justify their application.

Root analysis

Nutrition should be geared to the root analysis described in Appendix 2.

7 Irrigation

See Generic Standards and/or Generic Guidance Notes.

8 Crop protection

8.1 The basic approach to crop protection

Chicory is susceptible to a number of pest and disease problems but it is a guiding principle that pesticide inputs should be minimised through prevention rather than cure.

An integrated approach should be adopted to achieve this by involving the following management steps:

a) It is a useful principle to attempt to grow Chicory crops in isolation as pest and disease infestations, if they do occur, are late and less prolific.

b) Sensible crop rotation avoids the build up of soil-borne problems or disease carry-over from one crop to the next.

Cultural preventative techniques

a) Any crop waste left in the field should be ploughed in straight after harvesting to promote rapid breakdown by soil microbes. This prevents the debris acting as a source of inoculum to the remaining unharvested crop.

b) Any crop waste (after storage and forcing periods) needs to be collected together before being taken to a designated dumping zone where it is preferably buried. Returning store crop waste to the source field is likely to result in the establishment of soil-borne diseases, and should be avoided.

c) Crops enjoying good plant health through adequate nutrient supply are more tolerant to pest and disease attack.

d) General plant health may also be assisted by reducing stresses, eg. the judicious use of irrigation.

Corrective action

a) First establish the nature of any problem by receiving regular updates on monitoring and forecast services such as the Aphid Monitoring Service from Broom's Barn Research Station. These will provide information on any prevailing general threat.

b) Monitor crops at regular intervals to detect the early presence of any pests or diseases. Care needs to be taken to correctly identify any potential pest or disease so that any corrective action is appropriate.

c) Consider any prevailing factors which may mean the pest or disease becomes less significant, eg. dry weather slows disease progress, but wet weather may reduce the threat from cutworm damage.

d) The timing of an agrochemical input can affect its efficacy. As a general rule applications early after infection or infestation are more effective than late applications, therefore, regular crop monitoring to detect early problems is essential.

e) If chemical control is needed the following points should be considered:

- use the least toxic and persistent product;
- use the most selective product to reduce the impact on naturally occurring beneficial organisms;
- use the minimum effective dose rate;
- use appropriate application methods with properly maintained equipment (exceeding the dose is illegal under COPR).

8.2 Plant protection product choice

See Generic Standards and/or Generic Guidance Notes.

Approved uses not included on the product label

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

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

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

8.3 Advice on the use of pesticides

See Generic Standards and/or Generic Guidance Notes.

8.4 Application of pesticides

See Generic Standards and/or Generic Guidance Notes.

8.5 Records of application

See Generic Standards and/or Generic Guidance Notes.

8.6 Protective clothing/equipment

See Generic Standards and/or Generic Guidance Notes.

8.7 Pesticide storage

See Generic Standards and/or Generic Guidance Notes.

8.8 Empty pesticide containers

See Generic Standards and/or Generic Guidance Notes.

8.9 Pesticide residues in fresh produce

See Generic Standards and/or Generic Guidance Notes.

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

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

The key targets are:

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

Currently there are no residue issues associated with this crop but the awareness needs to be maintained for any future issues.

8.10 Pest, disease and weed control

8.10.1 Pest Control

8.10.1.1 Leaf miner

There are no currently approved insecticides available for the control leaf miners (*Liriomyza* spp) in Chicory.

8.10.1.2 Peach-potato aphid

Several aphid species attack Chicory but only one, the peach-potato aphid *(Myzus persicae),* has shown resistance to insecticides. It is important to identify which aphid species is present to determine whether a resistance control strategy is appropriate.

Aphid populations generally increase by the females reproducing without mating, under suitable conditions populations may increase very rapidly. As a general principle, good aphid control is obtained by early treatments so regular monitoring to detect aphids and predator presence allows timely treatments to be made.

Predators are useful in controlling low aphid populations so care needs to be taken to decide if an insecticide is needed at all. If it is, a selective insecticide will not affect predators that should then control later infestations.

The following guidelines indicate how an insecticide's efficiency may be improved:

i) In general medium sized droplets work well, but if weather conditions permit fine droplets are ideal as these provide better cover of the foliage and increase the probability of direct contact (the standard rate is 250 l/ha of water) but heavy aphid infestations require increased water rates up to 500 l/ha. Water rates below 250 l/ha applied conventionally, increase the probability of poor control and need for re-application.

ii) Pyrethroid insecticides are prone to breakdown by ultra violet light so early evening applications are preferable as the aphids are likely to be mobile at night and so pick up insecticide more readily.

iii) Anticholinesterase pesticides must not be mixed unless otherwise stated on their labels, for operator safety reasons.

iv) Pirimicarb has both contact and vapour phase action, working best between 15°C and 25°C under still conditions. Its effectiveness is largely lost in windy conditions.

v) Nicotine is a broad spectrum, contact and vapour phase insecticide that works best between 15°C and 25°C. It is a general metabolic poison with no known insect resistance but it generally only achieves a partial kill.

vi) If peach-potato aphids are present the following tables provide a guide to effective product types:

Esterase resistance:

S	R1	R2	R3
pyrethroids	OP	pirimicarb	nicotine
OP	pirimicarb	nicotine	
pirimicarb	nicotine		
nicotine			

Note: As resistance increases from S to R3 aphid colour changes from lime green to rosy pink.

Modified acetylcholinesterase (MACE) resistance values:

MACE-resistant peach-potato aphids only show resistance to pirimicarb, other aphicides are effective. However, in 1996 when MACE resistance was discovered, it was only found in association with esterase resistance, this then giving the following table of effective products:

MACE + S	MACE + R1	MACE + R2	MACE + R3
pyrethroids	OP	nicotine	nicotine
OP	nicotine		
nicotine			

8.10.1.3 Lettuce root aphid

Lettuce root aphid (LRA) can become a serious pest of Chicory if the adults burrow into the soil and begin feeding on the roots. Several generations of LRA may be produced, causing sufficient root damage to result in plant stress from reduced water and nutrient uptake.

The aphid over winters as eggs laid the previous autumn on lombardy or black poplar trees. In the spring the newly hatched immature aphids live in characteristic flask shaped galls on the leaf stalks. During the spring the young aphids develop into winged forms by June. The gall changes from green to orange/brown, dries and opens to release the winged adults to fly to a suitable host crop.

Once they have reached a suitable host crop the time between landing on a leaf and burrowing down into the soil is very short - a few hours at the most. The control of LRA depends on the aphicide being present on plants before they arrive so the correct timing of aphicide requires monitoring of galls on poplar trees and noting the development of aphids within them.

LRA can be particularly harmful in drought years, because the dry conditions exacerbate the stress induced by root damage.

8.10.1.4 Cutworm

Cutworm is a general term given to the caterpillar larvae of the turnip moth. However, in some years the heart and dart moth, large yellow underwing moth and garden dart moth larvae may also cause cutworm-type problems. Risk of attack occurs under dry weather conditions on a range of broad-leaved crops, including Chicory when grown on light soils.

Adult moths emerge from May or early June until the end of July. Eggs are laid on the leaves of host plants the young caterpillars hatch 10 to 14 days later and begin feeding on the leaves. After three instars, the growing caterpillars drop to the soil surface and burrow into the soil to begin feeding on the roots and tap (storage) roots. Root feeding over June and July may cause serious damage to crops. Late attacks merely 'graze' the shoulder of the root and are not economically damaging. Through the winter the caterpillars remain underground, pupating between February and May, from which the adult form emerges.

The control of cutworms depends on killing the leaf-feeding caterpillar stages. Control measures are ineffective once burrowing into the soil has occurred. Two main options for control are water droplets (ie. rain/irrigation) or insecticide application.

Water, particularly as heavy droplets striking the crop leaves, 'knocks' young caterpillars to the soil surface, where they are unable to find leaves again and eventually die. A minimum of 12 mm of heavy rain or 25 mm of irrigation is effective at controlling cutworm larvae.

Note: If irrigation is to be relied upon, even applications are required, as no control will be exerted in the underlaps.

Pyrethroid insecticides are effective at killing young cutworm caterpillars on the leaf, and will need to be used if rainfall irrigation has not occurred in time.

Effective cutworm control depends on the correct timing of control measures. Various cutworm warning services provide timely warnings for control based on day-degree accumulation to indicate cutworm development, coupled with rainfall/irrigation data. If rain/irrigation has not intervened and 3rd instar development has been reached, a recommendation to apply insecticide is given. The use of this service ensures the use of insecticides is minimised whilst seeking to achieve effective control.

8.10.2 Disease control

8.10.2.1 Sclerotinia

Sclerotinia is an important disease of a wide range of broad-leaved crops, including Chicory. Sclerotia are the survival organs and consist of a waterproof mass of tightly enmeshed hyphae. Sclerotia may survive for over 20 years in the soil, and will grow out to infect a suitable host crop when roots are in close vicinity. Susceptible crops include carrots, parsnips, brassicas (vegetables and oilseed rape), sugar beet, and beans. Some broad-leaved crops are less susceptible, but may still host *Sclerotinia* eg. potatoes and linseed/flax. Monocotyledonous crops are not susceptible to *Sclerotinia* disease; this includes cereals (wheat, barley, triticale etc.), other graminaceous crops (maize and sweet corn) and the allium family (onions, garlic, chives and shallots).

As sclerotia last for considerable periods of time in the soil, the key to long term cropping is to prevent this disease establishing from the outset. *Sclerotinia*-free land may be sustainably cropped with vegetables so long as break crops are used in the rotation. This has the effect of either maintaining or reducing inoculum at low levels.

Sclerotinia may be particularly aggressive on Chicory in store or in the forcing room where the high humidity and wet surfaces allows the pathogen to develop freely. Managing the storage conditions may helpful to limit disease expression, but it is most effective if inoculum from the field is minimal at harvest. The use of *Sclerotinia*-free land for Chicory cropping also helps as no fungicides currently have approval for use on Chicory in the field in the UK. Rovral WP® (iprodione) is approved as a root drench at lifting and is often necessary on all late stored roots.

8.10.2.2 Phytophthora

Phytophthora spp. are common soil-borne fungi that generally affect Chicory in storage, particularly during forcing. This fungus can be severe as inoculum may build up rapidly in hydroponic systems. A combination of pH control and calcium chloride additions provide partial control. Aliette (fosetyl aluminium) will improve the degree of control. Good cleaning of the hydroponic system and hygiene generally is critical to prevent spread of infection. *Phytophthora* transmission is greatest in water or wet conditions. Good field drainage is important. Chicory is often grown on ridges in Holland.

8.10.2.3 Phoma

Phoma generally is more problematic in store than in the field. The fungus survives in crop debris between susceptible host crops; thus limiting soil inoculum build up by ensuring good rotational intervals between Chicory crops is essential. The expression of disease in store partly depends on the level of wounding at harvest so gentle handling helps reduce disease levels.

8.10.2.4 Botrytis

Botrytis is a wide spread disease that can manifest itself in store. Rovral WP® drench applied after lifting and before storage will help contain this disease.

8.10.3 Weed control

Weed control in Chicory is difficult. Only one herbicide, propyzamide, is approved in the UK. When applied pre-emergence in moist conditions, it will give good control of many weeds. However, several common weeds are outside the spectrum controlled. Mayweeds, groundsel, shepherd's purse, fat hen and small nettles are among the most troublesome and therefore site selection and previous cropping will be important.

Chicory is frequently drilled in late May so a stale seed bed technique can aid weed control. Mechanical weed control in the crop is likely to be necessary.

Currently approved herbicides are listed in Appendix 5.

8.11 Forcing

There are fewer products approved in the UK than elsewhere in Europe to protect Chicory whilst it is being forced. Hence, high levels of hygiene and separation must be relied upon for minimising pest and disease problems. Good tray washing is essential. Basins and all growing systems must be cleaned with sodium hypochlorite solutions between forcing batches of Chicory roots.

8.11.1 Fruit flies and aphids

If an infestation occurs, control using nicotine shreds is approved. Applications should be made last thing at night to minimise any health hazard to store operators and to effectively control all stages in the fruit fly's breeding cycle.

8.11.2 Diseases

There is no control available for *Sclerotinia* and *Botrytis* beyond Rovral® already mentioned. *Phoma*, *Erwinia* and *Pseudomonas* can occur but there are no products approved for their control.

Higher forcing temperatures early in the season can encourage bacterial diseases.

8.11.3 Nutrition

Calcium nitrate and trace elements are added to the hydroponic solution. Electrical conductivity levels must be constantly monitored to minimise overdosing. Conductivity around 2.0-2.5 is normal. Where pH levels are also being modified, levels must be constantly monitored.

8.11.4 Waste management

Water from growing rooms and washings should be disposed of in a non-polluting fashion.

9 Harvesting and storage

9.1 Hygiene

It is advisable that precautions are taken to ensure that the chicory handled or stored is not contaminated by, damaged or exposed to anything that could affect its food quality.

9.2 Post-harvest treatments

See Generic Standards and/or Generic Guidance Notes.

9.3 Post-harvest washing

See Generic Standards and/or Generic Guidance Notes.

9.4 Time of harvest

Harvest timing will depend on the market specification of the final root size that is usually between 3-6 cm wide at the shoulder. Chicory crops can bulk up quickly in October so careful and regular monitoring is necessary. Rain before harvest can retard and setback maturity.

Root analysis is practised in Europe and the technique is being developed in the UK. A potassium:calcium ratio of 8:1 or less is desirable. The dry matter level for late production should be more than 23%.

9.5 Harvesting

Accurate topping is important, as any overtopped roots are effectively valueless. Accurate topping also minimises the amount of foliage in store. Mechanical handling can damage roots so care is needed to ensure damage is limited in all harvesting and handling operations.

Early forced roots should be topped to 2.5 cm. Late forced roots to 5 cm.

9.6 Storage

9.6.1 Loading stores

Storage can be either in bulk or in boxes. Box storage may be preferable especially in refrigerated stores where the crop is unloaded for forcing over a long period of time. There must be adequate provision made for the removal of any free soil.

9.6.2 Storage temperature

Temperatures must be reduced as quickly as possible in refrigerated stores therefore adequate refrigeration capacity is needed. Initially the newly stored crop is respiring at a high rate so extreme caution must be taken when entering sealed stores as oxygen levels may be seriously depleted.

Early crops of Chicory require vernalization by a minimum period of chilled storage for 10 days at 5°C. Crops forced before Christmas can be stored at 0-1°C. After Christmas, the temperatures should be brought down to -1°C.

Everything must be done to maintain turgidity of the roots and minimise water loss. This includes good insulation, low temperature differentials on the evaporators in cold store, adding humidification to the store by fogging or introducing water, and also by dipping roots in water tanks.

9.6.3 Refrigerant specification

Some CFC-based refrigerant gases can damage the ozone layer it they escape from the refrigeration plant. Refrigeration plant should comply with the provisions of the Montreal Protocol and the EC's Directive EEC 91/549 on ozone depletants.

10 Pollution control and waste management

See Generic Standards and/or Guidance Notes.

11 Energy efficiency

See Generic Standards and/or Generic Guidance Notes.

12 Health and safety

See Generic Standards and/or Generic Guidance Notes.

13 Conservation

See Generic Standards and/or Generic Guidance Notes.

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Appendix 1 Typical application rates for nutrients

Major nutrient requirements (kg/ha)

Chicory	N, P, K or Mg Index					
	0	**1**	**2**	**3**	**4**	**4 +**
Fen peats						
Nitrogen (N)	40	0	Nil	Nil	Nil	Nil
Phosphate (P_2O_5)	250	200	125	100	50	Nil
Other soils						
Nitrogen (N)	75	40	Nil	Nil	Nil	Nil
Phosphate (P_2O_5)	200	150	100	50	25	Nil
All soils						
Potassium (K_2O)	150	100	50	25	0	Nil
Sands/light soils						
Magnesium	100	50	30	Nil	Nil	Nil
Other soils						
Magnesium	60	60	30	Nil	Nil	Nil

Note:

See Nitrogen fertiliser adjustment (Appendix 2)

The following table shows the ADAS classification of soil analysis results into Index values.

Nutrient Need	Index	Phosphate mg/l	Potassium mg/l	Magnesium mg/l
Essential	0	0-9	0-60	0-25
High response	1	10-15	61-120	26-50
Responsive	2	16-25	121-240	51-100
Some response	3	26-45	241-400	101-175
Little response	4	46-70	401-600	176-250
No response	4 +	71-100	601-900	251-350

Appendix 1A Nitrogen fertiliser adjustment

Dutch work suggests that after harvest roots should be sampled and analysed for major nutrients.

Target results should be in the following ranges for best forcing yields:

Dry Matter		21-24%
Nitrogen	(early forcing)	700 - 1000 mg/100gm DM
	(mid forcing)	1000 - 1100 mg/100gm DM
	(late forcing)	1100 - 1300 mg/100gm DM
Phosphate		225 - 275 mg/100gm DM
Potassium		1500 - 2000 mg/100gm DM
Calcium		270 - 290 mg/100gm DM
Magnesium		125 - 150 mg/100gm DM

In addition, the K : Ca ratio should be less than 8 : 1

Appendix 2 Nitrogen fertiliser adjustment

Correct nitrogen fertilisation is extremely important for good quality roots. Too high a level can adversely affect storage and subsequent forcing. Too low a level will affect root yield and also subsequent forcing.

Even, steady growth of the roots is important for good forcing results and small applications of nitrogen fertilisers can be useful. Mineral N samples should be taken in March/April before sowing, again in early July in the growing crop. One approach is to top up soil mineral N to 75 kg/Ha. Prior to sowing this can be done with granular fertilisers. In the growing crop small foliar applications of Urea can be used. (This should be applied on a dull day to minimise the risk of scorch). It is also important to consult the seed supplier, as some varieties are more tolerant of higher Nitrogen levels than others.

Experiments on a range of crops have determined the total amounts of nitrogen (from available from the soil and applied fertiliser) above which vegetable crops no longer respond. If the available soil nitrogen is known then fertiliser applications can be adjusted so that the total lies at maximum crop response. 'N min' techniques attempt to assess the level nitrogen which has mineralised from organic matter and is available to plants as nitrate or ammonium ions in the soil water.

Representative field soil samples at 0 to 30 cm and 30 to 60 cm depths should be taken. It is important the bulked samples are frozen if they are not immediately sent for analysis as increased temperatures (and thereby increased bacterial activity) might lead to false readings.

The analytical laboratory should provide a report sheet indicating the nitrogen available as nitrate and ammonium in ppm. Most report sheets also provide a conversion of ppm into available nitrogen as kg N/ha. In case no such conversion is provided, the following guide may be used:

For each soil horizon, add together the nitrate and ammonium ppm values to give total available nitrogen in ppm for that horizon. Add together the values for both horizons to arrive at a total nitrogen ppm for the rooting zone (ie. 0 to 60 cm). Multiply the total available nitrogen ppm value by one of the following factors to result in kg available N/ha.

Dry sand **Dry peat**	**Moist sand** **Dry loam**	**Dry clay, Dry silt** **Moist loam, Moist peat**	**Moist clay** **Moist silt**
1.0	1.1	1.2	1.4

This table assumes a soil bulk density of 1.4, if the actual soil bulk density is markedly different from this multiply the total available nitrogen ppm value by the known bulk density then divide by 1.4. To calculate the nitrogen fertiliser requirement in kg N/ha deduct the "N min" value from the desired level.

Notes: Only 40 kg N/ha should be applied as a maximum base dressing before sowing, the balance is then applied after crop establishment when the crop is growing strongly, no nitrogen dressings should be made after the 15 August. The nitrogen calculation equation for Chicory has been arrived at by adding the usual Dutch nitrogen application (i.e. 70 kg N/ha) to the average available soil nitrogen in Holland (i.e. 60 kg N/ha) to give an estimated 130 kg N/ha total requirement. This means that nitrogen fertiliser applications can be reduced if soil-available nitrogen is plentiful, or increased if it is meagre.

Appendix 3 Insecticides currently approved for use on Chicory

Active Ingredient	Product Features	Harvest Interval [1]	LERAP Category	Hazard Rating	MRL (mg/kg)
PREFERRED					
lambda cyhalothrin[2]	contact and ingested pyrethroid	7 days	A	Harmful	0.02
pirimicarb [2]	selective carbamate	7 days	none stated	Harmful	none set
cypermethrin [2]	a contact and stomach acting pyrethroid	1 day	A	Harmful	0.05
ALSO APPROVED					
nicotine	a contact insecticide	2 days	none stated	Harmful	none set

Notes:[1] or latest time of application

[2] SOLA - see Appendix 6 for specific product and expiry data

Not all formulations of each active ingredient may be currently approved for use on Chicory. Check before use. Label recommendations are revised regularly, read a current label before use.

Appendix 4 Fungicides currently approved for use on Chicory

Active Ingredient	Product Features	Harvest Interval [1]	LERAP Category	Hazard Rating	MRL (mg/kg)
iprodione [2]	protective dicarboximide	5 weeks before forcing	none stated	none stated	2
fosetyl aluminium [2]	systemic phosphonic acid	21 days	none stated	none stated	none set
azoxystrobin [2]	systemic translaminar and protectant strobilurin	21 days	none stated	none stated	none set
mancozeb [2]	protective dithiocarbamate	21 days	none stated	none stated	none set

Notes:

[1] or latest time of application

[2] SOLA - see Appendix 6 for specific product and expiry date

Appendix 5 Herbicides currently approved for use on Chicory

Active Ingredient	Product Features	Harvest Interval [1]	LERAP Category	Hazard Rating	MRL (mg/kg)
propyzamide [2]	soil-acting residual	6 weeks	none stated	none stated	0.02
triflusulfuron-methyl [2]	sulfonyl urea herbicide	before row meet	B	none stated	none set

Notes:

[1] or latest time of application

[2] SOLA - see Appendix 6 for specific product and expiry data

Appendix 6 Specific off-label approvals for Chicory

Number	Product Name	Ingredients	Expiry
2650/05	Kerb 50W®	propyzamide	Unlimited
1283/01	Aphox®	pirimicarb	Unlimited
1749/05	Phantom®	Pirimicarb	31/12/2008
0538/04	Rovral WP®	iprodione	Unlimited
0866/03	Aliette 80 WG®	fosetyl aluminium	Unlimited
2260/99	Cyperkill 5®	cypermethrin	Unlimited
1605/05	Hallmark with Zeon Technology®	lambda cyhalothrin	Unlimited
1392/94	Nicotine Shreds®	nicotine	Unlimited
1813/05	Amistar®	azoxystrobin	01/07/2008
1676/05	Dithane 945®	mancozeb	31/12/2008
0937/05	Debut®	triflusulfuron-methyl	31/12/2008

Notes:

Specific off-label approvals (SOLAs) provide for the use of the product named in respect of crops, situations or pests other than those included on the product label. Such use is undertaken at the user's choosing and the risk is entirely theirs and/or their advisers.

Specific off-label uses may only take place if all the conditions given in the "Notice of Approval" document, the product label and/or leaflet and any additional guidance on off-label approvals have first been read and understood. The conditions of approval given in the "Notice of Approval" are statutory and supersede any on the label which would otherwise apply.

All SOLAs are conditional on the extant approval of the specific product.

Appendix 7 Control Points: Chicory

CS.37 CHICORY		Score
CS.37.1	Have you evidence of soil nitrate sampling - Protocol reference: Section 6.1	1
CS.37.2	Do you sample root stocks to determine maturity and order of forcing - Protocol reference: Section 4	1
CS.37.3	Are micro / macro nutrient deficiencies identified by soil / leaf / tissue analysis where appropriate - Protocol reference: Section 6.1	1