



Assured Produce

Crop Specific Protocol

BRUSSELS SPROUTS

(CROP ID: 59)



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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 Rotations	6
4 Site management	7
4.1 Soil mapping	7
4.2 Soil management	7
4.3 Soil fumigation	7
4.4 Substrates	7
4.5 Drilling and transplanting	7
5 Variety selection	10
6 Nutrition	10
6.1 Nutrient requirement	10
7 Irrigation	12
8 Crop protection	12
8.1 The basic approach to crop protection	12
8.2 Plant protection product choice	12
8.3 Advice on the use of pesticides	12
8.4 Application of pesticides	12
8.5 Records of application	12
8.6 Protective clothing/equipment	12
8.7 Pesticide storage	13
8.8 Empty pesticide containers	13
8.9 Pesticide residues in fresh produce	13
8.10 Pest, disease, physiological disorders and weed control	13
9 Harvesting and storage	26
9.1 Hygiene	26
9.2 Post-harvest treatments	26
9.3 Post-harvest washing	26
9.4 Harvesting	26

9.5 Cooling	27
10 Pollution control and waste management	27
11 Energy efficiency	28
12 Health & Safety	28
13 Conservation	28
Appendix 1 Minor pests	29
Appendix 2 Fertiliser requirements for Brussels Sprouts (kg/ha)	31
Appendix 3 Nitrogen Index based on previous cropping	32
Appendix 4 Insecticides currently approved for cabbage root fly control on leaf, head and flowerhead brassicas	33
Appendix 5 Insecticides currently approved for aphid control in leaf, head and flowerhead brassicas ..	34
Appendix 6 Insecticides currently approved for caterpillar control in leaf, head and flowerhead brassicas ..	37
Appendix 7 Fungicides currently approved for use on leaf, head and flowerhead brassicas ..	39
Appendix 8 Seed treatments for use on leaf, head and flowerhead brassicas	42
Appendix 9 Herbicides currently approved for use on leaf, head and flowerhead brassicas ..	43
Appendix 10 Molluscicides currently approved for use on leaf, head and flowerhead brassicas ..	46
Appendix 11 Off-label approval for Broccoli by extrapolation	47
Appendix 12 Specific off-label approvals for leaf, head and flowerhead brassicas ..	48
Appendix 13 Guidelines on minimising pesticide residues	54
Appendix 14 Control Points: Brussel Sprouts	55

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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. The score required for these "**should**" control points can be found in the "APS Members' Checklist".

Disclaimer and trade mark acknowledgement

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

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

Notes:

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

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

There may be changes for the following reasons:

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

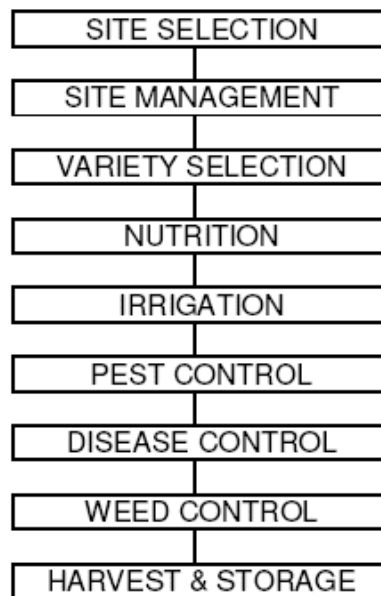
In the following Appendices products and use by dates are only listed for SOLAs, and in some cases new product MAPP numbers may not be available yet.

For pesticides on-label, only active substances are shown. Any new standards have been prefixed in the text with **(NEW)**

1 General introduction

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

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



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

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

2 Planning and records

See Generic Standards and/or Generic Guidance Notes.

3 Site selection

3.1 Site history

When selecting a site for growing a Brussels sprouts crop it is important to consider the following requirements.

3.1.1 Climate

The crop can be grown throughout the UK, although wetter areas in the West can increase the risk of ringspot. In drier areas of the South and East, irrigation may be required during periods of drought to maintain continuity. Wind erosion can be a problem on the fen soils particularly for direct drilling.

3.1.2 Weed status

Perennial weeds such as couch, docks and thistles should be controlled prior to planting/drilling a crop of sprouts. The presence of potato groundkeepers can also be a problem to control in the growing crop.

3.1.3 Topography

Fields should be suitable for use of harvest machinery and safe for the use of spraying machinery avoiding the risk of toppling over. Use of fields sloping to the South and West should be made for early production.

3.1.4 Position

Access

Easy access into the field is necessary to facilitate the use of spraying and harvesting machinery.

Pest havens

Avoid heavily wooded field margins and wasteland, where pests such as rabbits, hares and pigeons can devastate crops. Also any rodent colonies should be identified and controlled.

Obstacles

Pylons, telegraph poles, walls and fences make it difficult to operate spraying and harvesting machinery without crop damage.

Spraying safety

- a. To humans: where possible avoid cropping adjacent to schools, housing estates, playing fields etc. where there is a risk of drift from spraying operations.
- b. To flora: avoid areas adjacent to wildlife reserves, sites of specific scientific interest. Note the position of any beehives.
- c. To watercourses: buffer zones now apply where the spraying of certain pesticides, using ground based vehicle mounted/drawn sprayers, is undertaken within 5 metres of the top of the bank of a watercourse. Protocol operators should be aware of LERAP regulations introduced in 1999. Further information can be obtained from local NFU offices (see Generic Standards 8.5.5).

3.2 Rotations

Crop rotation can be used to assist with crop health in conjunction with other practices.

Club root is a problem in some brassica production areas particularly on naturally acid soils. Production in these areas should be based on a wider rotation of four to five years between brassica crops together with a well-planned liming policy. However certain areas are uniquely placed for a frost-free climate enabling good early production, requiring a balanced approach to be taken.

Brassicac crops thrive best on moisture retentive high alkaline situations and often continuous production can be sustained without detriment to crop quality or to the environment. In such cases growers must be able to justify their rotation with consideration to the following:

- a. *Crop health*
- b. Avoidance of disease carry over by incorporating post harvest residues quickly and efficiently.
- c. Satisfactory record of pH levels and liming policy

4 Site management

4.1 Soil mapping

See Generic Standards and/or Generic Guidance Notes.

4.2 Soil management

Soils

Good drainage is essential. The more retentive mineral soils such as well-structured calcareous clays and silts are the most suitable, although with irrigation the crop can be grown on a wide range of soil types. A pH level of 7.0 to 7.5 is required, particularly where club root may be a problem. Over liming is wasteful and can cause temporary 'lock-up' of some nutrients such as manganese and boron. Lime should be applied well before planting/drilling if possible. As lime takes many months to balance soil acidity it is not advisable to grow any brassicas where liming has recently been carried out in very low pH situations. Sprouts can be grown on a wide range of soil types, but lighter sandier soil types will require irrigation. One should also consider possible soil structure damage caused by harvesting on heavier soil types. The heavier soil types may also be difficult to obtain a good tilth for drilling in March or April.

Cultivations

Direct drilled sprouts are sensitive to soil surface capping, which can reduce and delay germination and disrupt uniformity of emergence, causing uneven maturity at harvest. Drill press wheels, rolling and irrigating after sowing can contribute to this problem, especially on soils of weak structure or low organic matter.

Whether the crop is drilled to a stand or transplanted, firm soil, with a good tilth is required. Timely cultivations are important, particularly on fine, sandy, or silty soils that have a weak structure and low organic matter content. On the lighter soils late ploughing with the minimum of cultivations, will help to maintain soil structure. Roots will not penetrate a compacted or smeared soil layer and high yields of good quality sprouts will not be produced unless the plants root deeply.

Loss of soil structure in the surface layers, due to excessive or inappropriate cultivations, (e.g. particularly excessive use of reciprocating tines at high speeds) can lead to soil capping and reduced emergence.

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

4.5.1 Plant populations

Plant population has important effects on:

- a. Total yield.
- b. Market for which the crop is grown.
- c. Period over which the crop is to be harvested.
- d. Cost of production.
- e. Method of harvesting.

Increasing the plant population results in:

- a. Reduced sprout size.
- b. Increased stem length.
- c. Delayed maturity.
- d. Greater uniformity of sprout development on the stem.
- e. Increased susceptibility to disease.

Overall plant population has been found to be more important than the spatial arrangement of the plants.

4.5.2 Sowing

Seedbed

Drilling can take place when soil conditions are suitable from early March, for early maturing varieties, to late April for late varieties. Under poor conditions and low temperature deferred sowing is preferable.

The seed should be sown at a constant depth of 18-20 mm, to ensure even emergence. Cabbage root fly control may be required (see Appendix 4).

Direct drilling is widely used where crops are grown at close spacing, (especially for processing market), but is sometimes used for widely spaced crops. To establish the crop the method requires greater precision than transplanting with direct drilling:

- i. Land is occupied for a longer period.
- ii. Expensive hybrid seed requirements are higher.
- iii. Less labour is involved than with transplanting.
- iv. No specialised transplanting equipment is required.
- v. Unlike transplanting, the grower is not striving to establish the crop in early-summer, possibly under dry conditions.

There is no advantage in using pelleted seed but seed priming is a technique that can bring greater uniformity and speed of emergence to field sown crops.

Vacuum or belt drills cause less damage to the seed than cell wheel drills. Ground wheel drive is superior to unit wheel drive allowing drilling to continue when the soil surface is wet.

Drilling into soils liable to cap

Minimum pressure should be applied over the rear wheels of the drill. Also drill accessories should be considered, such as:

- a. Anti-capping wheels. Twin rear wheels which run on each side of the row with a 25 mm gap between, so that the soil is not compressed directly over the seed.
- b. Cage wheels. They have expanded metal surfaces instead of the standard steel band.
- c. Small rakes. Fitted behind each rear wheel to loosen the consolidated topsoil without disturbing the seed.

Shallow drilling, with irrigation if necessary pre drilling is preferable to drilling deeper to reach moist soil. Avoid

deep drilling on soils liable to cap.

Chemicals for the control of cabbage root fly may be applied simultaneously at drilling (see Appendix 4).

4.5.3 Transplanting

Propagation

The majority of transplanted crops are grown from glasshouse raised modular transplants or small peat blocks. The modular trays (the most common size has cells of 14 ml volume containing peat compost) enable the propagator to exercise complete control over plant growth. Trays also provide a system that facilitates the application of a cabbage root fly insecticide under glass, prior to despatch. This uses less active ingredient per hectare than field applications (See Appendix 4).

To ensure the best chances of good establishment, growers should ensure that transplants are:

- *Strong and well rooted in the module.*
- *Transplanted when plants are ready and not left too long in module.*
- *Adequately drenched for cabbage root fly where necessary.*
- *Are free from pest and disease .*
- *Are fully soaked and primed with nitrogen immediately prior to planting.*

Soft, floppy plants are undesirable and can have adverse effects on establishment.

Plants should be given high nitrogen feed prior to despatch. Growers, especially those without irrigation, should ensure that the modules are at maximum water holding capacity at planting. (Avoid over watering as this can leach out cabbage root fly insecticide.) It is advantageous for the grower to have modules analysed routinely to check whether the propagator has applied the correct rate of cabbage root fly insecticide. This is especially important prior to the peaks of first and second-generation cabbage root fly. For those growers with irrigation, if the soil is dry or the weather hot or windy, water should be applied immediately post planting.

Propagators

Under EU Plant Health Regulations, propagators must be registered with the Plant Health and Seeds Inspectorate (PHSI) of DEFRA. Plant passport details may be incorporated on the delivery note or invoice.

To comply with the requirement of due diligence throughout the food distribution chain of the major multiples, details of all pesticides **must** be agreed and recorded by the propagator and passed to the grower. Applications of liquid feeds should be treated similarly.

Transplanting system

The majority of transplanted crops are now grown from modules, due to improved efficacy of cabbage root fly products, control of growth during propagation and faster transplanting techniques. The choice of strong rooting varieties and other agronomic factors have enabled the initial problems of stem lodging in the field to be overcome.

Planting can commence in April, but planting delayed beyond the first week in June will substantially reduce yield even with late maturing varieties.

Bare root plants

Bare root plants pulled from plant bed should be laid in shallow layers in trays and immediately protected from exposure to wind and bright sunshine.

If planting is interrupted after the plants have been pulled, they can be stored at 5.0°C, with a relative humidity of 90-95% for up to two weeks. If the plants are large, bolting may result from this treatment.

5 Variety selection

None of the current commercially important varieties have resistance to all the five major brassica diseases, (ringspot, *Alternaria*, light leaf spot, white blister and club root). Varieties do differ in their susceptibility to foliage diseases. The National Institute of Agricultural Botany (NIAB) records and publishes varietal susceptibility.

Provided they have good commercial qualities, future disease resistant varieties should be included in any integrated crop management system.

A succession of appropriate hybrid varieties can give a harvesting programme that spreads from August until March. Varietal choice, in combination with plant spacing, can influence button size. Some varieties, under certain prescribed conditions can be susceptible to internal browning.

Varietal choice has a greater influence on Brussels Sprout flavour than any other agronomic factor. Glucosinolates contribute to the flavour and aroma of Brussels sprouts. Chemical analysis and taste panels have found a close relationship between bitterness and the level of the glucosinolates sinigrin and progoitrin. Whenever large amounts of either, or both, of these compounds are present excessive bitterness results. A list of the relative flavour characteristics of current varieties is available from the HDC or NIAB.

Plant breeders are now selecting varieties with low levels of sinigrin and progoitrin whilst maintaining, or even increasing, the content of other glucosinolates necessary for endowing good flavour characteristics.

6 Nutrition

6.1 Nutrient requirement

Macro-nutrients

Excessive use of macronutrients is not only wasteful, but can be costly and have a detrimental effect on groundwater supplies.

Nitrogen in particular must be tailored accurately to the precise needs of the Brussels sprout crop. Excess nitrogen must be avoided because:-

- a. The crop does not need it - even in dry conditions there is no advantage in applying extra nitrogen.
- b. Maturity can be delayed.
- c. Soft unbalanced growth results in increased damage when handling, poor shelf life and increased susceptibility to disease.
- d. It contaminates groundwater supplies, possibly introducing a health risk to drinking water and exaggerates eutrophication.

Growers should use soil nitrogen prediction system such as Soil Nitrogen Supply (SNS) and where applicable Soil Mineral Nitrogen (SMN) to schedule efficient nitrogen applications. Nitrogen prediction models such as WELLN offer a complete solution to nitrogen requirement.

When using 'WELL N' soil samples should be taken prior to each crop to determine the soil mineral nitrogen content and analysed for nitrate and ammonium content.

'WELL N' takes into account the residual nitrogen in the soil and the amount of nitrogen released from the organic breakdown of the previous crop residues, and predicts the total nitrogen required. Residual nitrogen

testing also enables applications to reflect accurately the need, taking into account soil residues, thus reducing the opportunity of excess nitrate leaching into ground water.

If it is not possible to undertake nitrate analysis, a soil nitrate index should be used, taking into account previous crop and manuring. (See Appendix 3).

On intensive brassica land, where samples are being taken frequently for soil nitrate determination, it is cheap and economical to simultaneously analyse for pH, phosphate, potassium and magnesium. Otherwise, in the absence of crop failure, fields should be sampled and analysed every three years. Interim nutrient status can be evaluated using a balance sheet method.

When planning fertiliser applications, growers **must take** soil type and variety into consideration.

Nutrients should be applied according to soil analysis. Typical fertiliser recommendations are shown in Appendix 2.

Establishment of both drilled and transplanted crops can be affected adversely by excessive levels of fertiliser salts, especially from nitrogenous fertiliser in the seedbed.

Where high rates of potash are also required, the total nitrogen and potassium application prior to drilling should not exceed 190 kg/ha; the base nitrogen level may be reduced to 50 kg/ha, and the remainder of the potassium should be applied well before drilling, (in the winter if possible) and well incorporated into the soil.

Nitrogen Vulnerable Zones

Certain vegetable production areas within the UK may be designated Nitrate Vulnerable Zones (NVZ). These are areas where water sources are high in nitrate, and growers are asked to observe a programme of measures designed to reduce nitrate loss from the land and help reduce nitrate levels in water.

Key action points relevant to brassica growers are:

- Growers must plan all applications of nitrogen from organic manures and manufactured nitrogen fertilisers to each crop in each field.
- Do not apply inorganic nitrogen fertiliser between 1st September and 1st February unless there is a specific crop requirement during that time.
- Do not exceed crop requirement for quantity of nitrogen fertiliser on each field each year, taking account of crop uptake and soil supply from organic matter, crop residues and organic manures.
- Application of organic manures should not exceed 190 kg/ha of total nitrogen averaged over the farm area each year.
- Do not apply fertiliser or manures when soil is water logged, flooded, frozen hard or covered in snow.
- Consider a cover crop to use up excess nitrogen over the winter months, ryegrass, is a good choice as it does not involve a 'green bridge'. Sowing must be completed before September 15th to be of any value.

Trace elements

These should only be applied when deficiencies are evident according to analysis, where crop growth and development appears to be reduced. In the absence of adverse symptoms, a healthy looking crop may not need foliar treatment with trace elements.

pH

In common with all horticultural brassica crops the soil pH for Brussels sprouts should be maintained at 7.0 to 7.5, although this may cause problems where potatoes are grown in the rotation.

7 Irrigation

The greatest response is likely to be obtained by irrigating immediately pre-sowing in direct drilled crops. In transplanted crops irrigate soon after planting out to assist rapid crop establishment.

Plants under drought stress tend to be susceptible to pest attack; therefore adequate irrigation helps avoid attacks in addition to improving the yield and quality of the buttons.

If available, apply 25 mm irrigation to early and mid season Brussels sprouts when the lower buttons are 15-18 mm in diameter and when the soil moisture deficit is greater than 25 mm between August and October.

8 Crop protection

8.1 The basic approach to crop protection

See Generic Standards and/or Generic Guidance Notes.

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. This issue is not just one of meeting the MRL trading standard but ensuring that any individual or multi residues are kept as low as possible below this level.

The key targets are -

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

See Appendix 13 for the pesticide targets and guidelines

8.10 Pest, disease, physiological disorders and weed control

8.10.1 Pest control

The main principle, with the exception of cabbage root fly, is that control measures should only be applied when the pest is present. Routine applications of insecticides at set time intervals are not desirable. Prevention is also better than cure; therefore, wherever possible an integrated approach is strongly preferred.

Prevention

- i. Management and planning. Where geographical and agricultural factors permit choose sites away from existing brassica and oilseed rape production to avoid a continuous 'green bridge' throughout the year. Plough in crop residues immediately harvesting ceases.
- ii. Crop rotation.
- iii. Provide good soil structure, correct nutrition and irrigation if possible to ensure conditions to give good strong, healthy growth.

Control

- i. Use available pest forecasts as management tools to aid when to scout for pests.
- ii. Regular systematic crop walking to monitor crop development, pest and disease levels. Increase frequency of crop walking during periods of high pest incidence particularly during hot weather.
- iii. In addition to crop walking, use of insect traps eg. pheromone traps, chemical attractant traps and soil sampling (cabbage root fly eggs) as monitoring tools.
- iv. Once validated in the field, the use of tolerance levels may be introduced for cabbage aphids and caterpillars.

- v. Identify both pests and naturally occurring predators to determine whether it is necessary to apply control measures and where possible use selective pesticides to reduce impact on naturally occurring predators and beneficial organisms. However, choice must be weighed up against efficacy and longevity of treatment. Use the least toxic product where possible.
- vi. Resistance is building within aphid populations particularly peach potato aphid to many insecticides. It is important to alternate the use of different active ingredients to enable the best chance of control with the existing range of actives.
- vii. *Use the minimum effective dose rate, normally being that recommended. Do not reduce dose rate for peach potato aphids.*
- viii. *Consider the use of natural and biological methods of pest control if available.*
- ix. Avoid spraying, or allowing drift into grassy banks, dyke sides, hedgerows etc., as they provide reservoirs of insect predators e.g. ladybird larvae, hoverflies, ground beetles, etc. However, also consider the implication of buffer zone restrictions on certain chemical uses.
- x. Carefully consider the anticipated harvest date when selecting the appropriate product. Ensure you have enough time for the harvest interval to elapse prior to harvesting.

The use of some approved pesticides may not be acceptable to processors. In order to conform to such requirements, proposed applications should be confirmed with the contracting company.

Section 8.10.1 reviews the main brassica pests in the UK. A review of the minor pests can be found in Appendix 1.

8.10.1.1 Cabbage root fly (*Delia brassicae*)

Even light attacks by larvae, which feed on the roots, can reduce yield. Severe infestations cause stunting, bluish or purple/red discoloration of the leaves and the plants may wilt and die. There are two or three generations each year, starting from emergence and egg laying in late April - early May and extending, with some overlapping into September. Preventive treatments are essential for the peak of the first generation, irrespective of whether the crop is direct drilled or transplanted.

Occasionally in the third generation eggs may be laid on the lower buttons and the larvae tunnel into the centre. Early damage to the sprouts is not visible from the outside, but as the larvae mature they tunnel out and drop into the soil to pupate. At this stage damaged sprouts are noticeable and must be graded out. Crops maturing from August to the end of October are most at risk. A combination of crop walking and forecasting can determine whether to apply supplementary control for the buttons. It is rarely justified to treat sprout buttons maturing after November.

The eggs of cabbage root fly are attacked by several beetle species. These beetles remain in the soil for long periods and insecticides applied to other crops in the rotation can reduce their numbers.

Forecasting

Present monitoring methods include counting eggs laid at the stem base of brassicas to predict the size of the next generation, and non-selective water traps to catch adult flies. The HRI computer prediction model gives the timing and duration of populations based on statistical information and local weather data.

A chemical attractant trap is available, which selectively captures adult flies. In future, a combination of "trap" data and the HRI computer prediction model may give a more reliable monitoring system.

Control methods

Plant propagation

Pre-planting drenches

Chlorpyrifos and spinosad can be used as a pre-planting drench on block and module raised plants. Do not use chlorpyrifos on cells smaller than about 14 ml capacity. Chlorpyrifos should not be used to treat blocks/modules which will be planted out before April 1st.

When drenching with chlorpyrifos, ensure it does not become washed or leached into glasshouse soils. Where plants are treated outside glasshouses, safe disposal of all run-off liquor is required. Where chlorpyrifos drenches are used subsequent applications of pesticides in the glasshouse or in the field should be delayed until adequate wax has formed on plant leaves.

Transplanted crops

Crops grown from block or module raised plants, which were treated before planting, should not normally need any further treatment in the field; however there are occasions where subsequent treatments may be necessary:

- a. Where, due to planting delays, considerable irrigation was applied on the nursery and planting was delayed which may have led to leaching of the insecticide.
- b. Insufficient insecticide applied by propagator. It is advisable to maintain a check at planting by routine analysis of compost.
- c. Early in the season, when the incorporated treatment is not persistent enough to protect the young plants up to the first peak of egg laying.
- d. In the absence of irrigation, when the upper layers of the soil are dry or the soil conditions are cloddy, it is essential to plant deeper for the plants to survive. This necessitates covering the module with soil and thus renders the stem at soil surface level open to attack.

Treatment methods

Granules

Band treatment gives the most efficient placement and is recommended for all granules, but label recommendations may specify the exact method to be used, (e.g., surface band or bow wave, width of band etc.) Applicators must be calibrated in the field before use. Recently increases in the speed of degradation of some soil applied granules have been observed and the persistency of the product may possibly be shorter than that quoted by the manufacturer. A full list of approved actives is included in Appendix 4.

Sprays

Should only be used in areas of low cabbage root fly activity. Time of application is stipulated on product label.

Occasionally buttons are seriously affected by larvae tunnelling into them.

8.10.1.2 Brassica aphids (*Brevicoryne brassicae* and *Myzus persicae*)

Plants affected by aphids may show the following symptoms: the growth of young plants is checked, occasionally followed by wilting and death in dry conditions. On older plants, infested leaves curl and turn yellow and the buttons may be spoiled with contamination by aphids.

Invasion occurs from April to July and, in favourable weather the build up of aphids is greatest from July to October. Crops should be examined regularly from April onwards and treated when aphids are found.

There are two species of aphid that are of commercial relevance:

Mealy grey aphid (*Brevicoryne brassicae*)

A widespread pest of Brussels sprouts, which checks the growth of young plants resulting in wilting and possible mortality, particularly in dry conditions. On older plants leaves curl up and marketable quality is spoiled by contamination with the aphid colonies.

All stages, including eggs, occur on stems and leaves of winter hosts (usually other cruciferous species) winged forms migrate to summer hosts from May/June onwards resulting in an early peak during July followed by a population crash. This is followed by a second, often higher peak in September/October. Early identification and treatment is essential as once colonies become established control is much more difficult and spoilage is inevitable.

Peach potato aphid (*Myzus persicae*)

Becoming more important of late, particularly in warmer, drier seasons, this aphid rarely causes significant damage but can be present in fairly high numbers affecting marketable quality. It doesn't normally form dense colonies and overwinters as adult and immature stages, on winter brassicas and Beet crops together with many herbaceous plants outdoors and under glass. Winged forms migrate to summer hosts in May and June reaching peaks similar to those of the mealy grey aphid. The pest is an important vector of many plant viruses.

Four insecticide resistant mechanisms exist in UK populations; metabolic - conferring resistance to organophosphates; modified acetyl-cholinesterase (MACE) conferring resistance to carbamates, knock-down (KDR) and Super KDR both conferring resistance to pyrethroids. No current resistance mechanisms exist with regard to pymetrozine (Plenum[®]) or nicotine or the neonicotinoids, imidacloprid (Gaucho[®]), thiacloprid (Biscaya[®]), or acetamiprid (Insyst[®]). Use of these five actives should be made where there has been a previous history of resistance or where resistance populations are suspected.

Current work at HRI is creating forecasting techniques for aphid populations. Studies of populations show a regular midsummer "crash" where natural mortality can be greater than the use of aphicides. This normally occurs in late July - early August.

Cultural control: *Most aphid infestations develop from colonies, which overwinter on old brassica crops and autumn sown oilseed rape. Old crop residues should be ploughed in or otherwise destroyed.*

Aphid populations can be reduced by a multitude of insect predators including ladybirds, hoverflies and parasitic wasps. Crops should be walked regularly to determine the balance of predators in relation to plant size etc., to determine whether the crop actually needs spraying, or whether the predators will naturally take care of the aphids. Many factors are involved in this biological 'integrated' approach and the risks associated with the various field-walking techniques are being determined by HRI/ADAS currently.

Chemical control: Numerous insecticides are currently approved for use and should be selected from the approved list in Appendix 5. *Foliar sprays should be chosen for cabbage aphid control, selecting insecticides with the least harmful effect on beneficial insects and avoiding broad-spectrum insecticides.* Some synthetic pyrethroids, despite their reputations, often kill a wide range of beneficial predators.

Choose alternate insecticides from different chemical groups in order to avoid build-up of aphid resistance. Weather conditions and time of year should be taken into account when selecting the aphicide, eg. late in the season from October onwards, control of cabbage aphid with pirimicarb may fail. Aphids resistant to carbamate insecticides have developed in certain areas.

During dry periods the uptake of systemic insecticides is reduced.

8.10.1.3 Caterpillars

Caterpillars of many species attack brassicas and may appear at almost any time between mid-May and

November, although the degree of infestation varies from season to season. The damage caused depends upon the species responsible - both leaves or buttons may be eaten, or the very presence of caterpillars in the button makes the product unmarketable. Some species, when nearly mature, are difficult to kill with insecticides and cause considerable spoilage. *Others even when numerous, may not justify treatment.* The caterpillars of the diamond back moth feed on the undersides of leaves, leaving the upper surface as a 'window pane'. Now becoming a common pest and it can have several generations in a season. If control is needed insecticides need to be applied whilst the caterpillars are still young. To help in crop walking and establishing pest thresholds, pheromone traps are available to catch a number of moth species.

Cultural control: *Frequent crop walking is essential to identify both the caterpillar species and natural predators. Some predators are so numerous that they destroy every caterpillar in the population. In addition, some caterpillar species only have one generation per year and thus if the feeding is at a low level on the vegetative parts of the plant where no buttons are visible, chemical control may not be necessary. Commercial pheromone traps are available to monitor diamond back moth populations.*

Chemical control: Check crops regularly and apply insecticides when caterpillars found. List of currently approved insecticides in Appendix 6.

Treatment of only the crop headlands and the periphery of the field may be sufficient, as the adults of some species will tend to invade the field from the field margins.

Consider using more specific control measures such as *Bacillus thuringiensis* and diflubenzuron that do not have such a damaging effect on beneficial predators as broad spectrum insecticides.

8.10.1.4 Cutworms

Cutworms are the caterpillars of several species of noctuid (night-flying) moth; the most important of which is the turnip moth (*Agrotis segetum*). The young caterpillars hatch in June and July, feed on the foliage for at least a week, before descending to feed on the underground parts of the host plant.

Cutworm attacks are most severe in hot dry summers; routine treatment is not required. Warnings are issued based on trap catches combined with a weather model to define 'high risk' periods. When the caterpillars are small, they can be controlled by rainfall/irrigation or chemical treatment. Use pheromone traps to monitor moth numbers if local information is not available, and if irrigation is possible, apply at least 20mm of water as advised by the cutworm warning. In absence of rainfall or irrigation, control with a pyrethroid insecticide, timed as recommended by the spray warning.

8.10.1.5 Pollen beetle

Adults, dispersing principally from oilseed rape, can damage brassicas in summer. They are occasionally capable of inflicting damage to the quality buttons on early sprout crops.

Cultural control: *A forecasting service is already available to HDC members that will predict the onset of migration of pollen beetles. This should alert growers to start field monitoring. Simple yellow sticky traps set slightly above the crop level will adequately indicate the level of this pest.*

Chemical control: If beetles are found damaging the crop or are likely to contaminate harvested produce, apply an insecticide with a recommendation for application to leafy brassicas. Pyrethroids should be particularly considered because of their subsequent repellent action. Re-inspect crops frequently.

8.10.1.6 Slugs

Slugs damage brassica seedlings and established plants on medium to heavy-textured soils in wet seasons; sprout buttons may be grazed. In warm damp conditions sprouts at all levels of the plant may be attacked.

Slugs are occasionally taken with produce into the processing factory.

Cultural control: *Consolidate soils to inhibit slug movement where necessary. Surface bait traps will determine the need and timing of further control measures.*

Chemical control: Broadcast affected areas with an approved molluscicide if trap catches and weather pattern indicate a period of high risk. Aerial applications are permitted and have given good results. See Appendix 10 for a current list of approved molluscicides. *The use of metaldehyde has been found to be beneficial in preserving ground beetle populations.*

8.10.1.7 Cabbage stem weevil (*Ceutorhynchus quadridens*)

A widely distributed but sporadic pest which attacks all cruciferous crops, particularly direct drilled Brussels sprouts. The larvae feed in stems and petioles of plants, which may subsequently wilt.

Some granular treatments applied for cabbage root fly give incidental control.

8.10.1.8 Beneficial organisms

Beneficial organisms include predators, parasitoids and disease. Although a great deal of research has been undertaken regarding the biology and behaviour of natural enemy species, relatively little is known about the numerical impact that they have on pest populations in commercial brassica crops.

Natural enemies of pests can themselves be attacked by predators, parasitoids and disease; which may limit their effectiveness. They can also be affected by the use of agrochemicals, which may cause mortality, have sub-lethal effects on development or behaviour, or suppress disease outbreaks.

Finally, with cases of direct pest damage, natural enemies are often effective only after the crop damage has been done. The presence of some natural enemies in produce may also at times cause problems for growers.

Predators

Specific predators - such as ladybird larvae and adults and hoverfly larvae consume only aphids. They are able to consume large numbers of aphids but may be present in crops only at certain times of the year.

Generalist predators - Many predators consume a wide range of pest and non pest species. Generalist predators include species of beetles, spiders, mites, harvestmen, lacewings, flies, earwigs, ants, bugs, wasps and vertebrates such as birds and small mammals. It is estimated that, in cereal fields, there may be about 400 species of generalist predator. Laboratory studies have shown that some predators are able to consume large numbers of pests. However, predation rates in the field will depend upon how often particular pests are encountered and whether there are alternative sources of food. Some species, such as ground beetles, eat both live and dead material.

Parasitoids

Parasitoids spend their larval stages as parasites, feeding on host tissue and killing the host in the process. They tend to be fairly specific, although some species will, for example attack several species of aphid.

The cabbage root fly is attacked by two main parasitoids, a wasp and a rove beetle. The adult rove beetle is also a predator. Rates of parasitism vary from crop to crop and are reduced usually when non specific insecticides are used.

Cabbage aphids have only one parasitoid, the small wasp, *Diaeretiella rapae* which also attacks the peach potato aphid. The life-cycles of aphids and their parasitoids are closely linked. Again, levels of parasitism vary

between crops and may be affected by insecticide use.

Caterpillar pests are also attacked by a range of parasitoids, mainly wasps and flies. These may cause significant mortality in species such as the diamond-back moth.

Diseases

Insect pests may be attacked by a number of bacterial, fungal and viral diseases. Aphids and adult cabbage root flies appear to be particularly susceptible to fungal diseases, whilst caterpillars are more susceptible to bacteria and viruses. Fungal diseases can be particularly devastating, but may be triggered only when environmental conditions are favourable.

Exploiting beneficial organisms

1. Monitor crops regularly to determine the balance of insect predators in relation to pest numbers and plant size to determine whether to apply a pesticide or not.
2. If a pesticide is required avoid use of broad spectrum insecticides which can have a harmful effect on beneficial insects.
3. Consider the use of biological control agents such as *Bacillus thuringiensis*.

Research is currently being funded by BBSRC into aphid control using entomopathogenic fungi and there is continuing DEFRA funded research being undertaken by Warwick HRI looking for methods of controlling various pests with predators, parasitoids, nematodes and bacteria.

For further information on beneficial organisms contact Mrs R Collier, Warwick HRI.

8.10.2 Disease control

Brussels sprouts are subject to many of the diseases that attack brassicas. In modular plant propagation under glass, seedling diseases are common and consistently damaging, thus requiring routine treatment. *Regular monitoring during propagation and crop walking in the field, coupled with correct disease identification, is an important element in minimising fungicide use.*

Most of the major fungi cause spots and blemishes on buttons rendering them unmarketable. These diseases are prevalent in the main production areas in most seasons, eg. ringspot, which was traditionally a disease only seen in the wetter western areas of the UK. The spread of oilseed rape growing, especially spring sown, and proliferation of rape volunteers on set-aside land have aided disease spread. End market tolerance of marking on buttons is invariably zero.

Where possible, the guiding principle is that pesticide inputs should be minimised through prevention rather than cure. Where possible an integrated approach is needed, involving the following management steps:

Good management and planning

- a. Careful site selection. Where possible avoid known potential or previous problems, thereby enhancing plant health. If possible site away from crops such as oil seed rape and other brassica. In intensive brassica areas, where this is not possible, plough in plant remains immediately harvesting ceases, to prevent spread of diseases such as mildew etc.
- b. It is good agronomic practice to rotate crops to prevent the build up of soil-borne diseases. In intensive areas this is not possible; therefore agronomy and disease monitoring must be of a high standard.
- c. Use resistant varieties where available whilst respecting the need to meet the required agronomic, quality parameters and eating requirements. Refer to the NIAB assessment sheets for the various resistance levels for each variety.

Cultural control techniques :

- a. Plant propagation under glass goes a long way to reducing the incidence and severity of seedling diseases, especially downy mildew.

Irrigate plants in the morning, or soon enough to allow leaves to dry off before the evening. Avoid over-watering, as this both washes nutrients and crop protection chemicals out of compost, and creates favourable conditions for damping-off pathogens. The amount of time seedlings are allowed to sit wet in the glasshouse should be kept to a minimum.

Maintain adequate ventilation to prevent the creation of a still, humid environment around seedlings and control feeding to prevent over-soft growth.

Adequately sterilise trays to prevent carry-over of diseases such as club root, *Pseudomonas*, damping-off etc.

- b. In the field apply nutrients according to soil analysis.
- c. Encourage steady growth by ensuring regular supply of water where possible.
- d. Through good agronomy, provide good growing conditions, ie. avoiding poorly drained soils, or the presence of soil pans.

Chemical control:

- a. Regularly field walk and monitor the crop for diseases, in conjunction with monitoring pests, to establish the need to take corrective action and refer to thresholds where established. Regular monitoring, both during propagation and in the field, coupled with correct identification of diseases, is an important element in minimising fungicide use. The decision whether it is worthwhile to apply fungicides must consider the disease, time of year, degree of infection and nearness to harvest. The effect of prevailing weather conditions should also be considered. *Computer prediction models have been developed by Warwick HRI/HDC for Alternaria, ringspot and white blister and are now in widespread commercial use. Growers should use these models to target fungicide use and avoid applications on a routine prophylactic basis.*
- b. Where fungicidal control is needed, the following points should be considered, whilst ensuring effective control is achieved:-
- c.
 - o *Use the least toxic and most persistent product as possible.*
 - o *Use the minimum effective dose rate.*
 - o *Check for restrictions on label for use within 5m of the top of the bank of watercourses .*
- d. Carefully consider anticipated harvest date when selecting product to use, ensuring adequate time exists for the safe harvest interval.

Taking account of a) where disease levels are not severe, two well timed applications of protectant and eradicant fungicides (late July or early August and in September) can control disease levels on the buttons.

8.10.2.1 Club root (*Plasmodiophora brassica*)

This affects all vegetables of the cabbage family and a number of ornamental cruciferous plants and weeds, including charlock and Shepherds Purse. It causes swelling of the roots which subsequently rot; the leaves turn blue and wilt, the plant may be stunted or even die. Club root is of considerable significance in some Brussels sprouts areas, particularly where soil pH is naturally marginal. Resting spores of the fungus remain viable in soil for at least twenty years.

Cultural control:

- i. *Wide rotation as possible in vulnerable areas.*
- ii. *Soil tests can give a guide to potential infection. Sample at least 3 - 4 months before anticipated planting date to allow changes in cropping.*
- iii. *Liming to maintain a soil pH 7.0-7.5 gives good control, but there is no cure once plants are affected. In susceptible areas, patches, (usually of lower pH) of club root can occur. These small areas should be limed separately.*
- iv. *High pH levels can give rise to minor nutrient problems.*
 - v. *In dry times, plants suffering from a small infestation can be brought to marketable yield by copious irrigation.*
- vi. *It is essential to use disease free modules.*
- vii. *Liming will not work immediately. It should be part of rotational planning.*
- viii. *Use of Clubroot resistant varieties should be considered.*

Chemical control: None available.

8.10.2.2 Damping off and wirestem (*Pythium* spp. and *Rhizoctonia solani*)

These fungi attack the roots and stems of young seedlings and can cause serious losses during glasshouse propagation and occasionally affect field drilled crops. With *Rhizoctonia* infections in the field the stem base becomes hard, brown and shrunken and the stems usually break later in the season.

Pythium control is most effective in glasshouse propagation stage when fungicides are used as preventative treatments pre-sowing or pre-planting. For both diseases treatment of field crops is impractical.

Cultural control:

- i. *Good glasshouse hygiene is essential*
- ii. *Good glasshouse management as outlined in Section 8.10.2 (Introduction), above.*
- iii. *Use plastic modular trays rather than polystyrene. The former can be sterilised easier and more effectively. With polystyrene trays the surface coating wears off, allowing roots and fungi to penetrate the polystyrene and present a reservoir of disease.*

Chemical control: Fungicides approved for use in propagation both as pre-sowing drenches or pre-planting treatments listed in Appendix 7.

8.10.2.3 Downy mildew (*Peronospora parasitica*)

An endemic fungal disease in propagation under glass but in the field sprout button infection only becomes significant when mild wet weather conditions prevail in late autumn. Air and soil borne the fungus may affect young plants via the roots. Spores are produced on infected plants and are distributed in air currents and by rain splash to re infect plants via the leaves. Yellow brown areas develop between the veins on the upper surface of the leaves corresponding with white/grey fungal growth on the under surface. Severely attacked leaves turn yellow and die off. Affected buttons show irregular black speckling with occasional yellowing.

Cultural control:

- i. *Good glasshouse hygiene is essential.*
- ii. *Good glasshouse management as outlined in Section 8.10.2 (Introduction) is essential.*
- iii. *Varieties vary in susceptibility - Therefore choose the more resistant varieties, provided they give the other agronomic features required.*
- iv. *Increase rotation.*

Chemical control:

- i. In propagation, routine treatment, both on a preventative and eradicant basis, is essential.
- ii. Currently approved products are listed in Appendix 7 and 8.
- iii. Preferably alternate fungicides from differing chemical groups to avoid development of resistant strains.

8.10.2.4 Dark leaf spot (*Alternaria brassicae* and *Alternaria brassicicola*)

Usually seed and air-borne, these fungi are also soil-borne due to incorporation of affected plants. All brassica crops including oil seed rape, cruciferous weeds and seed are sources of these diseases.

Symptoms range from small discrete black spots (which can be confused with those of powdery mildew) to circular zonate spots up to 12 mm in diameter. The latter have greyish, brown or almost black centres, which in the case of *A. brassicicola* may be covered with sooty spores. In the field, spots caused by the two species are indistinguishable. The spots may be surrounded by chlorotic haloes and severely affected leaves may show extensive yellowing. With ageing the centre of the spot appears thin, dry and papery and may fall out giving a 'shot-hole' appearance. Elongated dark brown lesions are found on stems and leaves.

On the buttons, lesions appear as discrete small dark brown or black spots, which could be confused with powdery mildew symptoms. Such spots can extend through several leaf layers within the sprout button . *In propagation on young plants, dark leaf spot can be controlled by seed treatments that use very small amounts of fungicide compared to overall foliar application.*

In the field disease is favoured by warm, moist conditions and spread by wind-borne spores. The influx of *Alternaria* normally coincides with the harvest of soil seed rape in July.

Cultural control:

- i. *Good glasshouse hygiene is essential.*
- ii. *Good glasshouse management as outlined in Section 8.10.2 (Introduction) is essential.*
- iii. *Plough in crop residues as soon as possible.*
- iv. *If possible, isolate brassica crops from each other.*
- v. *Collect intelligence about problems in oilseed rape.*

Chemical control:

- i. Currently approved seed treatments are listed in Appendix 8.
- ii. Currently approved fungicides are listed in Appendix 7.

8.10.2.5 Ring spot (*Mycosphaerella brassicicola*)

This disease is seed and also soil-borne through plant debris in the soil. Infection and disease development are dependent on high humidity and temperatures of 10-20°C. Traditionally troublesome in the wetter southwest it is now endemic in the main production areas. Periods of frequent rainfall appear to be critical for epidemic development and button infection on sprouts usually occurs around October.

This disease first appears on lower leaves as small circular necrotic, brown or purplish-black spots, which gradually enlarge, to 1.5 cm in diameter. As the ring spots develop, concentric rings of dead tissue are formed, surrounded by a narrow water-soaked area or yellow halo. With age, the ringspots appear grey with the distinctive fruiting bodies of the fungus arranged in concentric rings mainly on the upper leaf surface. Severely affected leaves quickly become yellow and prematurely wither. When buttons are infected early, the ring spots become very large as the buttons develop. The ring spot lesions are grey when dry, but are black and have a water-soaked appearance when wet. Yield may not be affected but quality is drastically reduced.

Cultural control:

- i. Isolate out-door plant beds.
- ii. *If possible, have a wide brassica rotation .*
- iii. *If possible, isolate sprouts crops from other brassica.*

Chemical control: Currently approved fungicides are listed in Appendix 7.

8.10.2.6 White blister (*Albugo candida*)

This occasional problem is now becoming more frequent. It occurs widely in the major brassica growing areas but shows considerable seasonal variation in severity. All the aerial parts of the plant may be affected. The fungus survives in the soil or on plant debris. Initially, small green blisters are produced which later form white patches, at first small and glossy but later turning powdery.

Late in the season the white patches may turn brown. They first appear on the lower surfaces of the leaves and on stems. Similar symptoms appear on the buttons and marketable quality is reduced.

The strains that attack cruciferous weeds such as Shepherds Purse are distinct and will not transfer to Brussels sprouts.

Cultural control: *Plant beds should be in a dry open position .*

Chemical control: Currently approved fungicides listed in Appendix 7.

8.10.2.7 Powdery mildew (*Erysiphe cruciferarum*)

Spread by wind-borne spores from affected brassica crops, this disease appears as small patches of thin white fungal growth on either leaf surface and on the stem. In severe attacks, the whole leaf surface is colonised. On the buttons, symptoms range from white or grey patches of fungal growth, to fine black speckling. After frost affected sprout buttons may also show discrete black spotting which could be confused with *Alternaria* symptoms. The disease is severe in hot dry summers as infection is favoured by warm (15-20°C) conditions with periods of high humidity.

Cultural control: *Use resistant varieties, if suitable for other agronomic and retail requirements. The resistance of some varieties on the buttons is good. Apply nitrogen as dictated by soil analysis and computer prediction. Heavy applications of nitrogen favours disease development. In dry growing seasons, plants under water stress appear to be more susceptible (particularly shallow-rooted varieties), therefore, irrigate if available.*

Chemical control: Fungicides only warranted on the more susceptible varieties in high-risk years. Currently approved fungicides are listed in Appendix 7.

8.10.2.8 Light leaf spot (*Pyrenopeziza brassicae*)

A soil-borne fungus from infected debris, which is also spread by rain splash, and wind from neighbouring infected brassica crops, particularly oilseed rape.

Lesions are initially superficial, developing mainly on the upper surface of the older leaves and producing a diffuse silvery appearance. Young lesions show little discoloration but become paler in the centre and bleach with age. Individual spots may merge to produce large bleached patches, particularly on the lower leaves.

Around the edge of the lesion, black speckling and concentric rings of white spore droplets can be found. On the buttons the fungus infects the outer 'wrapper' leaves producing black specks that can turn to large dark patches, eventually causing a superficial rot. Spread and development are favoured by cold wet conditions.

Cultural control: *Infected crop residues should be carefully and quickly ploughed in. A minimum 4 year rotation, if possible, reduces the risk of carry-over on debris.*

Chemical control: Currently approved fungicides are listed in Appendix 7. It is important to apply fungicide in late September or October to ensure good control on mid-season varieties.

8.10.2.9 Canker (*Phoma lingam*)

Seed and soil-borne from infected debris, this fungus produces well-defined spots with ashen-grey centres, on the upper side of the leaf. These spots are often green. Larger spots can appear on the sprout buttons. On the sprout stems, near the base and on the tap root, brown or purplish areas can be seen, which turn black.

Cultural control: *A minimum of four years rotation on infected fields. Do not grow outdoor plant beds adjacent to infected sites.*

Chemical control: Currently approved fungicides listed in Appendix 7.

8.10.2.10 Root rot (*Phytophthora megasperma*)

This soil-borne fungus disease is occasionally seen on heavier soils or poorly drained fields. It attacks roots and stems leading to a severe pungent rot and the leaves wilt.

Cultural control: *Avoid wet heavy, poorly structured soils.*

Chemical control: None available.

8.10.2.11 Grey mould (*Botrytis cinerea*)

A fungal disease that appears on the buttons as a grey growth or soft brown rot usually associated with damage or the retention of dead and decaying lower leaves. The disease is spread by wet weather and high humidity and can be difficult to control, especially where the buttons are close together on the stem.

Cultural control: *Avoid lush soft growth from excess nitrogen. Select varieties that have widely spaced buttons and shed mature leaves cleanly.*

Chemical control: Currently approved fungicides are listed in Appendix 7. Fungicides applied for *Alternaria* should give some control.

8.10.2.12 Virus diseases

- a. Turnip mosaic (TuMV)
Probably the most severe virus attacking Brussels sprouts, causing dark necrotic rings and spots on the older leaves of severely stunted plants.
- b. Cauliflower mosaic (CaMV)
This is much more common. Symptoms are vein clearing followed by vein banding with stunted growth and distorted leaves. Affected plants are usually very susceptible to frost injury. Cauliflower and turnip mosaics often infect the same plant. The mealy cabbage aphid and the peach potato aphid spread both viruses.
- c. Turnip Yellows Virus (TYV) formerly Beet Western Yellows Virus (BWYV)
Commonly affects brassica crops. Symptoms vary considerably as the virus is commonly associated with CaMV or TuMV. Recent work at Warwick HRI suggests that TYV is implicated in tipburn in storage cabbage.

Cultural control: *If possible, grow apart from other brassica crops. Isolate outdoor beds from other*

growing brassica. Destroy and plough in immediately, especially overwintered crops, and all other brassica crop residues.

Chemical control: Control aphids, especially in outdoor plant beds or early in the life of a direct drilled crop. Seed treatments with imidacloprid can help to reduce/delay infection. Currently approved aphicides are listed in Appendix 5.

8.10.3 Physiological disorders

8.10.3.1 Internal browning

This physiological disorder, producing necrosis and associated secondary rot inside the sprout button, is initially confined to the youngest tissue in the centre of the button. Historically, it was more severe on open pollinated varieties.

The origin of the disorder is not clear but it is thought to be caused by a localised calcium deficiency arising from immobility within the plant under certain stress conditions. Stresses caused by water shortage, nutrition (especially excessive nitrogen) and fluctuating temperature, individually and collectively, are thought to contribute to the condition.

Varieties vary in susceptibility. Large and over-mature sprouts are usually more severely affected.

Cultural control: *Avoid excessive nitrogen. Avoid placing crop under stress in the growing period after establishment. Select less susceptible varieties. Harvest sprouts before they become over-mature.*

Chemical control: None.

8.10.3.2 Oedema

A physiological disorder that is apparent as raised blisters or ridges (sometimes appear white and powdery) that appear usually on the veins of the under surface of the leaves and on the sprout buttons. Research at Warwick HRI suggests that thrips are the main cause of oedema; the 'warty' growths caused are a direct result of feeding damage of both adults and nymphs.

8.10.4 Weed control

The use of herbicides can be reduced considerably by attention to the following:

- a. Use of stale seedbed technique.
- b. Avoiding use of covers where resistant weeds (eg. Pennycress) are a problem.
- c. Identifying those weeds present and targeting with the use of more selective active ingredients.
- d. Use of mechanical weeding machines frequently through the crop. These should be set to give minimal disturbance to the soil in drier conditions and so that soil is lightly thrown around the base of the stem thus "smothering" seedling weeds. New designs involving spring lines are now available to effect better control of seedling weeds within the cropping row. Provided soil conditions are not too wet this method is much preferred.

A range of soil acting residual and post emergence contact herbicides is available. Generally approved herbicides for Brussels sprouts are given in Appendix 9. Select a herbicide that controls the weed spectrum present.

For residual herbicides to work effectively a fine, firm, moist tilth is required. Cloddy soil conditions greatly reduce the effectiveness of herbicides.

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

See Generic Standards and/or Generic Guidance Notes.

9.4 Harvesting

9.4.1 Stopping

In addition to plant density and selection of the correct variety for the season of production, 'stopping' the plants to improve uniform sprouts development may be required for crops due to be single harvested up to the beginning of December. Stopping is done to arrest apical dominance and may be carried out by:

- a. Pinching out a walnut-sized piece at the top of the plant containing the apical bud or growing point.
- b. Striking the growing point a sharp downward blow with a soft rubber hammer or glass bottle.

Stopping may start when 50% of the button sprouts are 12 mm (0.5 in) in diameter. If continuity is to be maintained, stopping date must be according to a pre-planned harvesting programme. Stopping may be done four to ten weeks before harvesting, depending on time of harvesting and plant spacing. Stopping the plants too early may lead to 'blowing' of the upper sprouts. It is now common to stop only early sprouts scheduled for harvest in August and early September.

9.4.2 Harvesting

Prior to harvesting, all protocol operators must ensure that the statutory harvest intervals have elapsed from every chemical applied to that crop. Spraying records need to show a safe harvesting date (positive release date) for each application.

Growers **must** ensure that harvested product is not contaminated by or exposed to anything that could affect food quality.

9.4.2.1 Hand picking

The crop is picked as the sprouts mature up the stem, with an interval of three to five weeks between picks. Delayed picking can result in a deterioration of quality by discoloration of outer leaves, over large loose sprouts, outer leaves of the sprout parting from the buttons or appearance of internal browning.

9.4.2.2 Single harvesting

Stems may be cut by hand and passed to operators on a mobile harvester, where the stems are fed through mechanical strippers. On the strippers, knives and grab rollers must be adjusted thus avoiding cut buttons, ragged butts to the sprouts or failure to remove sufficient stalk. The leaves and stems fall back onto the soil, and the buttons are fed into bulk bins for subsequent transport to packhouse.

9.4.2.3 Hand/machine harvesting

Occasionally a combination of methods is used - early maturing sprouts picked by hand and remainder taken by destructive single harvest.

9.4.2.4 Single harvesting - hand stripped

The cut stems of plants de-leafed in the field are transported to the packhouse, where on an adapted bench, the sprout buttons are hand stripped. The stem is held vertically on a sloping grid and a knife removes the sprouts. The sprouts roll down the grid, whilst bits of loose leaf and broken petioles fall through the grid. This is an expensive operation and used only for high-class outlets.

Brussels sprouts are at risk from physical damage such as cuts, grazes and bruises, which can speed up the post harvest deterioration, as well as affecting appearance. When full of water or following a frost sprouts bruise easily, therefore, efforts should be made to reduce any large drops on the machine or excessive abrasion.

All harvesting equipment must comply with the relevant agricultural safety provisions and the Health and Safety at Work regulations.

9.5 Cooling

In August and in a warm and wet autumn, Brussels sprouts have a very high post harvest respiration rate, especially in bulk bins. Unless cooled rapidly soon after harvesting the sprouts will heat up and quickly become discoloured, therefore delays between harvesting and the commencement of cooling should be minimised. The causes of sprout button deterioration (dehydration, microbiological attack and physiological changes, including browning of the butt) are all temperature related. Cooling immediately after harvest, followed by distribution in a cool chain, is the most effective means of preserving quality and shelf life.

9.5.1 Cooling rate

Equipment should be capable of reducing Brussels sprouts temperature down to possibly a minimum of 6°C in 12 hours. Cooling rates faster than this are unnecessary and require very expensive cooling equipment.

Brussels sprouts should be held in cool conditions where the relative humidity is in excess of 95% and this should be maintained right through to the retail point of sale.

9.5.2 Cooling equipment

Conventional direct expansion refrigeration cool stores are not generally suitable unless coupled with supplementary humidification and some form of forced air ventilation.

Wet air coolers with positive ventilation such as ice bank coolers are ideal. Other suitable systems available use water to air heat exchange or inject a fine moisture mist into the cooling air as in the Hydrair method, eg. Bi-tec Air-Spray, Howe-Cool and Polacell. Most refrigeration engineers can supply a suitable wet air system if they are provided with detailed design information. The major disadvantages are the difficulty of cooling packaged produce and the need for moisture resistant packaging materials.

Once cooled Brussels sprouts must be held at the target temperature, this often involves a holding store.

If the Brussels sprouts are to be pre-packaged, they must be taken out of the primary cooling equipment, passed through the packhouse, then re-cooled prior to despatch.

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

See Generic Standards and/or Generic Guidance Notes.

Appendix 1 Minor pests

Chemical treatment for these pests is only justified if they are present in crops or where there is a history of infestation on the farm.

Beet cyst nematode (*Heterodera schachtii*)

Found mainly in East Anglia and the Isle of Axholme. These nematodes attack most members of the beet and cabbage families. Although sprouts are rarely damaged they host the nematode which multiplies to a level that will affect future beet crops.

Sample if its presence is suspected and avoid frequent cropping with alternative host crops if the nematode is present.

Brassica cyst nematode (*Heterodera cruciferae*)

This pest is widely distributed; it rarely reduces crop yields. Cysts survive in the soil for several years until stimulated to hatch by the presence of a fresh host crop.

Sample if its presence is suspected and avoid overcropping with brassica crops. Routine treatment is rarely justified.

Cabbage leaf miners (*Phytomyza rufipes* and *Scaptomyza aplicalis*)

Both species are widely distributed, occasionally damaging Brussels sprouts . *As large populations can develop in oilseed rape crops, avoid siting Brussels sprouts nearby if possible. Control measures are only required if damage levels are high ;* sprays applied for diamond back moth will keep leaf minor under control.

Cabbage seed weevil

In recent years large numbers of adult cabbage seed weevils have infected brassica crops in some localities in mid-summer. Weevils can damage the mature crop by feeding on outer leaves and contaminating the button prior to harvest. They have occasionally checked the growth of newly planted crops.

Vulnerable crops, particularly those on the point of harvest, should be examined frequently from mid-July to mid-August . Applications of a synthetic pyrethroid for the control of caterpillars should kill some weevils and deter others from entering the crop.

Cabbage stem flea beetle (*Psylliodes chrysocephala*)

A widespread and locally serious pest attacks most overwintering brassica crops, especially seed crops. The build up of this pest on oilseed rape may lead to more serious attacks on vegetable brassicas. Even comparatively light attacks can reduce yield.

Site overwintering vegetable brassica crops as far as possible from oilseed rape or other seed crops which can harbour large number of the pest . Pyrethroids applied as soon as serious adult feeding is seen, or when larval damage is noted will give some control.

Cabbage whitefly (*Aleyrodes proletella*)

An occasional pest, but damage on Brussels sprouts is rare; damage is caused by the white scale like larvae living on the undersides of the leaves and sucking the sap. Where large numbers present vigour may be reduced.

Up to five generations a year may occur as adults over-winter on the undersides of the leaves. Severe infestations leave a

sticky secretion that attracts a black-sooty mould.

Destroy overwintering brassica crops soon after harvest to prevent the movement of whitefly to the new season's crops. Treatment is rarely necessary, but pyrethroids (given good coverage) will provide some control of adults.

Flea beetles (*Phyllotreta* spp.)

In direct drilled crops, small holes are eaten in cotyledons, stems and first and second true leaves. In warm dry conditions, the damage can be severe and seedlings may be killed.

Damage to young plants is fairly rare and most crops establishing quickly grow away satisfactorily without further treatment.

If damage is severe, or seedlings are growing slowly, apply deltamethrin.

Leatherjackets (*Tipula* spp.)

Leatherjackets are only likely to be of importance in fields previously in grass or weedy stubble. Most damage occurs in the spring.

Plough grassland before early August to prevent egg laying. If early ploughing is not possible, seek advice on potential risk. If this is high, it may be necessary to use an organophosphorus insecticide, applied pre-planting.

Turnip gall weevil (*Ceutorhynchus pleurostigma*)

This localised and sporadic pest is frequently found in southwest England attacking late-sown or late-planted Brussels sprouts. The legless larvae feed on the roots within hollow marble-sized galls. Yields are rarely affected.

Good soil and growing conditions help plants withstand attack.

Wireworms (*Agriotes* spp.)

Wireworms are only likely to be of consequence in fields cropped soon after long term grass.

Plough early with additional cultivations if wireworm damage is anticipated. Seek advice on degree of risk if in doubt. Little can be done once an attack has started.

Swede midge (*Contarinia nasturtii*)

Midge occasionally causes severe localised damage in the growing points of young plants, resulting in premature death of the plant or blindness that may be followed by a stem rot. The first generation of larvae appears during the second half of May/beginning of June. There are two or three generations in a season. High humidity situations favour their build-up, whereas drought slows or stops emergence. The larvae hatch from eggs laid in groups of 15-25 and feed on the young tissue in the growing point. Attacks are very rare in the UK.

At present no chemical has approval for the control of swede midge, however, when pyrethroids have been used for caterpillar control, midge larvae control has been observed.

Appendix 2 Fertiliser requirements for Brussels Sprouts (kg/ha)

Based on DEFRA Fertiliser recommendations (RB209)

Nutrient (kg/ha)	Soil Index						
	0	1	2	3	4	5	6
Nitrogen - mineral soils	330	300	270	230	180	80	0
Phosphorus	200	150	100	50M	0	0	0
Potassium	300	250	200 (2-) 150 (2+)	60	0	0	0
Magnesium (all soils)	150	100	nil	nil	-	-	0

Notes:

The magnesium/potassium ratio should not exceed 1:4; otherwise compensatory magnesium will need to be applied. For vegetable crops, soils should be maintained at Index 3 for phosphorous, and Index 2 for potassium. At these indices maintenance amounts of fertiliser are needed (M).

Good farmyard manure at about 25 t/ha will provide adequate phosphate and potash at Index 3 for phosphate and potassium, without the addition of fertiliser, but at lower indices the recommended fertiliser rates shown in the table above should be reduced for each 10 t/ha farmyard manure applied by 15 kg/ha nitrogen 20 kg/ha phosphorous and 40 kg/ha potassium.

On direct drilled crops any nitrogen over 100 kg/ha should be top-dressed to reduce the risk of seedling damage. With transplants on sands and light loams, any nitrogen over 100 kg/ha required, should be applied as a top dressing within one month of transplanting.

On shallow or sandy soils, when rainfall greatly exceeds transpiration, extra top dressing may be required within 2 months of applying basal nitrogen to replace the nitrogen leached through the soil.

Appendix 3 Soil Nitrogen Supply (SNS) Indices based previous cropping and rainfall

Detailed SNS tables based on previous cropping and average annual rainfall can be found in DEFRA publication 'Fertiliser Recommendations for Agricultural and Horticultural Crops – 7th Edition (RB209) published by the Stationary Office (ISBN 0 11 243058 9) telephone orders 0870 600 5522. Tables can also be downloaded free of charge from www.defra.gov.uk/farm/environment/land-manage/nutrient/fert/rb209/intro.pdf

Appendix 4 Insecticides currently approved for cabbage root fly control on leaf, head and flowerhead brassicas

Active Ingredient	Product Features	Crop Approval Type				Harvest Interval	LERAP Category	Hazard Rating	UK MRL (mg/kg)				
		Broccoli	Brussels Sprouts	Cabbage	Cauliflower				Collards	Broc	B Spr	Cabb	Cauli
chlorpyrifos ⁽¹⁾	available as granule and emulsifiable concentrate formulation. Contact and ingested organo-phosphate. Broad spectrum. Only EC/WG formulations approved for use on Kale/Collards and Sprouts.	Full	Full EC & WG formulations. Module and plant drench only.	Full	Full	SOLA's Various see App. 12.	A	Harmful Irritant	0.05 LOD	0.05 LOD	1.0	0.05 LOD	0.05 LOD
spinosad	a selective insecticide derived from naturally occurring soil fungi. Applied as a module or in-field drench. All MRLs, tMRLs.	SOLA 2086/06	SOLA 0319/06	SOLA 0319/06	SOLA 0319/06	No Approval	B	None	2.0	2.0	2.0	2.0	2.0

Notes:

MRL Key : Broc - Broccoli, B Spr - Brussels Sprouts, Cabb - Head Cabbage, Coll - Collards

LOD - MRL set at or about the Limit of Determination

⁽¹⁾ **SOLA** - See Appendix 12 for specific product names and expiry dates.

Not all products containing these active ingredients may be currently approved for use on leaf and flowerhead brassicas. As label recommendations are revised regularly, always read a current label prior to use.

MRL's have been included where a level has been set in the Maximum Residue in Crops, Food and Feeding Stuffs Regulations, 1995.

Appendix 5 Insecticides currently approved for aphid control in leaf, head and flowerhead brassicas

Foliar sprays

Active Ingredient	Product Features	Crop Approval Type			Harvest Interval			LERAP Category	Hazard Rating	UK MRL (mg/kg)			
		Broccoli	Brussels Sprouts	Cabbage	Cauliflower	Collards	Harvest Interval			Broc	B Spr	Cabb	Cauli
acetamiprid ⁽¹⁾	neo-nicotinoid systemic insecticide	No Approval	SOLA	No approval			21 days	None	0.01 LOD	0.05	0.01 LOD	0.01 LOD	0.01 LOD
alpha cypermethrin ⁽¹⁾	contact and ingested pyrethroid insecticide	Full	Full	Full	Full	SOLA	7 days	Harmful Irritant		0.5			1.0
bifenthrin	contact and residual pyrethroid insecticide for control of aphid and whitefly.	Full	Full	Full	Full	No approval	2 days	Harmful Irritant	0.2	1.0	1.0	0.2	0.05 LOD
chlorpyrifos	contact organo-phosphate, broad spectrum.	Full	No approval for field application	Full	Full	No approval	21 days	Harmful Irritant	0.05 LOD	0.05 LOD	1.0	0.05 LOD	0.05 LOD
cypermethrin	contact and ingested pyrethroid insecticide.	Full	Full	Full	Full	No approval	Zero	Harmful Irritant	0.5	0.5	0.5	0.5	1.0
deltamethrin ⁽¹⁾	contact and ingested pyrethroid insecticide.	Full	Full	Full	Full	SOLAs	Zero	Harmful Irritant Flammable		0.1			0.5

Notes:

MRL Key : Broc - Broccoli, B Spr - Brussels Sprouts, Cabb - Head Cabbage, Coll - Collards

LOD - MRL set at or about the Limit of Determination.

⁽¹⁾ **SOLA** - See Appendix 12 for specific product names and expiry dates.

Not all products containing these active ingredients may be currently approved for use on leaf and flowerhead brassicas. As label recommendations are revised regularly, always read a current label prior to use.. MRL's have been included where a level has been set in the Maximum Residue in Crops, Food and Feeding Stuffs Regulations, 1995.

Appendix 5 Insecticides currently approved for aphid control in leaf, head and flowerhead brassicas (Cont'd)

Foliar sprays (Cont'd)

Active Ingredient	Product Features	Crop Approval Type				Harvest Interval	LERAP Category	Hazard Rating	UK MRL (mg/kg)					
		Broccoli	Brussels Sprouts	Cabbage	Cauliflower				Collards	Broc	B Spr	Cabb	Cauli	Coll
dimethoate ⁽¹⁾	systemic organo-phosphate. Broad spectrum. Dangerous to a wide range of beneficial insects.	Full	Full	SOLA (up to 7TL only)	Full	SOLA (up to 7TL only)	21 days	A	Harmful Irritant	0.02 LOD	0.3	1.0	0.2	0.02 LOD
lambda cyhalothrin	contact and ingested pyrethroid insecticide. Broad spectrum.	Full	Full	Full	Full	No Approval	Zero	B	Harmful Irritant	0.1	0.05	0.2	0.1	1.0
lambda cyhalothrin* + pirimicarb**	useful combination of pyrethroid and carbamate insecticides where both caterpillars and aphids are a problem.	Full	Full	Full	Full	No Approval	3 days	A	Irritant	**2.0	**1.0	**1.0	**2.0	**2.0

Notes:

MRL Key : Broc - Broccoli, B Spr - Brussels Sprouts, Cabb - Head Cabbage, Coll - Collards

LOD - MRL set at or about the Limit of Determination.

⁽¹⁾ **SOLA** - See Appendix 12 for specific product names and expiry dates.

⁽²⁾ True Leaf.

Not all products containing these active ingredients may be currently approved for use on leaf and flowerhead brassicas. As label recommendations are revised regularly, always read a current label prior to use.

MRL's have been included where a level has been set in the Maximum Residue in Crops, Food and Feeding Stuffs Regulations, 1995.

Appendix 5 Insecticides currently approved for aphid control in leaf, head and flowerhead brassicas (Cont'd)

Foliar sprays (Cont'd)

Active Ingredient	Product Features	Crop Approval Type				Harvest Interval	LERAP Category	Hazard Rating	UK MRL (mg/kg)						
		Broccoli	Brussels Sprouts	Cabbage	Cauliflower				Collards	Broc	B Spr	Cabb	Cauli	Coll	
nicotine ⁽¹⁾	general purpose, non-persistent, contact, alkaloid insecticide. All approvals expire 08/06/2010	Full	Full	Full	Full	SOLA	2 days	None stated	Very Toxic Irritant	LOD 0.01					
pirimicarb	contact, fumigant and translaminar insecticide. Little effect on bees or beneficial insects. <i>Myzus persicae</i> resistance reported in some areas.	Full	Full	Full	Full	Full	3 days	None stated	Harmful Toxic Irritant	2.0	1.0	1.0	2.0	2.0	
pymetrozine ⁽¹⁾	novel azomethine systemic aphicide which prevents aphid feeding. Controls OP and carbamate resistant <i>Myzus persicae</i> .	Full approval				SOLA	Full 14 days	None stated	Harmful	0.02 LOD	0.02 LOD	0.05	0.02 LOD	0.2	
thiacloprid ⁽¹⁾	neo-nicotinoid insecticide controls MACE resistant <i>Myzus persicae</i>	Full approval				SOLA	7 days	none	Harmful	0.1	0.05	0.2	0.1	1.0	

Notes:

MRL Key : Broc - Broccoli, B Spr - Brussels Sprouts, Cabb - Head Cabbage, Kale - Kale/Collards

LOD - MRL set at or about the Limit of Determination

⁽¹⁾ **SOLA** - See Appendix 12 for specific product names and expiry dates.

Not all products containing these active ingredients may be currently approved for use on leaf and flowerhead brassicas. As label recommendations are revised regularly, always read a current label prior to use.

MRL's have been included where a level has been set in the Maximum Residue in Crops, Food and Feeding Stuffs Regulations, 1995.

Appendix 6 Insecticides currently approved for caterpillar control in leaf, head and flowerhead brassicas

Active Ingredient	Product Features	Crop Approval Type				Harvest Interval	LERAP Category	Hazard Rating	UK MRL (mg/kg)					
		Broccoli	Brussels Sprouts	Cabbage	Cauliflower				Collards	Broc	B Spr	Cabb	Cauli	Coll
alpha cypermethrin (1)	contact and ingested pyrethroid insecticide.	Full	Full	Full	Full	7 days	A	Harmful Irritant		0.5				1.0
<i>Bacillus thuringiensis</i> (1)	bacterial insecticide affecting the gut lining of the larvae and therefore must be eaten to be effective	Full	Full	Full	Full	Full - Zero SOLA - 28 days	None stated	None stated		LOD 0.01				
bifenthrin	contact and residual pyrethroid insecticide for control of aphid and whitefly	Full	Full	Full	Full	2 days	A	Harmful Irritant	0.2	1.0	1.0	0.2		0.05 LOD
chlorpyrifos	contact organo-phosphate, broad spectrum	Full	No Approval	Full	Full	21 days	A	Harmful Irritant	0.05 LOD	0.05 LOD	1.0	0.05 LOD		0.05 LOD
cypermethrin (1)	a contact and stomach acting pyrethroid insecticide	Full	Full	Full	Full	Zero	A	Harmful Irritant		0.5				1.0
deltamethrin	a pyrethroid insecticide with contact and residual activity.	Full	Full	Full	Full	Zero	A	Harmful Irritant Flammable		0.1				0.5
diflubenzuron	selective, persistent, contact and stomach acting substituted urea. Acts by disrupting chitin synthesis and prevents egg hatch.	Full	Full	Full	Full	14 days	B	None stated		1.0				

Notes:

MRL Key : Broc - Broccoli, B Spr - Brussels Sprouts, Cabb - Head Cabbage, Kale - Kale/Collards

LOD - MRL set at or about the Limit of Determination

(1) **SOLA** - See Appendix 12 for specific product names and expiry dates.

Not all products containing these active ingredients may be currently approved for use on leaf and flowerhead brassicas. As label recommendations are revised regularly, always read a current label prior to use.

MRL's have been included where a level has been set in the Maximum Residue in Crops, Food and Feeding Stuffs Regulations, 1995.

Appendix 6 Insecticides currently approved for caterpillar control in leaf, head and flowerhead brassicas (Cont'd)

Active Ingredient	Product Features	Crop Approval Type				Harvest Interval	LERAP Category	Hazard Rating	UK MRL (mg/kg)					
		Broccoli	Brussels Sprouts	Cabbage	Cauliflower				Collards	Broc	B Spr	Cabb	Cauli	Coll
indoxacarb	Ingested and contact oxadiazine insecticide	Full	SOLA	Full	Full	No Approval	Full - 1 day SOLA - 28 days	None	Harmful	0.3	0.02 LOD	3.0	0.3	LOD 0.02
lambda cyhalothrin	contact and ingested pyrethroid insecticide. Broad spectrum.	Full	Full	Full	Full	No Approval	Zero	A	Harmful Irritant	0.1	0.05	0.2	0.1	1.0
lambda cyhalothrin* + pirimicarb**	useful combination of pyrethroid and carbamate insecticides where both caterpillars and aphids are a problem.	Full	Full	Full	Full	No Approval	3 days	A	Harmful	0.1*	0.05*	0.2*	0.1*	1.0*
nicotine ⁽¹⁾	general purpose, non-persistent, contact, alkaloid insecticide. All approvals expire 08/06/2010	Full	Full	Full	Full	SOLA	2 days	None stated	Very Toxic Irritant	**2.0	**1.0	**1.0	**2.0	
spinosad ⁽¹⁾	a selective insecticide derived from naturally occurring soil fungi.	SOLA	Full	Full	Full	No Approval	3 days	B	None stated	2.0	2.0	2.0	2.0	2.0
Teflubenzuron ⁽¹⁾	selective insecticide for caterpillar control	SOLA	SOLA	No approval	SOLA	No approval	14 days	None	Toxic	0.5	0.5	0.5	0.5	0.5

MRL Key : Broc - Broccoli, B Spr - Brussels Sprouts, Cabb - Head Cabbage, Kale - Kale/Collards

⁽¹⁾ **SOLA** - See Appendix 12 for specific product names and expiry dates.

LOD - MRL set at or about the Limit of Determination.

Not all products containing these active ingredients may be currently approved for use on leaf and flowerhead brassicas. As label recommendations are revised regularly, always read a current label prior to use.

MRL's have been included where a level has been set in the Maximum Residue in Crops, Food and Feeding Stuff's Regulations, 1995.

Appendix 7 Fungicides currently approved for use on leaf, head and flowerhead brassicas

Field application

Active Ingredient	Product Features	Crop Approval Type					Harvest Interval	LERAP Category	Hazard Rating	UK MRL (mg/kg)				
		Broccoli	Brussels Sprouts	Cabbage	Cauliflower	Collards				Broc	B Spr	Cabb	Cauli	Coll
azoxystrobin ⁽¹⁾	target : Xanthomonas; systemic translaminar and protectant strobilurin	Full	Full	Full	Full	Full	14 days	None stated	None	0.5	0.3	0.3	0.5	5
azoxystrobin* + difenoconazole**	target : ringspot, Alternaria. Mixture of eradicant triazole and protectant strobilurin fungicide	Full	Full	Full	Full	Full	21 days	None stated	Irritant	0.5* **0.2	0.3* **0.2	0.3* **0.2	0.5* **0.2	5* **0.2
boscalid* + pyraclostrobin**	target : ringspot, <i>Alternaria</i> and white blister. Anilide and strobilurin fungicide mixture.	No Approval	Full	Full	Full	No Approval	14 days	B	Harmful	1.0*	2.0*	2.0*	1.0*	10.0*
chlorothalonil	target : <i>Alternaria</i> sp., <i>Botrytis</i> sp., downy mildew, damping off and wirestem. Protectant chlorophenyl.	Full	Full	Full	Full	No Approval	7 days	B	Harmful Irritant	3.0	3.0	3.0	3.0	0.01 LOD
chlorothalonil* + metalaxyl-M†	target : white blister & downy mildew. Protectant chlorophenyl and systemic phenylamide.	Full	Full	No Approval	Full	No Approval	14 days	B	Harmful Irritant	3.0*	3.0*	3.0*	3.0*	0.01* LOD
copper oxychloride ⁽¹⁾	bactericide: for control of spear rot and <i>Xanthomonas</i>			SOLA			3 days	None stated	None stated			20.0		0† 0.05 LOD

Notes:

MRL Key : Broc - Broccoli, B Spr - Brussels Sprouts, Cabb - Head Cabbage, Coll - Collards

⁽¹⁾ **SOLA** - See Appendix 12 for specific product names and expiry dates.

LOD - MRL set at or about the Limit of Determination.

Not all products containing these active ingredients may be currently approved for use on leaf and flowerhead brassicas. As label recommendations are revised regularly, always read a current label prior to use. MRL's have been included where a level has been set in the Maximum Residue in Crops, Food and Feeding Stuffs Regulations, 1995.

Appendix 7 Fungicides currently approved for use on leaf, head and flowerhead brassicas (Cont'd)

Field application (Cont'd)

Active Ingredient	Product Features	Crop Approval Type			Harvest Interval	LERAP Category	Hazard Rating	UK MRL (mg/kg)					
		Broccoli	Brussels Sprouts	Cabbage				Cauliflower	Collards	Broc	B Spr	Cabb	Cauli
difenoconazole	target: <i>Alternaria</i> sp & ringspot. Diphenyl-ethertriazole protectant and curative fungicide.	Full	Full	Full	Full - 21 days SOLA 14 days	None stated	Irritant		0.2			2.0	
flusilazole (1)	target: phoma and light leaf spot. Systemic conazole	No approval	SOLA	No approval	35 days	None stated	Toxic			0.02 LOD			
Iprodione	target: <i>Alternaria</i> sp. Protectant dicarboximide fungicide with some eradicant activity.	Full	Full	No Approval	14 days	B	Harmful	0.1	0.5	5.0	0.1	0.02 LOD	
mancozeb* + metalaxyl-m† (1)	target: white blister. Systemic and protectant fungicide mix.	No Approval	No Approval	SOLA I610/01	14 days	None stated	Irritant	1.0*	1.0*	1.0*	1.0*	2.0*	
prothioconazole (1)	target: ringspot, phoma and alternaria. Eradicant triazole	No Approval	No Approval	SOLA	21 days	B	None stated	0.2†	0.05† LOD	1.0†	0.2†	0.2†	
tebuconazole (1)	target: <i>Alternaria</i> sp. ring spot, light leaf spot and powdery mildew. Systemic conazole.	SOLA	No Approval	Full	21 days	None stated	Harmful Irritant	1.0	0.5	1.0	1.0	0.05 LOD	
tebuconazole* + trifloxystrobin**	target: <i>Alternaria</i> sp. ring spot, light leaf spot and powdery mildew. Systemic conazole + protectant strobilurin	Full	Full	Full	21 days	None stated	Harmful Irritant	*1.0 **0.05	*0.5 **0.2	*1.0 **0.2	*1.0 **0.05	*0.05 LOD **0.02 LOD	

Notes:

MRL Key : Broc - Broccoli, B Spr - Brussels Sprouts, Cabb - Head Cabbage, Coll - Collards

LOD - MRL set at or about the Limit of Determination

(1) **SOLA** - See Appendix 12 for specific product names and expiry dates.

Not all products containing these active ingredients may be currently approved for use on leaf and flowerhead brassicas. As label recommendations are revised regularly, always read a current label prior to use.

MRL's have been included where a level has been set in the Maximum Residue in Crops, Food and Feeding Stuffs Regulations, 1995.

Appendix 7 Fungicides currently approved for use on leaf, head and flower head brassicas (Cont'd)

Fungicide drench treatments for storage cabbage

Active Ingredient	Product Features	Crop Approval Type			Harvest Interval	LERAP Category	Hazard Rating	UK MRL (mg/kg)				
		Broccoli	Brussels Sprouts	Cabbage				Cauliflower	Collards	B Spr	Cabb	Cauli
metalaxyl-m ⁽¹⁾	target : <i>Phytophthora</i> in storage cabbage.	No Approval	No Approval	SOLA	No Approval	7 weeks before sale or processing	None stated	0.2	0.05 LOD	1.0	0.2	0.05 LOD

Notes:

MRL Key : Broc - Broccoli, B Spr - Brussels Sprouts, Cabb - Head Cabbage, Coll - Collards

LOD : MRL set at or about the Limit of Determination

⁽¹⁾ **SOLA** - See Appendix 12 for specific product names and expiry dates.

Not all products containing these active ingredients may be currently approved for use on leaf and flowerhead brassicas. As label recommendations are revised regularly, always read a current label prior to use.

MRL's have been included where a level has been set in the Maximum Residue in Crops, Food and Feeding Stuffs Regulations, 1995.

Appendix 8 Seed treatments for use on leaf, head and flowerhead brassicas

The following seed treatments have been approved and are available either individually or in a mixture as an optional service from UK seedhouses.

Active Ingredient	Product Features	Crop Approval Type				Harvest Interval	LERAP Category	Hazard Rating	UK MRL (mg/kg)				
		Broccoli	Brussels Sprouts	Cabbage	Cauliflower				Collards	Broc	B Spr	Coll	
imidacloprid (1)	target : early aphid control (Myzus persicae). Systemic insecticide.	SOLA				NA	None stated	Irritant	0.5				
thiram	target : seedling damping off diseases	No Approval	No Approval	Full	Full	NA	None stated	Irritant	1.0	2.0	3.0	1.0	0.5

Notes:

MRL Key : Broc - Broccoli, B Spr - Brussels Sprouts, Cabb - Head Cabbage, Coll - Collards

LOD : MRL set at or about the Limit of Determination

(1) **SOLA** - See Appendix 12 for specific product names and expiry dates.

Not all products containing these active ingredients may be currently approved for use on leaf and flowerhead brassicas. As label recommendations are revised regularly, always read a current label prior to use.

MRL's have been included where a level has been set in the Maximum Residue in Crops, Food and Feeding Stuffs Regulations, 1995.

Appendix 9 Herbicides currently approved for use on leaf, head and flowerhead brassicas

Active Ingredient	Product Features	Crop Approval Type				Harvest Interval	LERAP Category	Hazard Rating	UK MRL (mg/kg)				
		Broccoli	Brussels Sprouts	Cabbage	Cauliflower				Collards	Broc	B Spr	Cabb	Cauli
chlorthal-dimethyl ⁽¹⁾	target : residual benzoic. Apply after drilling, before crop emergence or after planting. Do not plant lettuce within 6 months other crops within 3 months.	Full	Full	Full	Full	SOLA	None stated	0.5	0.5	5.0	5.0	0.5	
chlorthal-dimethyl* + propachlor** ⁽¹⁾	target : residual benzoic and chloracetamide herbicide mix.	Full	Full	Full	Full	SOLA	None stated	*0.5 **0.3	*0.5 **0.3	*5.0 **0.3	*5.0 **0.3	*0.5 **0.2	
clomazone	target: residual herbicide	SOLA				Not restricted	None stated	Irritant	0.01 LOD				
clopyralid	target : control of <i>Compositae</i> weeds. Foliar, translocated piclonic.	Full	Full	Full	Full	SOLA	None stated	None stated	0.5				
cycloxydim	target : annual grasses, blackgrass and couch. Translocated post-emergence oxime herbicide. No control of annual meadow grass.	No Approval	Full	Full	Full	No Approval	None	Irritant	2.0	3.0	3.0	5.0	2.0

Notes:

MRL Key : Broc - Broccoli, B Spr - Brussels Sprouts, Cabb - Head Cabbage, Coll - Collards

LOD : MRL set at or about the Limit of Determination

⁽¹⁾ **SOLA** - See Appendix 12 for specific product names and expiry dates.

Not all products containing these active ingredients may be currently approved for use on leaf and flowerhead brassicas. As label recommendations are revised regularly, always read a current label prior to use.

MRL's have been included where a level has been set in the Maximum Residue in Crops, Food and Feeding Stuffs Regulations, 1995.

Appendix 9 Herbicides currently approved for use on leaf, head and flowerhead brassicas (Cont'd)

Active Ingredient	Product Features	Crop Approval Type				Harvest Interval	LERAP Category	Hazard Rating	UK MRL (mg/kg)					
		Broccoli	Brussels Sprouts	Cabbage	Cauliflower				Collards	Broc	B Spr	Cabb	Cauli	Coll
fluzifop-p-butyl (1)	target : volunteer cereals and couch (no control of annual meadow grass). Phenoxypropionic acid graminicide.	No Approval	No Approval	SOLA	No Approval	SOLA	see SOLA	Irritant Harmful	None stated	0.2	2.0	0.3	0.2	0.5
metazachlor	target : residual anilide herbicide for broad leaved weed control.	Full	Full	Full	Full	SOLA	Full - 42 days see SOLA	Harmful	None stated	0.3				
pendimethalin	target : residual dinitroaniline. Approval for pre-planting application only.	Full	Full	Full	Full	No approval	Pre-planting	None stated	None stated	0.05 LOD				
propachlor	target : residual chloroacetanilide for control of annual dicotyledons and annual grasses. Note all approvals expire 18/3/10.	Full	Full	Full	Full	Various SOLAs see App 12	Young plant	Harmful Irritant	None stated	0.3				0.2

Notes:

MRL Key : Broc - Broccoli, B Spr - Brussels Sprouts, Cabb - Head Cabbage, Coll - Collards

LOD : MRL set at or about the Limit of Determination

(1) **SOLA** - See Appendix 12 for specific product name and expiry date.

Not all products containing these active ingredients may be currently approved for use on leaf and flowerhead brassicas. As label recommendations are revised regularly, always read a current label prior to use.

MRL's have been included where a level has been set in the Maximum Residue in Crops, Food and Feeding Stuffs Regulations, 1995.

Appendix 9 Herbicides currently approved for use on leaf, head and flowerhead brassicas (Cont'd)

Active Ingredient	Product Features	Crop Approval Type					Harvest Interval	LERAP Category	Hazard Rating	UK MRL (mg/kg)				
		Broccoli	Brussels Sprouts	Cabbage	Cauliflower	Collards				Broc	B Spr	Cabb	Cauli	Coll
pyridate	target : annual dicotyledons. Contact acting herbicide.	No Approval	Full	Full	No Approval	No Approval	Before 6TL	None stated	0.05 LOD					
Trifluralin	target : annual dicotyledons & grasses. Soil incorporated dinitroaniline. Long residual action.	All approvals expire 20 March 2009					Pre-planting	None stated	Irritant Flammable	0.5	0.5	0.5	3.0	0.5
tepraloxymidim	A systemic post emergence herbicide	No approval	No approval	Full Approval	No approval	No approval	Before head/curd forms	Irritant	0.5	0.1	0.5	0.5	1.0	

Notes:

MRL Key : Broc - Broccoli, B Spr - Brussels Sprouts, Cabb - Head Cabbage, Coll - Collards

LOD : MRL set at or about the Limit of Determination

(1) **SOLA** - See Appendix 12 for specific product names and expiry dates.

Not all products containing these active ingredients may be currently approved for use on leaf and flowerhead brassicas. As label recommendations are revised regularly, always read a current label prior to use.

MRL's have been included where a level has been set in the Maximum Residue in Crops, Food and Feeding Stuffs Regulations, 1995.

Appendix 10 Molluscicides currently approved for use on leaf, head and flowerhead brassicas

Active Ingredient	Product Features	Crop Approval Type				Harvest Interval	LERAP Category	Hazard Rating	UK MRL (mg/kg)					
		Broccoli	Brussels Sprouts	Cabbage	Cauliflower				Collards	Broc	B Spr	Cabb	Cauli	Coll
copper silicate	target : slugs/snails. Repellent effect.	Full	Full	Full	Full	None stated	None				20.0			
ferric phosphate	target : slugs/snails. Low toxicity to non target species.	Full	Full	Full	Full	None stated	None				0.01 LOD			
metalddehyde	target : slugs/snails. Use does preserve ground beetle populations.	Full	Full	Full	No Approval	None stated	None				1.0			
methiocarb	target : slugs/snails. Stomach acting carbamate. Reduces population of cutworms and millipedes.	No approval	Full	Full	Full	14 days	None stated	Harmful			0.01 LOD			
phasmarhabditis hermaphrodita	target : slugs. Parasitic nematode. Best applied in moist conditions.	Full	Full	Full	Full	None	None stated	None			0.01 LOD			

Notes:

MRL Key : Broc - Broccoli, B Spr - Brussels Sprouts, Cabb - Head Cabbage, Coll - Collards

LOD : MRL set at or about the Limit of Determination

⁽¹⁾ **SOLA** - See Appendix 12 for specific product name and expiry date.

Not all products containing these active ingredients may be currently approved for use on leaf and flowerhead brassicas. As label recommendations are revised regularly, always read a current label prior to use.

MRL's have been included where a level has been set in the Maximum Residue in Crops, Food and Feeding Stuff's Regulations, 1995.

Appendix 11 Off-label approval for Broccoli by extrapolation

The green flower-head brassica referred to as "Broccoli" throughout this protocol is referred to as "Calabrese" in the 2006 U.K. Pesticide Guide, whilst "Broccoli" is used as a generic term to describe various minor forms such as white sprouting, purple sprouting and cape Broccoli.

Broccoli and Calabrese are in the same PSD crop hierarchy therefore both SOLA and full label approvals stating broccoli can be legally used on calabrese and vice versa. PSD define broccoli/calabrese as “varieties of *Brassica oleracea var italica* grown for their immature inflorescences. Includes all forms of purple and green sprouting broccoli and calabrese”.

Appendix 12 Specific off-label approvals for leaf, head and flowerhead brassicas

SOLA Number	Product	Active Ingredient	Crop	Expiry
2866/07	Insyst	Acetamiprid	brussels sprout (outdoor)	31-Dec-14
2265/05	Contest	Alpha-cypermethrin	collard (outdoor)	31-Dec-13
0739/04	Dipel DF (11184)	Bacillus thuringiensis var. kurstaki	calabrese (outdoor)	31-Aug-12
2922/05	Agriguard Chlorothalonil	Chlorothalonil	calabrese (outdoor)(seedling)	28-Feb-11
2940/05	Bravo 500	Chlorothalonil	calabrese (outdoor)	31-Dec-13
2940/05	Bravo 500	Chlorothalonil	calabrese (outdoor)(seedling)	31-Dec-13
0993/07	Cleancrop Rio	Chlorothalonil	calabrese (outdoor)	28-Feb-11
0993/07	Cleancrop Rio	Chlorothalonil	calabrese (outdoor)(seedling)	28-Feb-11
2948/05	Jupital	Chlorothalonil	calabrese (outdoor)(seedling)	31-Dec-13
2888/05	Repulse	Chlorothalonil	calabrese (outdoor)	31-Dec-13
2053/07	Sonar	Chlorothalonil	calabrese (outdoor)	31-Dec-13
3667/06	Ballad	Chlorpyrifos	broccoli (outdoor)	31-Dec-13
3654/06	CYREN	Chlorpyrifos	broccoli (outdoor)	31-Dec-13
3655/06	Dursban WG	Chlorpyrifos	broccoli (outdoor)	31-Dec-13
3640/06	Equity	Chlorpyrifos	broccoli (outdoor)	31-Dec-13
1587/06	Parapet	Chlorpyrifos	collard (outdoor)	31-Dec-13
1587/06	Parapet	Chlorpyrifos	collard (outdoor)(seedling)	31-Dec-13
1552/06	Dacthal W75	Chlorthal-dimethyl	collard (outdoor)	31-Dec-13
0087/08	Centium 360 CS (11607)	Clomazone	broccoli (outdoor)	31-Dec-09
0087/08	Centium 360 CS (11607)	Clomazone	brussels sprout (outdoor)	31-Dec-09
0087/08	Centium 360 CS (11607)	Clomazone	cabbage (outdoor)	31-Dec-09
0087/08	Centium 360 CS (11607)	Clomazone	calabrese (outdoor)	31-Dec-09
0087/08	Centium 360 CS (11607)	Clomazone	cauliflower (outdoor)	31-Dec-09
0417/08	Gamit 36 CS (12598)	Clomazone	broccoli (outdoor)	28-Feb-10
0417/08	Gamit 36 CS (12598)	Clomazone	brussels sprout (outdoor)	28-Feb-10
0417/08	Gamit 36 CS (12598)	Clomazone	cabbage (outdoor)	28-Feb-10
0417/08	Gamit 36 CS (12598)	Clomazone	calabrese (outdoor)	28-Feb-10
0417/08	Gamit 36 CS (12598)	Clomazone	cauliflower (outdoor)	28-Feb-10
3315/07	Barclay Karaoke	Clopyralid	collard (outdoor)	30-Apr-09
2637/06	Dow Shield	Clopyralid	collard (outdoor)	31-Dec-13

Notes:

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Specific off-label uses may only take place if all the conditions of approval, 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 12 Specific off-label approvals for leaf, head and flowerhead brassicas (Cont'd)

SOLA Number	Product	Active Ingredient	Crop	Expiry
3318/07	Fernpath Torate	Clopyralid	collard (outdoor)	30-Apr-09
1956/06	Glopyr 200 SL	Clopyralid	collard (outdoor)	31-Dec-13
3333/07	Loncid	Clopyralid	collard (outdoor)	30-Apr-09
1932/06	Lontrel 200	Clopyralid	collard (outdoor)	31-Dec-13
0115/01	Cuprokylt	Copper oxychloride	broccoli (outdoor)	31-Dec-13
0115/01	Cuprokylt	Copper oxychloride	brussels sprout (outdoor)	31-Dec-13
0115/01	Cuprokylt	Copper oxychloride	cabbage (outdoor)	31-Dec-13
0115/01	Cuprokylt	Copper oxychloride	calabrese (outdoor)	31-Dec-13
0115/01	Cuprokylt	Copper oxychloride	cauliflower (outdoor)	31-Dec-13
0156/08	Headland Inorganic Liquid Copper	Copper oxychloride	broccoli (outdoor)	31-Dec-13
0156/08	Headland Inorganic Liquid Copper	Copper oxychloride	brussels sprout (outdoor)	31-Dec-13
0156/08	Headland Inorganic Liquid Copper	Copper oxychloride	cabbage (outdoor)	31-Dec-13
0156/08	Headland Inorganic Liquid Copper	Copper oxychloride	calabrese (outdoor)	31-Dec-13
0156/08	Headland Inorganic Liquid Copper	Copper oxychloride	cauliflower (outdoor)	31-Dec-13
1801/07	Cleancrop Decathlon	Deltamethrin	collard (outdoor)	31-Dec-13
2458/08	Decis	Deltamethrin	collard (outdoor)	31-Dec-13
1687/07	Pearl Micro	Deltamethrin	collard (outdoor)	31-Dec-13
0389/94	BASF Dimethoate 40	Dimethoate	broccoli (outdoor)	31-Dec-13
0389/94	BASF Dimethoate 40	Dimethoate	calabrese (outdoor)	31-Dec-13
0808/06	Danadim	Dimethoate	broccoli (outdoor)(seedling)	31-Dec-13
0808/06	Danadim	Dimethoate	calabrese (outdoor)(seedling)	31-Dec-13
0682/05	Danadim Progress	Dimethoate	calabrese (outdoor)(seedling)	31-Dec-13
1776/08	Fusilade 250 EW	Fluazifop-P-butyl	collard (outdoor)	31-Dec-13
0328/08	Fusilade Max	Fluazifop-P-butyl	cabbage (outdoor)	31-Dec-13
1777/08	Fusilade Max	Fluazifop-P-butyl	collard (outdoor)	31-Dec-13
1777/08	Fusilade Max	Fluazifop-P-butyl	collard (outdoor)(spring greens)	31-Dec-13
0102/07	Capitan 25	Flusilazole	brussels sprout (outdoor)	31-Dec-13
0101/07	Genie 25	Flusilazole	brussels sprout (outdoor)	31-Dec-13
3998/06	Lyric	Flusilazole	brussels sprout (outdoor)	31-Dec-13

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

Appendix 12 Specific off-label approvals for leaf, head and flowerhead brassicas (Cont'd)

SOLA Number	Product	Active Ingredient	Crop	Expiry
0100/07	Sanction 25	Flusilazole	brussels sprout (outdoor)	31-Dec-13
3524/06	Aliette 80 WG	Fosetyl-aluminium	broccoli (outdoor)	31-Dec-13
2031/08	Aliette 80 WG	Fosetyl-aluminium	broccoli (outdoor)	31-Dec-13
3524/06	Aliette 80 WG	Fosetyl-aluminium	broccoli (outdoor)(seedling)	31-Dec-13
3524/06	Aliette 80 WG	Fosetyl-aluminium	brussels sprout (outdoor)	31-Dec-13
2031/08	Aliette 80 WG	Fosetyl-aluminium	brussels sprout (outdoor)	31-Dec-13
3524/06	Aliette 80 WG	Fosetyl-aluminium	brussels sprout (outdoor) (seedling)	31-Dec-13
3524/06	Aliette 80 WG	Fosetyl-aluminium	cabbage (outdoor)	31-Dec-13
2031/08	Aliette 80 WG	Fosetyl-aluminium	cabbage (outdoor)	31-Dec-13
3524/06	Aliette 80 WG	Fosetyl-aluminium	cabbage (outdoor)(seedling)	31-Dec-13
3524/06	Aliette 80 WG	Fosetyl-aluminium	calabrese (outdoor)	31-Dec-13
2031/08	Aliette 80 WG	Fosetyl-aluminium	calabrese (outdoor)	31-Dec-13
3524/06	Aliette 80 WG	Fosetyl-aluminium	calabrese (outdoor)(seedling)	31-Dec-13
3524/06	Aliette 80 WG	Fosetyl-aluminium	cauliflower (outdoor)	31-Dec-13
2031/08	Aliette 80 WG	Fosetyl-aluminium	cauliflower (outdoor)	31-Dec-13
3524/06	Aliette 80 WG	Fosetyl-aluminium	cauliflower (outdoor) (seedling)	31-Dec-13
3524/06	Aliette 80 WG	Fosetyl-aluminium	collard (outdoor)	31-Dec-13
2031/08	Aliette 80 WG	Fosetyl-aluminium	collard (outdoor)	31-Dec-13
3524/06	Aliette 80 WG	Fosetyl-aluminium	collard (outdoor)(seedling)	31-Dec-13
3570/07	Cleancrop Chicane	Fosetyl-aluminium	broccoli (outdoor)	31-May-09
3570/07	Cleancrop Chicane	Fosetyl-aluminium	broccoli (outdoor)(seedling)	31-May-09
3570/07	Cleancrop Chicane	Fosetyl-aluminium	brussels sprout (outdoor)	31-May-09
3570/07	Cleancrop Chicane	Fosetyl-aluminium	brussels sprout (outdoor) (seedling)	31-May-09
3570/07	Cleancrop Chicane	Fosetyl-aluminium	cabbage (outdoor)(seedling)	31-May-09
3570/07	Cleancrop Chicane	Fosetyl-aluminium	calabrese (outdoor)	31-May-09
3570/07	Cleancrop Chicane	Fosetyl-aluminium	calabrese (outdoor)(seedling)	31-May-09
3570/07	Cleancrop Chicane	Fosetyl-aluminium	cauliflower (outdoor)	31-May-09
3570/07	Cleancrop Chicane	Fosetyl-aluminium	cauliflower (outdoor) (seedling)	31-May-09
3570/07	Cleancrop Chicane	Fosetyl-aluminium	collard (outdoor)	31-May-09

Notes:

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

Appendix 12 Specific off-label approvals for leaf, head and flowerhead brassicas (Cont'd)

SOLA Number	Product	Active Ingredient	Crop	Expiry
3570/07	Cleancrop Chicane	Fosetyl-aluminium	collard (outdoor)(seedling)	31-May-09
0271/08	Standon Fullstop	Fosetyl-aluminium	broccoli (outdoor)	31-Dec-13
0271/08	Standon Fullstop	Fosetyl-aluminium	broccoli (outdoor)(seedling)	31-Dec-13
0271/08	Standon Fullstop	Fosetyl-aluminium	brussels sprout (outdoor)	31-Dec-13
0271/08	Standon Fullstop	Fosetyl-aluminium	brussels sprout (outdoor) (seedling)	31-Dec-13
0271/08	Standon Fullstop	Fosetyl-aluminium	cabbage (outdoor)	31-Dec-13
0271/08	Standon Fullstop	Fosetyl-aluminium	cabbage (outdoor)(seedling)	31-Dec-13
0271/08	Standon Fullstop	Fosetyl-aluminium	calabrese (outdoor)	31-Dec-13
0271/08	Standon Fullstop	Fosetyl-aluminium	calabrese (outdoor)(seedling)	31-Dec-13
0271/08	Standon Fullstop	Fosetyl-aluminium	cauliflower (outdoor)	31-Dec-13
0271/08	Standon Fullstop	Fosetyl-aluminium	cauliflower (outdoor) (seedling)	31-Dec-13
3927/02	Gaicho	Imidacloprid	broccoli (outdoor)	31-Dec-13
3927/02	Gaicho	Imidacloprid	brussels sprout (outdoor)	31-Dec-13
3927/02	Gaicho	Imidacloprid	cabbage (outdoor)	31-Dec-13
3927/02	Gaicho	Imidacloprid	calabrese (outdoor)	31-Dec-13
3927/02	Gaicho	Imidacloprid	cauliflower (outdoor)	31-Dec-13
3927/02	Gaicho	Imidacloprid	collard (outdoor)	31-Dec-13
1485/08	Steward	Indoxacarb	brussels sprout (outdoor)	31-Mar-16
1610/01	Fubol Gold WG	Mancozeb/metalaxyl-M	cabbage (outdoor)	31-Dec-13
3643/06	Fubol Gold WG	Mancozeb/metalaxyl-M	collard (outdoor)	31-Dec-13
0381/08	MetMan 680	Mancozeb/metalaxyl-M	cabbage (outdoor)	30-Jun-11
3306/07	Alpha Metazachlor 50 SC	Metazachlor	collard (outdoor)	31-Dec-13
1420/08	Sultan 50 SC	Metazachlor	collard (outdoor)	31-Dec-13
3012/06	Devrinol	Napropamide	collard (outdoor)	31-Dec-13
3010/06	Devrinol (09374)	Napropamide	collard (outdoor)	31-Dec-13
3278/06	No-FID	Nicotine	collard (outdoor)	31-Dec-13
3288/06	Stalwart	Nicotine	collard (outdoor)	31-Dec-13
3292/06	XL All Nicotine 95%	Nicotine	calabrese (outdoor)	31-Dec-13
2565/08	Alpha Propachlor 50 SC	Propachlor	collard (outdoor)	18-Mar-10

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Appendix 12 Specific off-label approvals for leaf, head and flowerhead brassicas (Cont'd)

SOLA Number	Product	Active Ingredient	Crop	Expiry
2542/07	Alpha Propachlor 50 SC (04873)	Propachlor	collard (outdoor)	31-Jan-09
2578/08	Brasson	Propachlor	collard (outdoor)	18-Mar-10
2586/08	Ramrod 20 Granular	Propachlor	calabrese (outdoor)	18-Mar-10
2582/08	Ramrod 20 Granular	Propachlor	collard (outdoor)	18-Mar-10
3130/06	Ramrod Flowable	Propachlor	collard (outdoor)	18-Mar-10
2599/08	Sentinel 2	Propachlor	collard (outdoor)	18-Mar-10
2595/08	Tripart Sentinel	Propachlor	calabrese (outdoor)	18-Mar-10
2596/08	Tripart Sentinel	Propachlor	collard (outdoor)	18-Mar-10
0788/07	Chess WG	Pymetrozine	broccoli (outdoor)	31-Oct-11
0788/07	Chess WG	Pymetrozine	broccoli (outdoor)(seedling)	31-Oct-11
0788/07	Chess WG	Pymetrozine	brussels sprout (outdoor)	31-Oct-11
0788/07	Chess WG	Pymetrozine	brussels sprout (outdoor) (seedling)	31-Oct-11
0788/07	Chess WG	Pymetrozine	cabbage (outdoor)	31-Oct-11
0788/07	Chess WG	Pymetrozine	cabbage (outdoor) (seedling)	31-Oct-11
0788/07	Chess WG	Pymetrozine	calabrese (outdoor)	31-Oct-11
0788/07	Chess WG	Pymetrozine	calabrese (outdoor) (seedling)	31-Oct-11
0788/07	Chess WG	Pymetrozine	cauliflower (outdoor)	31-Oct-11
0788/07	Chess WG	Pymetrozine	cauliflower (outdoor) (seedling)	31-Oct-11
2246/08	Plenum WG	Pymetrozine	collard (outdoor)	31-Oct-11
2081/08	Plenum WG	Pymetrozine	collard (outdoor)	31-Oct-11
2086/06	Tracer	Spinosad	broccoli (outdoor)	30-Apr-13
0849/07	Tracer	Spinosad	broccoli (outdoor)	30-Apr-13
2086/06	Tracer	Spinosad	broccoli (outdoor)(seedling)	30-Apr-13
0319/06	Tracer	Spinosad	brussels sprout (outdoor)	30-Apr-13
0319/06	Tracer	Spinosad	cabbage (outdoor)	30-Apr-13
2086/06	Tracer	Spinosad	calabrese (outdoor)	30-Apr-13
0849/07	Tracer	Spinosad	calabrese (outdoor)	30-Apr-13
2086/06	Tracer	Spinosad	calabrese (outdoor) (seedling)	30-Apr-13
0319/06	Tracer	Spinosad	cauliflower (outdoor)	30-Apr-13

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Appendix 12 Specific off-label approvals for leaf, head and flowerhead brassicas (Cont'd)

SOLA Number	Product	Active Ingredient	Crop	Expiry
1375/07	Alpha Tebuconazole 20 EW	Tebuconazole	broccoli (outdoor)	31-Dec-13
1375/07	Alpha Tebuconazole 20 EW	Tebuconazole	calabrese (outdoor)	31-Dec-13
1375/07	Alpha Tebuconazole 20 EW	Tebuconazole	cauliflower (outdoor)	31-Dec-13
1874/03	Folicur	Tebuconazole	broccoli (outdoor)	31-Dec-13
1874/03	Folicur	Tebuconazole	calabrese (outdoor)	31-Dec-13
1874/03	Folicur	Tebuconazole	cauliflower (outdoor)	31-Dec-13
1371/07	Mitre	Tebuconazole	broccoli (outdoor)	31-Dec-13
1371/07	Mitre	Tebuconazole	calabrese (outdoor)	31-Dec-13
1371/07	Mitre	Tebuconazole	cauliflower (outdoor)	31-Dec-13
1824/08	Orius	Tebuconazole	broccoli (outdoor)	31-Jul-09
1824/08	Orius	Tebuconazole	calabrese (outdoor)	31-Jul-09
1824/08	Orius	Tebuconazole	cauliflower (outdoor)	31-Jul-09
1326/07	Orius 20 EW	Tebuconazole	broccoli (outdoor)	31-Dec-13
1326/07	Orius 20 EW	Tebuconazole	calabrese (outdoor)	31-Dec-13
1326/07	Orius 20 EW	Tebuconazole	cauliflower (outdoor)	31-Dec-13
0546/07	Riza	Tebuconazole	broccoli (outdoor)	31-Dec-13
0546/07	Riza	Tebuconazole	calabrese (outdoor)	31-Dec-13
0546/07	Riza	Tebuconazole	cauliflower (outdoor)	31-Dec-13
2121/07	Nemolt	Teflubenzuron	broccoli (outdoor)	31-Dec-13
2121/07	Nemolt	Teflubenzuron	brussels sprout (outdoor)	31-Dec-13
2121/07	Nemolt	Teflubenzuron	cauliflower (outdoor)	31-Dec-13
2266/08	Biscaya	Thiacloprid	collard (outdoor)	31-Dec-14
2266/08	Biscaya	Thiacloprid	collard (outdoor)(spring greens)	31-Dec-14
3527/06	Basilex	Tolclofos-methyl	broccoli (outdoor)	31-Dec-13
3219/07	Ipifluor	Trifluralin	collard (outdoor)	20-Mar-09

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/or their advisers.

Specific off-label uses may only take place if all the conditions of approval, 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 13 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 potential alternative strategies.

Active ingredient	Target: pest, weed, disease	Current position	Suggested guidelines
cypermethrin deltamethrin	insect pests	Residues very occasionally found in <1% samples	Both deltamethrin and cypermethrin have a zero harvest interval. However, application on the day of harvest can lead to occasional residues being detectable. Whilst these residues are well within current MRLs it is advisable to avoid the application of these insecticides within 3 days of harvest.

Appendix 14 Control Points: LEAF & FLOWERHEAD BRASSICAS

LEAF & FLOWERHEAD BRASSICAS

- CS.59.1 Evidence should be produced to show that you have taken into consideration soil type and variety when planning fertiliser application -
Protocol reference: Section 6.1
- CS.59.2 Do you use a soil nitrogen prediction system such as Soil Nitrogen Supply (SNS) and where applicable Soil Mineral Nitrogen (SMN) to schedule nitrogen applications?
Protocol reference: Section 6.1
- CS.59.3 *Deleted 2004*
- CS.59.4 *Deleted 2009*
- CS.59.5 You should provide evidence to show that you can justify the use of fungicides and do not apply them on a routine prophylactic basis -
Protocol reference: Section 8.10.2 (**Revised 2005**)
- CS.59.6 Evidence must be provided to show that polythene crop covers have been disposed of or recycled in the most appropriate manner -
Protocol reference: Section 4.5.4
- CS.59.7 Evidence must be provided to show that you ensure harvested product is not contaminated by or exposed to anything that could affect food quality
- Protocol reference: Section 9.4