Crop Module: Cabbage
Effective 1st September 2015
This crop specific module for cabbage has been written to complement and avoid duplicating the generic principles of the Red Tractor Farm Assurance Fresh Produce Scheme standards. It is advisable to read the Red Tractor Farm Assurance Fresh Produce standards before reading this crop specific module. This module is designed to stimulate thought in the mind of the reader. It contains crop specific guidance and standards, where applicable, in addition to the requirements stated in the generic Fresh Produce standards.

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

Disclaimer and trade mark acknowledgement

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

Notes: Pesticide Information

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

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

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


General Introduction

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

Acknowledgements

Red Tractor Farm Assurance Produce gratefully acknowledges the contribution of all consultees in the preparation of this protocol, particularly members of the Brassica Growers Association and Andrew Richardson, Allium & Brassica Centre, Kirton, Boston, Lincs.
### ADDITIONAL REQUIREMENTS AGAINST CURRENT STANDARDS

None for this crop module

### CROP SPECIFIC STANDARDS

<table>
<thead>
<tr>
<th>STANDARDS</th>
<th>HOW YOU WILL BE MEASURED</th>
<th>RECORDS (to be kept for 2 years)</th>
</tr>
</thead>
</table>
| CQ.58.a   | The following has been considered:  
- crop health  
- avoidance of disease carry over by incorporating post-harvest residues quickly and efficiently  
- satisfactory record of pH levels and liming policy | Records of pH levels  
Liming policy |
GUIDANCE

CHOICE OF VARIETY OR ROOTSTOCK AND PLANT HEALTH CERTIFICATION

CHOICE OF VARIETY

Cabbages can be divided into six types, depending on leaf structure, density, colour and time of maturity. Most varieties in current commercial use are hybrids.

Spring greens (also known as Cabbage greens or collards)

The Chemical Regulation Directorate defines collards, for the purposes of pesticide approvals, as: “varieties of cabbage Brassica oleracea var. capitata grown for harvest as spring greens or before the ‘head’ has formed.”

Usually overwintered in the juvenile stage and cut from March to May, spring greens are now available in the winter period from Cornwall and Thanet, with production spreading to other areas as spring temperatures increase. Traditionally required in the summer by the wholesale markets, multiple retailers have developed an all year round market for bagged compact greens with a minimum of stem and inedible outer leaf. Semi-hearted varieties are acceptable especially in the late spring, and also have limited late summer/autumn trade.

Irrigation is essential on all soils, except silts, for the summer production of ‘spring greens’.

The crop is grown at a high plant density and may be either direct drilled or grown from transplants. Seedling emergence may be inhibited in drilled crops due to soil capping.

When direct drilling seed with the highest germination and vigour should be used to ensure an even as possible emergence and final plant stand.

Trials have shown that two-thirds of the variation in weight at harvest is associated with variation in seedling emergence, even when the spread of emergence is only five days. Much of this variation is associated with sowing depth as seedlings from small seeds emerge slightly later. Also for several days after emergence, seedlings from deep sowings grow at a slower rate than those from shallow sowings. Plant density studies have shown that even at the wide spacings used commercially, the growth of later emerged plants is suppressed by competition from larger neighbours.

Nitrogen top dressing

Often applied as ammonium nitrate, sulphate of ammonia or calcium nitrate. Sulphate of ammonia has been shown to be more effective than the nitrate forms in the wetter areas of the South West, but the choice is largely governed by price and availability.

Where nitrogen top dressings are broadcast over the crop there is a risk of scorch and subsequent Botrytis infection. To minimise this risk, application should be made when the crop is dry or very wet so that as little as possible sticks to the foliage. Use of calcium nitrate will reduce scorch symptoms.

Pests

With the overwintered crop the most damaging and expensive pest is the wood pigeon!

Disease

None of the current commercially important varieties have resistance to all the five major diseases, (ringspot, Alternaria, light leaf spot, white blister and club root). Varieties differ in their susceptibility to downy mildew, up to date guidance can be obtained from plant breeders and seed houses. In the case of spring greens information can be obtained from the Duchy trials conducted by HDC and the Duchy College.

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

The main problems can be ringspot, Alternaria, and downy mildew. Ringspot is a major problem throughout the year, although downy mildew can be significant in the autumn.

Trials in Cornwall, under low disease pressure, showed that no one treatment produces a significant yield response or improved leaf quality. Low levels of disease, therefore, do not warrant routine fungicide spray treatments unless overall marketability is likely to be affected.
Harvesting and packing
Customer preference is for greens with entire, medium deep green leaves with a high leaf area relative to vein, mid rib and stem, and of fresh appearance. A typical specification is 2-5 pieces per 500g bag. Care should be taken not to include yellowing leaves or those fouled by mud.

The cost of harvesting and marketing can amount to at least 80% of the total cost of production, half of which may be the labour for cutting.

All field-packing rigs should always conform to Health and Safety Executive standards and specific end market requirements.

With this leafy product, rapid cooling is essential especially in the summer period.

Early summer cabbage (Primo)
These round cabbage varieties are the first types of a new season. Certain varieties are prone to bolting when sown early. Production begins in mid to late May.

For the early crop, transplanting using blocks or modules is essential. Maturity ranges from approximately 65 to 76 days after transplanting. On the early crops the use of plastic or non-woven polypropylene fleeces can advance maturity by up to 14 days. Unlike polythene, non-woven polypropylene can be left on the crop almost up to cutting as maximum temperatures recorded under fleece are lower than those recorded under polythene. Irrigation may aid early maturity in the event of dry weather during May and June.

Pests
Early pest identification and appropriate justified control are essential with fast growing crops such as primo cabbage.

Diseases
With early primo varieties, application of fungicides is generally not justified.

Harvesting
This type of cabbage quickly becomes over-mature and splits. The glossy young green leaves are especially prone to bruising.

Late summer/autumn cabbage
Continuity of production is possible from the early primo types in May and June through to November. A dark green cabbage with a favorable taste is generally the requirement now.

This crop can be either direct drilled or transplanted. Transplanting is preferred due to easier maturity programming and improved uniformity at harvest.

These cabbages are sown from March to May under glass maturing from July to October.

Pests
Cabbage root fly, aphids and caterpillars are the most common insect pests. For effective control of cabbage root fly preventative treatment is necessary. Aphids and caterpillars can be adequately controlled in response to thorough crop scouting, taking note of any threshold levels and ensuring to use insecticides that preserve beneficial predators.

Diseases
A proportion of the summer crop can be grown with little or no fungicide as disease levels remain low. Where disease levels are confined to the outer wrapper leaves, these are discarded when cutting, thus a small amount of infection on these leaves is not critical.

Winter cabbage (January King and green types)
Winter cabbages are grown for harvesting from November to early March.

These varieties are sown in May/early June for harvesting from mid November onwards. Agronomic factors should be considered when choosing varieties along with taste and appearance.

Pests
Aphids, etc. should be treated as per autumn cabbage during the growing season. Pigeons and rabbits can damage crops during the winter/spring.

Diseases
Low levels of disease infection on the outer leaves can be ignored but where build-up becomes severe, eradicant fungicides should be applied before the marketable head is affected. The most serious disease is usually ringspot. Correct identification is essential to determine the correct fungicide.
Harvesting

In the winter, preferably, cabbage should not be cut frozen when frost has penetrated the cabbage, because quality problems may occur when plant tissue thaws.

In most multiple retailer specifications for round green-hearted cabbage, one outer ring of loose leaf is allowed. The head size specification is usually 700g. with a maximum of 1.2kg. Internal stalk growth can be an issue in the spring (from late crops) and should be carefully monitored.

Packing rigs should always comply with statutory Health & Safety regulations and specific end market requirements. Placing the cabbage heads directly into the final packaging in the field reduces handling and thus potential damage.

Packed cabbages should be quickly transferred to the packhouse for final quality checks before cooling.

Winter white & winter red storage cabbage

Growing and storage using a combination of simple ambient barn storage, sophisticated cold storage or controlled atmosphere storage allows 12 month continuity of supply.

These cabbages are required for both home consumption (cooked and raw) and also for processing. The preferred size for retailing is usually 500g. to 1.2kg, whilst processors usually require a minimum of 2.5kg, with an optimum weight around 3.5kg.

Winter white cabbage for processing requires a long period of steady growth to ensure a high yield with good storage potential. True winter white types are sensitive to day length and are difficult to produce from the field before the end of August. Summer types are often used as a “filler” in the July/August period but are disliked on the grounds of colour, texture and conformation, thus this cabbage is often blended with stored winter whites.

The “high density crop” can be direct drilled or transplanted. The wide spaced crop is usually transplanted as modular transplants give a more even maturity.

Pests

Normal brassica pests should be controlled when they appear. Do not apply routine prophylactic sprays.

Diseases

It is essential that the crop be kept disease free. Secondary storage rots develop on leaves attacked by primary pathogens. The most troublesome is likely to be ringspot, although all the common brassica leaf pathogens can occur on this crop. Apply fungicides in the field only when onset of disease is noted. This can be aided by the use of disease forecasting systems such as Brassica Spot.

Savoy cabbage

Savoy cabbages are probably the most frost tolerant type. With early production and using short-term refrigerated storage at the end of the season, they are available from June to early April.

Savoy cabbage is characterised by blistered or wrinkled foliage that is dark green and has very little bloom.

Nearly all varieties are now F1 hybrids. Choose a variety with a compact habit and good internal structure, and density. Savoys are very winter hardy, but care should be taken if long periods of hard weather necessitates having to cut frozen cabbage. Frozen cabbage bruises easily and should be allowed to thaw out completely before sale.

The full range of brassica pests and diseases attacks this type of cabbage.

SITE AND SOIL MANAGEMENT

SITE HISTORY

When selecting a site for growing a cabbage crop it is important to consider the following requirements:

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.

Weed status

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

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

To humans: where possible avoid cropping areas adjacent to schools, housing estates, playing fields etc. where there is a risk of drift from spraying operations.

To flora: avoid areas adjacent to wildlife reserves, sites of specific scientific interest. Note the position of any beehives.

To watercourses: CRD has implemented an interim extension to the Local Environmental Risk Assessment (LERAP) scheme. This legislation allows the approval of plant protection products with aquatic buffer zones greater than the current 5 metres. As for products in category A these distances will not be reducible under the LERAP scheme. Further information can be obtained from the CRD or by following this link http://www.pesticides.gov.uk/Resources/CRD/Migrated-Resources/Documents/I/Interim-scheme.pdf

Chlopyrifos and buffer zone restrictions

Chlopyrifos is currently still undergoing a CRD review as part of its re-registration. At the end of the review process the cabbage root fly module drench approval will be revoked. Other chlopyrifos uses are currently in the balance as this active represents a significant risk to aquatic life and CRD are currently insisting on very large buffer zones alongside watercourses. The manufacturers (Dow, Adama and Headland) have launched the Say No to Drift campaign (www.saynotodrift.co.uk) to help maintain current approvals.

This campaign requires growers to adopt the use of low drift nozzles (3* rated) and establish a 20 metre buffer zone alongside watercourses (1m next to dry ditches). Chlopyrifos is an extremely useful active and it is strongly urged that growers adopt this approach and keep appropriate records when applying this active.

Rotation

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.

Brassicas thrive best on moisture retentive high alkaline soils 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:

- Crop health
- Avoidance of disease carry over by incorporating post-harvest residues quickly and efficiently
- Satisfactory record of pH levels and liming policy.
SOIL MANAGEMENT

Soils

Good drainage is essential. 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, phosphate 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 brassicas where liming has recently been carried out in very low pH situations. Cabbage can be grown on a wide range of soil types, but lighter sandy soil types will require irrigation. Consideration should be given to the damage caused by harvesting on heavy soil types particularly with winter cabbage. Heavier soil types may also be difficult to obtain a good tilth for drilling in March or April.

Direct drilled cabbage 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.

Cultivations

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 cultivation, will help to maintain soil structure. Roots will not penetrate a compacted or smeared soil layer and high yields will not be produced unless the plants can root deeply.

Loss of soil structure in the surface layers, due to excessive or inappropriate cultivations, can lead to soil capping and reduced emergence. Particularly excessive soil working, with reciprocating tines used at high speeds, is to be avoided.

Wheelings from pre-sowing or planting cultivations may cause compaction; therefore the bed system is to be commended. In large-scale production the tramline system, where two crop rows are left out for the passage of a tractor with wide tyres, facilitates easy fertiliser applications, spraying, irrigation and harvesting machinery access, in addition to confining wheelings to a designated area.

DRILLING AND TRANSPLANTING

Plant populations

Plant population has important effects on:

- Total yield
- Market for which the crop is grown
- Costs of production
- Disease control

Increasing plant population results in reduced cabbage size and delayed maturity. Overall plant population per hectare is more important than the spatial arrangement of the plants.

Direct drilling

With the exception of spring green production, this system is rapidly falling from favour. It is generally used where crops are grown at close spacing. The method requires greater precision to establish the crop than transplanting.

With direct drilling:

- land is occupied for a longer period
- expensive hybrid seed requirements are higher
- less labour is involved than with transplanting
- specialised transplanting equipment is not required
- unlike transplanting, there is less pressure to establish the crop in mid-summer, possibly in dry conditions

There is no advantage in using pelleted seed. 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. Adjustable land wheel drive may be required on some bed systems.

Drilling into soils liable to cap

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

Anti-capping wheels: Twin rear wheels which run on each side of the row with a 25mm gap between, so that the soil is not compressed directly over the seed.

Cage wheels: They have expanded metal surfaces instead of the standard steel band.
Small rakes: Fitted behind each rear wheel to loosen the consolidated topsoil without disturbing the seed.

Shallow drilling, together with pre-drilling irrigation if necessary, is preferable to drilling deeper to reach moist soil. Avoid deep drilling on soils liable to cap.

Cabbage root fly control should be considered at drilling, currently the only option available to growers is a field drench with chlorpyrifos.

**TRANSPLANTING**

**Propagation**

The majority of the transplanted crop is grown from glasshouse raised modular transplants or small peat blocks. Transplanting is a major aid in crop scheduling. The modular trays, the most common size having cells of 14ml volume containing peat compost, enable the propagator to have complete control over plant growth. They also provide a system that facilitates the application of a cabbage root fly insecticide treatment that uses less active ingredient per hectare than field applications.

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 the 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 a 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 insecticides). 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 EC Plant Health Regulations, propagators are required to 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 for due diligence throughout the food distribution chain, details of all pesticides should be agreed and recorded by the propagator and passed to the grower. Applications of liquid feeds should be treated similarly.

**Early production under covers**

Although mainly used for early production of summer primo and savoy cabbage, covers are occasionally used for small areas of white and red cabbage.

This technique needs easily worked soils with excellent structure and with the exception of the silts in Lincolnshire, growers usually need irrigation facilities.

Wide sheets, 12-16 metre wide, of perforated polythene are the most economical for covering. There is a disadvantage with narrow sheets due to an “edge effect”. Before laying plastic, it is important that plants are strong enough to carry weight of covers. Alternatively, plant in shallow ridges so that soil supports the cover during crop establishment.

The activity of herbicides under plastic film can be erratic. This may be due to high light intensities and warmth causing accelerated breakdown of the herbicide or possibly by the drying out of the soil surface. It is important that individual herbicides are applied to moist soil, or on soil moistened before the crop is covered with film, in order to improve the performance of the herbicide.

Physiological problems soon arise if covers are left on too long. Covers should be removed on a dull day or in the late afternoon period.

By using polythene film skillfully, early cropping can be advanced by 14 days. The cost of plastic and associated laying and removal is expensive and usually only justified on early crops that command a premium.

**Disposal of plastic**

To comply with legislation, and protect the environment, plastic should not be burnt. Growers should ensure that old polythene is either dispatched to a recycling company or disposed of in a registered landfill site.
ENVIRONMENTAL PROTECTION & CONTAMINATION CONTROL

PEST, DISEASE AND WEED CONTROL

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, is not the correct approach.

Prevention is also better than cure, therefore where possible, an integrated approach is needed.

Prevention

a. 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 cutting ceases.

b. Crop rotation.

c. Provide good soil structure, correct nutrition and irrigation if possible to ensure conditions to give good strong, healthy growth.

Control: Use available pest forecasts as management tools to aid when to scout for pests.

Crops should be regularly and systematically inspected to monitor crop development, pest and disease levels. Increase the frequency of crop walking during periods of high pest incidence particularly during hot weather.

In addition to crop walking, consider the use of insect traps e.g. pheromone traps, chemical attractant traps and soil sampling (cabbage root fly eggs) as monitoring tools.

Identify both pest 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 should be weighed up against efficacy and longevity of treatment. Use the least toxic product where possible.

Insecticide resistance is now common most seasons within populations of peach potato aphid. It is important to alternate the use of different active ingredients to enable the best chance of control with the existing range of actives.

Use the minimum effective dose rates, normally being that recommended. Do not reduce dose rate for peach potato aphid.

Consider use of natural and biological methods of pest control, if available.

Avoid spraying, or allowing drift into grassy banks, dyke sides, hedgerows etc., these can provide a reservoir of insect predators, such as ladybird larvae, hover flies, ground beetles etc. However consider the implication of buffer zone restrictions on certain chemical uses.

Carefully consider also the anticipated harvest date when selecting the appropriate product. Ensure you have enough time for the harvest interval to elapse prior to harvesting.

For various reasons 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.

Cabbage root fly (Delia brassicae)

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

The eggs of cabbage root fly are attacked by several beetle species. These beetles remain in the soil for long periods, unfortunately insecticides applied to other crops in the rotation can reduce their numbers making it difficult to predict how effective they may be in reducing cabbage root fly damage.

Forecasting/monitoring

Present monitoring methods include counting eggs laid at the stem base of brassica to predict the size of the next generation, and the use of non-selective water traps to catch adult flies. Warwick Crop Centre uses a computer model to predict the timing and duration of each generation. This information provides timings for several UK locations and is based on statistical information and local weather data.

A chemical attractant trap is available that selectively traps adult flies and thus in future a combination of this trap and Warwick Crop Centre computer prediction model, will give a more reliable monitoring system.
Control methods

Direct drilled crops
There are currently no effective UK approvals for in field control of cabbage root fly a chlorpyrifos drench at emergence will offer some control but may fail to give complete control.

Transplanted crops
Plant propagation pre-planting drenches: Chlorpyrifos or spinosad can be used as a pre-planting drench on block and module raised plants. Note: there is no approval for use of spinosad on collards. Do not use on cells smaller than about 14ml 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 have been used, subsequent applications of pesticides in the glasshouse or in the field should be delayed until adequate wax has formed on plant leaves.

Module drench approvals of chlorpyrifos are likely to expire at some point in 2015, with this potential loss in mind growers should investigate and gain confidence with other methods of cabbage root fly control including spinosad.

Crops grown from block or module raised plants, which were treated before planting (as above), should not normally need further treatment in the field but there are occasions where subsequent treatment may be necessary:

Where, due to planting delays, copious irrigation has been applied after treatment and considerable time has elapsed before planting which may have led to the leaching of the insecticide.

Insufficient insecticide applied by propagator (maintain a check at planting by routine analysis of compost).

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.

In the absence of irrigation, when upper layers of the soil are dry or soil conditions are cloddy, it is essential to plant deeper in search of moisture for the plants to survive. This necessitates covering the module with soil and this renders the stem at soil surface level open to attack.

Treatment methods
Granules - there are no currently approved granule treatments for cabbage root fly.

Brassica aphids (Brevicoryne brassicae and Myzus persicae)
There are two species of aphid that are of commercial relevance:

Mealy grey aphid (Brevicoryne brassicae)
Widespread pest of cabbage which checks the growth of young plants resulting in wilting and possible mortality, particularly in dry conditions. On older plants the leaves curl up and marketable quality is spoiled by contamination with the aphid colonies.

All stages, including eggs, occur on the 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)
In recent seasons this aphid has emerged as a major pest of cabbage crops. This aphids ability to develop resistance can see populations increase very quickly leading to severe infestations and crop yield implications. It is also a very efficient virus vector causing widespread distribution of several crop viruses including TuYV (which causes tipburn symptoms in storage cabbage) and TuMV (which causes cigar burn symptoms in storage cabbage). 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.

Three insecticide resistant mechanisms exist in UK populations; metabolic - conferring resistance to organophosphates; modified acetyl-cholinesterase (MACE) conferring resistance to carbamates and; knock-down (KDR) conferring resistance to pyrethroids. No resistance mechanisms are currently known to exist in the UK with regard to the pymetrozine (Plenum®) or the neo-nicotinoids i.e. thiacloprid (Biscaya®) or spirometramat (Movento®). Use of these four actives should be made where there has been a previous history of resistance or where resistance populations are suspected.
Cultural control: Most cabbage aphid infestations develop from colonies that overwinter on old brassica crops and autumn sown oilseed rape. Plough in or otherwise destroy old crop residues to help reduce aphid populations.

Aphid numbers 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, best practice has yet to be determined. Grower's and or adviser's experience should allow judged decisions to be made over control measures in the growing crop.

Chemical control: Select insecticides with the least harmful effect on beneficial insects and avoid broad-spectrum insecticides. Some synthetic pyrethroids, despite their reputations, often kill a wide range of beneficial predators.

Alternate insecticides with different modes of action in order to avoid build-up of aphid resistance. Weather conditions and time of year should be taken into account when selecting aphicides. Late in the season, from October onwards, control of cabbage aphid with pirimicarb and pymetrozine may fail.

During dry periods the uptake of systemic insecticides is reduced.

Current work at Warwick Crop Centre is focusing on the development of forecasting techniques for aphid populations. Studies of populations show a regular midsummer "crash" where natural mortality is actually greater than by applying aphicides. This normally occurs in late July - early August.

Whitefly (Aleyrodes proletella)

Now established in some UK growing areas this pest is a major issue especially during hot, dry seasons. Whitefly can complete their whole life cycle on vegetable brassica plants requiring no other host. They are also able to overwinter in the UK climate without significant mortality. The adult whitefly lays numerous eggs (up to 150 eggs per female adult) in waxy circles on the underside of leaves. The eggs hatch to produce a semi motile stage known as scales which remain on the underside of the leaf and feed on plant sap until they mature into adults. Honeydew excreted by both the adults and scales collect on lower leaves leading to spoilage by sooty moulds. Where populations are high the accumulation of honeydew and presence of adults can significantly reduce marketable yield and in extreme cases lead to crop loss.

Chemical control: Whitefly can overwinter in large numbers on vegetable brassicas and oilseed rape. Where possible site spring planted/sown crops away from overwintering sites.

Chemical control: As the pest remains predominantly on the underside of the leaf it is very difficult to target with standard insecticide application equipment. This has given rise to poor control from contact insecticides and the development of insecticide resistance as a result of low dose exposure. There is significant evidence that whitefly are resistant to pyrethroids. Products containing pymetrozine, the neonicotinoids and spirotetramat will give control. Take care to alternate products with different modes of action to reduce the likelihood of insecticide resistance developing. Spirotetramat is systematically active and is likely to give the most effective control, activity is however significantly reduced where the crop is dry and stressed.

Cabbage caterpillars

Caterpillars of many species attack brassicas and may appear at almost any time between mid-May and October, although the degree of infestation varies from season to season. The damage caused depends upon the species responsible. Some species larvae, when nearly mature, are difficult to kill with insecticides and cause considerable spoilage. Others, even when numerous, may not justify treatment. The diamond back moth is the most potentially damaging species as caterpillar numbers can increase very quickly leading to severe damage. They typically feed on the undersides of leaves, leaving the upper surface as a window pane. It can have several generations in a season and is generally more prevalent during hot dry seasons. Pheromone traps are available to catch Silver Y and Diamond Back Moths, these can be used as an early indication of moth activity and help in focusing crop inspections.

Cultural control: Frequent crop walking is essential to identify both the caterpillar species and natural predators. Caterpillar predators are unlikely to give effective control where levels are high but may adequately control low infestations. In addition, some caterpillar species only have one generation per year and thus if the feeding is at low levels on the vegetative parts of the plant chemical control may not be necessary.

Chemical control: Check crops regularly and apply insecticides when caterpillars found.

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

Consider using more specific control measures such as Bacillus thuringiensis, indoxacarb and diflubenzuron that do not have such a damaging effect on beneficial predators.
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 sometimes combined with a weather model to define high risk periods, when the caterpillars are small and can be controlled by rainfall/irrigation or chemical treatment. Use pheromone traps to monitor moth numbers. If local information is not available and 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.

Pollen beetle
Adults, dispersing principally from oilseed rape, can damage brassicas in summer. They are occasionally capable of inflicting damage to summer primo cabbage or may cause contamination issues.

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 head cabbage and leafy brassicas in the case of collards. In recent years resistance to pyrethroids has been observed across the UK. Growers should monitor crops post spraying to determine if control has been effective and should alternate insecticide applications with products from other groups to manage resistance pressure. Applications of neonicotinoids, pymetrozine and indoxacarb have all shown good efficacy against pollen beetle. More information on resistance levels in your area can be found via the Home Grown Cereals Authority (HGCA) who have produced an information sheet or by contact with Dr Rosemary Collier at Warwick Crop Centre.

Slugs
Slugs are potentially very damaging to cabbage crops, small plants can be severely damaged causing significant reduction in leaf area. They are also undesirable in larger plants not only for direct damage but also as a contaminant in produce. Wet heavier textured soils which are poorly consolidated represent the highest risk.

Cultural control: Consolidate soils to inhibit slug movement where necessary. Surface bait to determine 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.

Metaldehyde pellets should be applied under the guidelines of the current stewardship scheme which is designed to safeguard continued use of metaldehyde as a slug control by eliminating contamination of ground water and drinking water supplies. Voluntary guidelines limit maximum applications to 210g of active ingredient per hectare between 1st August and 31st December, and to a total application in a calendar year of 700g active ingredient per hectare. Applications should also observe a six metre buffer zone next to water courses and ditches. More details of the scheme can be found at www.pelletsarepesticides.co.uk.

Cabbage stem weevil (Ceutorhynchus quadridens)
A widely distributed but sporadic pest which attacks all cruciferous crops, particularly direct drilled cabbage crops. The larvae feed in stems and petioles of plants that may subsequently wilt. The use of yellow sticky traps may aid crop monitoring and control. In most seasons there is no requirement to treat crops for the control of this pest.

Beneficial organisms
Beneficial organisms include predators, parasitoids and pest specific diseases such as bacteria and fungal pathogens. 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 where broad spectrum 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.

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 favorable.

Exploiting beneficial organisms
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.

If a pesticide is required avoid use of broad spectrum insecticides which can have a harmful effect on beneficial insects.

Consider the use of biological control agents such as Bacillus thuringiensis.

For further information on beneficial organisms contact Dr R Collier, Warwick Crop Centre.

DISEASE CONTROL
Introduction
Cabbage is 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 identifications of diseases, and use of a disease forecasting system where applicable, are an important element in minimising fungicide use.

Most of the major fungi cause spots or blemishes on the cabbage leaves/head rendering it unmarketable. These diseases are prevalent in the main production areas in most seasons. This is partially due to the spread of oilseed rape growing, especially autumn sown and the proliferation of rape volunteers. End market tolerance of markings on the heads of cabbage 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
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.

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 it is important that agronomy and disease monitoring is of a high standard.

Use resistant varieties (where available) whilst respecting the need to meet the required agronomic, quality parameters and eating requirements. An indication of varietal resistance can be obtained from plant breeders, seed house representatives and via local knowledge.

Cultural control techniques: 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 night. Avoid over-watering, as this both washes nutrients and crop protection chemicals out of the 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. Control feeding to prevent over-soft growth. Adequately sterilise trays to prevent carry-over of diseases such as club root, Pseudomonas, damping-off etc.

In the field apply nutrients according to soil analysis.

Encourage steady growth by ensuring a regular supply of water where possible.

Through good agronomy, provide good growing conditions, i.e. avoid poorly drained soils, the presence of imposition or soil pans.

**Chemical control:** Regularly field walk and monitor the crop for diseases and pests, 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 should take into account 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 developed by Professor Roy Kennedy for Alternaria, Ringspot and White Blister are now in widespread commercial use. In the field, growers should ensure that fungicide use is justified and fungicides are not applied on a routine prophylactic basis.

Where fungicidal control is needed, the following points should be considered, whilst ensuring effective control is achieved:

- Use the least toxic and persistent product
- Use the minimum effective dose rate
- Check the buffer zone of products when applying to fields with water courses
- Carefully consider anticipated harvest date and ensure the selected chemical has an appropriate harvest interval

**Club root (Plasmodiophora brassicae)**

This disease 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 whilst the plant may be stunted or even die. This disease is of considerable significance in some cabbage production areas, particularly where soil pH is naturally marginal. The resting spores of the fungus remain viable in soil for at least twenty years.

**Cultural control:** Consider clubroot resistant varieties where available.

Maintain as wide a rotation as possible in vulnerable areas.

Soil tests can give a guide to potential infection. Sample at least 3 - 4 months before anticipated planting date, to allow change of cropping.

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.

High pH levels (>7.5) can give rise to minor nutrient problems.

In dry times, plants suffering from a small infestation can be brought to marketable yield by copious irrigation. It is essential to use disease-free modules.

Liming will not work immediately. It should be part of rotational planning.

Clubroot resistant cabbage varieties are now available for some cabbage types, where marketability is not affected use of these varieties should be considered.

**Chemical control:** None available

**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 drilled crops in the field.

With Rhizoctonia in the field the stem base becomes hard, brown and shrunken and the plants usually break off later in the season. Pythium is best controlled at propagation in the glasshouse with fungicides used pre-sowing or pre-planting as preventative treatments. For both diseases treatment in field crops is unlikely to give effective control.
Cultural control: Good glasshouse hygiene is essential.

Use plastic modular trays rather than polystyrene because when the surface coating wears off polystyrene trays, roots and fungi can penetrate the polystyrene and become a “reservoir” of disease. Plastic trays can be sterilised more easily and effectively.

Chemical control: Seed treatments and applications of tolclofos-methyl during propagation.

Downy mildew (*Peronospora parasitica*)
This disease is endemic in propagation under glass but in the field infections only become significant when mild wet weather conditions prevail. This fungus is both air- and soil-borne and may affect young plants via the roots. Spores are produced on infected plants and are distributed by air currents or rain splash, re-infesting 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.

Cultural control: Good glasshouse hygiene is essential.

Good management as outlined is essential.

Varieties vary in susceptibility - therefore choose the less susceptible varieties, provided they give the other agronomic features required.

Increase rotation.

Chemical control: In propagation, routine treatment, both on a preventative and eradicant basis, is essential.

Currently approved products include protectants such as azoxystrobin and eradicant applications of metalaxyl-M.

Preferably alternate fungicides from differing chemical groups to avoid development of resistant strains.

Dark leaf spot (*Alternaria brassicae* and *Alternaria brassicicola*)
Alternaria is primarily spread by air-borne spores where infected plant debris are the major source of spore creation. All brassica crops including oilseed rape and cruciferous weeds are potential sources of the disease. This disease can also be seed borne.

Symptoms range from small discrete black spots (which can be confused with those of powdery mildew and ringspot) to circular zonate spots, up to 12mm in diameter. The latter have greyish, brown or almost black centres, which 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 hot-hole appearance. Elongated dark brown lesions are found on stems and leaves. The influx of Alternaria normally coincides with the harvest of the oilseed rape crop in July.

Alternaria may be controlled by seed treatments on young plants in propagation. These treatments use very small amounts of fungicide compared to overall applications. In the field, the disease is favoured by warm moist conditions.

Cultural control:

Good glasshouse hygiene is essential.

Good management as outlined is essential.

If possible, isolate brassica crops from each other, particularly oilseed rape.

Collect intelligence about problems in oilseed rape crop.

Chemical control: Currently approved fungicides include protectants such as azoxystrobin and eradicants such as tebuconazole, difenconazole, prothioconazole, boscalid and iprodione.

Ring spot (*Mycosphaerella brassicicola*)
Infected crop debris is the major source of air borne spores which lead to disease spread. Infection and disease development is dependent on high humidity and temperatures of 10-20°C. Traditionally troublesome in the wetter southwest but now endemic in all main production areas. Periods of frequent rainfall appear to be critical for epidemic development.

The disease first appears on lower leaves as small circular necrotic, brown or purplish-black spots that gradually enlarge. As the ringspots 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.

The ringspot lesions are grey when dry, but are black when wet. Yield may not be affected but quality is drastically reduced.

Cultural control

Isolate out-door plant beds.

If possible, have a wide brassica rotation.

If possible, isolate cabbage crops from other brassica.

Chemical control: For currently approved fungicides refer to dark leaf spot.
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, and marketable quality is reduced.

The strains that attack cruciferous weeds such as shepherds purse are distinct and will not transfer to cabbage.

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

**Chemical control:** Currently approved fungicides include mancozeb and metalaxyl-M, boscalid, pyraclostrobin and azoxystrobin.

Powdery mildew (*Erysiphe cruciferarum*)
Powdery mildew is spread by wind-borne spores from affected brassica crops. Disease appears as small patches of thin white fungal growth on the upper leaf surface and/or on the stem. In severe attacks, the whole leaf surface is colonised. After frost, the disease may also show discrete black spotting which could be confused with Alternaria symptoms. The disease is severe in hot summers as infection is favoured by warm (15-20°C) conditions with periods of high humidity.

**Cultural control:** Use resistant varieties if they fulfill agronomic and retail requirements. Apply nitrogen as dictated by soil nitrogen supply, RB209 and/or 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, if available, irrigate accordingly.

**Chemical control:** Fungicides are only warranted on susceptible varieties in high-risk years. Foliar sprays containing tebuconazole, difenconazole or potassium hydrogen carbonate will control this disease.

Light leaf spot (*Pyrenopeziza brassicae*)
Other brassica crops and in particular their debris and aftermath represent the major source of inoculum. Spores are released from crop materials and debris as spore releasing structures mature. Thereafter wind dispersal can spread infection over large areas. Localised infection can also be spread by rain splash. This disease is most significant in northern England and Scotland where some tolerance to triazole fungicides can also be an issue.

Lesions are initially superficial and appear as small grey blotches. Infection can occur on older leaves but is most common on young leaves and on the buttons often with very little leaf symptoms. As the infection develops the lesions become darker and more distinct eventually developing into a broken circular spot which produces white spores.

**Cultural control:** Infected crop residues should be quickly ploughed in. Adopt a minimum 4 year rotation if possible to reduce the risk of carry-over on debris. Where practical situate vegetable brassicas away from oilseed rape crops.

**Chemical control:** Tebuconazole, difenconazole, prothioconazole and the protectant azoxystrobin.

Canker (*Phoma lingam*)
This disease is both seed-borne and soil-borne from infected debris. The fungus produces well-defined spots, with ashen-grey centres, on the upper side of the leaf. On the cabbage stems, near the base and on the tap root, brown or purplish areas develop, 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:** Fungicide activity as listed for dark leaf spot.

Root rot (*Phytophthora megasperma*)
This soil-borne fungus disease is occasionally seen on heavier or poorly drained soils. It attacks roots and stems leading to a severe pungent rot. The leaves wilt.

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

**Chemical control:** None available.

Grey mould (*Botrytis cinerea*)
A fungal disease that appears on the leaves as a grey growth or soft brown rot, it is usually associated with damage or the retention of dead and decaying lower leaves. The disease is spread by wet weather and high humidity. Botrytis can be difficult to control.

**Cultural control:** Avoid lush soft growth from excess nitrogen.

**Chemical control:** Iprodione.
Black rot (Xanthomonas campestris)
This is a bacterial disease commonly found on savoy, winter green cabbage, late autumn or overwinter cauliflower and occasionally on brussels sprouts.

Field infections are nearly always seed-borne or spread during propagation but then become endemic by surviving on incorporated residues. The symptoms are V-shaped chlorotic lesions on the leaf margins. Within the lesions the veins become blackened and a characteristic ring of vascular tissue can be seen when the stalks of affected plants are cut crosswise. The disease can develop very rapidly in warm damp conditions.

Control: Plant debris is a source of infection together with cruciferous weeds (e.g. Shepherd’s purse). Quick removal or soil incorporation of crop residue is advised. Where the disease is identified a rotational break of at least two years should be practised.

Seed testing
Major seed lots are batch tested. A negative result does not guarantee complete freedom from the disease but more usually subsequent disease expression is economically not significant.

If batches of seed are infected, hot water treatment is the only approved method of control but this can affect seed vigour.

Virus diseases
Turnip Mosaic (TuMV) virus is probably the most severe virus that attacks cabbage. Dark necrotic rings and spots on the older leaves of plants associated with severe stunting are the typical symptoms.

Cauliflower Mosaic virus (CaMV) is more common. The symptoms are vein clearing etc. followed by vein banding with stunted growth and distorted leaves. Affected plants are usually very susceptible to frost injury. Cauliflower and turnip mosaic virus’ often infect the same plant. Peach Potato aphids spread both viruses. Aphicides will not prevent introduction of virus but will restrict subsequent spread.

Turnip Yellows Virus (TuYV) formerly Beet Western Yellows Virus (BWYV) commonly affects brassica crops. Crops can remain symptomless but yield reductions in excess of 30% have been recorded. Work at Warwick Crop Centre suggests that TuYV is implicated in tipburn in processing 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 direct drilled crop.

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

Use of stale seedbed technique.

Avoiding use of covers where resistant weeds e.g. Pennycress is a problem.

Identifying those weeds present and targeting with the use of more selective active ingredients.

The use of mechanical weeding machines. 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 tines 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.

Chemical Control: Products containing Pendimethalin, dimethenamid-P, s-metolachlor, metazachlor and clomazone have approval for application to cabbage. Product choice will depend on weed spectrum and should take in to account any application restrictions. Refer to labels and EAMU where appropriate for rates and application timings.

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

APPROVED USES NOT INCLUDED ON THE PRODUCT LABEL
In many circumstances, particularly for minor crops, product labels do not include all of the approved uses and growers wishing to check the approval notice of a particular product should note that this information is available using the LIAISON® search accessible via their RED TRACTOR Farm Assurance home page after logging in. A search on the Extension of Authorisation for Minor Use in the UK by crop or product name should yield a results page. A click on the product name should link to a summary of the approval information. Near the bottom of the summary is the specific off-label number (e.g. 0246/09) and this link will open up a pdf of the current EAMU document giving details of the extension of use.
**Nutrient requirement**

Excessive use of macro-nutrients is not only wasteful, but can be costly and has a detrimental effect on groundwater quality.

Nitrogen in particular should be tailored accurately to the precise needs of the cabbage crop. Excess nitrogen should be avoided because:

- Maturity can be delayed.
- Soft unbalanced growth results in increased damage when handling, poor shelf life and increased susceptibility to disease.
- 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 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 crop’s need, taking into account soil residues, thus reducing the opportunity of excess nitrate leaching into ground water.

If it is not possible to undertake a soil analysis, a soil nitrogen index should be used, which takes into account the previous crop and its manuring (see Appendix). A computer based system such as PLANET v3.0 has been developed by ADAS and SAC with funding and support from DEFRA and the Scottish Government.

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.

Growers should ensure that when planning fertiliser applications soil type and variety are taken into consideration. Nutrients should be applied according to a recent soil analysis. Typical fertiliser recommendations are given in the Appendix.

Establishment of both drilled and transplanted crops can be adversely affected by excessive levels of fertiliser salts, especially nitrogenous fertiliser in the seedbed. The risk of poor results from high salt levels is less for transplants than for seed.

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

**Nitrate Vulnerable Zones**

Certain vegetable production areas within the U.K. may be located in designated nitrate vulnerable zones (NVZs). These are areas where 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:

- 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 every year, taking account of crop uptake and soil supply from soil organic matter, crop residues and organic manures.
- Application of organic manures should not exceed 170kg N/ha of total nitrogen averaged over the farm area each year or 250kg N/ha to individual fields.
- Do not apply fertiliser or manures when the soil is waterlogged, 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 should be completed before September 15th to be of any value.

**Trace elements**

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

**pH**

In common with all horticultural brassica crops the soil pH for cabbage should be maintained at pH 7.0 to 7.5, although this can cause problems where potatoes are grown in rotation.
IRRIGATION
The greatest response is likely to be obtained by achieving rapid establishment by irrigating immediately pre-sowing of direct drilled crops and (after planting out) with transplanted crops.

Plants under drought stress tend to be susceptible to pest attack; therefore irrigation helps improve yield and quality.

Summer Primo cabbages are the most likely to benefit from irrigation during the growing period. Typically apply 25mm at 25mm SMD and on soils of high available water capacity, apply 40mm at 50mm SMD during the growing period up to the end of August. Where water is limited satisfy the SMD up to 50mm about 20 days before cutting. It is usually not economic to irrigate during the growing period with other types of cabbage.

HARVEST AND STORAGE
All harvesting equipment is required to comply with the relevant agricultural safety provisions and the Health and Safety at Work regulations. Prior to harvesting, the grower needs to ensure that the statutory harvest intervals have elapsed for every chemical applied to that crop. Spraying records need to indicate a safe harvesting date (positive release date) for each application.

Cabbages are at risk from physical damage such as cuts, grazes and bruises, all of which speed up post-harvest deterioration as well as affecting appearance. Cabbage easily bruises when full of water or following a frost; therefore, efforts should be made to reduce any large falls or excessive abrasion on the harvesting machine. Although the Food Safety (General Food Hygiene) Regulations exempt harvesting, the more sophisticated packing rigs will need a hazard analysis assessment.

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

HARVESTING
Only firm mature heads should be selected for storage and these should be harvested before they suffer damage from frost. Cabbage should be in store by mid to late November as frosts below -3°C reduce storage life.

Do not start to cut until early morning ground frosts have disappeared. If possible, harvest in dry conditions to minimise mud splash.

Harvesting by hand is currently the only acceptable method. Loose outer leaves should be stripped off before cutting commences. Heads should then be cut cleanly with a clean sharp knife, leaving approximately 10-15mm (¼-½ inch) of stem. Closer cutting may lead to stem splitting and long jagged stems may cause damage when cabbages are being loaded into boxes. To prevent disease spread knives should not be stuck in the ground or used to cut up diseased heads in the field.

Heads should be carefully placed into storage boxes as rough handling causes bruising and splitting which promotes early rotting. It is also important that the cabbage and boxes are kept free of soil. Avoid windrowing cabbage since this can also cause soil contamination and lead to infection by Phytophthora. Do not put storage boxes on the ground in the field; preferably load whilst on trailers or forklifts or stand boxes on pallets.

DRENCHING
Fungicides may need to be applied to control storage disease and rots where Dutch white cabbage is stored for long periods.

Metalaxyl-M is approved for Phytophthora control and iprodione for Botrytis cinerea control. Post-harvest treatment with a fungicide reduces the amount of wastage occurring during storage.

Fungicide treatment is by either dipping (immersion) or drenching using either hand lance or appropriate machinery to ensure that all surfaces of every cabbage are covered in fungicide. If using drenching systems fresh solution should be made up when the existing solution becomes dirty and changed at least daily. Old solution should be disposed of in an approved manner.

Allow boxes of dipped/drenched cabbage to drain and dry off the cabbage using high airflows for the first two weeks in store. Maintain 0-1°C and 90-95% RH throughout the storage period and for controlled atmosphere storage, 5% carbon dioxide and 3% oxygen is required.
White cabbage supply pattern

<table>
<thead>
<tr>
<th>Month Range</th>
<th>Storage Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>September - November</td>
<td>Direct from the field</td>
</tr>
<tr>
<td>December - February</td>
<td>Can be from ambient, frost-free barn stores</td>
</tr>
<tr>
<td>March - July</td>
<td>From cold stores</td>
</tr>
<tr>
<td>July - August</td>
<td>From controlled atmosphere cool storage that tends to retain the colour, crisp texture and flavour better than air-stored samples, although shelf-life may be reduced</td>
</tr>
</tbody>
</table>

Storage disorders

Poor handling and inadequate control of storage conditions can all lead to the rapid spread of fungal and bacterial disorders.

Grey mould (*Botrytis cinerea*)

This common spoilage organism causes a brown soft rot which penetrates deeply into the head. It is easily recognised by the surface growth of grey mycelium and spores. Damage at harvest increases the incidence of this disease.

Other fungi such as Alternaria, Mycosphaerella and Phytophthora, may cause lesions which could lead to secondary invasion by Botrytis.

Control: Post harvest drench or dip with iprodione.

Bacterial soft rot (*Pseudomonas marginalis*)

This very soft watery rot is particularly serious because it often causes whole head losses. Infection generally begins at sites of mechanical damage. In store these rots spread very quickly by contact and by “dripping on” to cabbages below. As free water on the surface of the cabbage head encourages the development of bacterial rots, thoroughly dry off any surface moisture at the beginning of storage and maintain an adequate airflow within the store during storage.

Leaf necrosis

These symptoms frequently cannot be removed by trimming and their extent is only evident when the cabbage is cut open or shredded during processing. The use of colloquial names and the often vague descriptions, make identification and comparisons of the various disorders difficult. However, four clearly distinguishable necrosis symptoms occur:

1. **Pepper spot (Black speck or spotted necrosis)**

   The most serious and widespread of these disorders is characterised by the development of very small superficial black spots less than 1mm in diameter which appear randomly distributed over the leaf surfaces. The spots typically, but not invariably, appear first on the outer leaves of the heads and progress inwards during storage. The symptoms are rarely seen in growing crops. In each spot necrosis starts in the stomatal guard cells and spreads to a few surrounding epidermal cells. Pepper spot is a physiological disorder, not associated with any fungus, bacteria or virus. Incidence and severity varies considerably between growing sites and from season to season.

   Varieties vary considerably in their susceptibility or tolerance to pepper spot. Therefore choose a tolerant variety.

2. **Dark leaf spot (Alternaria brassicicola)**

   This airborne fungus causes grey or black lesions that become dry and leathery in store. At low levels of infection it is unlikely lesions will be seen on the trimmed cabbage when they are put into store, but lesions will grow slowly in store which may increase wastage levels.

   The growing crop should be kept free of visible infection.

3. **Ringspot (Mycosphaerella brassicicola)**

   This fungi should be controlled in the field, so that heads taken into store are free from any fungal lesions, which may lead to secondary Botrytis infection.

4. **Phytophthora rot (Phytophthora megasperma)**

   This soil-borne pathogen becomes active during wet weather. In store the disease spreads rapidly up the stem causing whole head losses, therefore, heads should be harvested when dry and without contact with the soil. Ensure cut heads are not windrowed, soil is not collected in bins, or that infection is spread by sticking knives into the soil.

   Control: Post harvest drench or dip with metalaxyl-m.
2. Large necrotic leaf spot (Cigar Burn)

After pepper spot, this is the most common necrosis problem of stored cabbage. The large brown or black lesions may be 5 to 10mm in diameter and frequently coalesce to form irregular discoloured areas. Tissue in the centre of the spots becomes sunken and eventually collapses to leave a brown, papery membrane.

This disorder is the result of viral infection, usually early in the growing season, by aphid borne turnip mosaic virus. Therefore, prompt control of aphids with a systemic insecticide, whilst not preventing, may help to slow down spread of the disease.

3. Vein streak

Similar to pepper spot and appears as superficial brown or black markings on the epidermis along the leaf midrib and petiole, occasionally spreading out along the larger veins. This infrequent physiological disorder rarely causes a serious problem.

4. Internal tipburn

Although most types of cabbage can be affected, tipburn is most commonly seen on stored processing white cabbage. The margins of the inner heartleaves, especially round the vein endings, become papery and a discoloured grey or brown.

Varieties vary in susceptibility and recent research undertaken by Warwick Crop Centre suggests that Turnip Yellows Virus (TuYV) is implicated.

Oedema

Symptoms are typically small brown corky areas on the undersides of leaves. Research at Warwick Crop Centre suggests that thrips are the main cause. There appears to be differences between varieties in their resistance, so where possible resistant varieties should be selected. Thorough crop inspection during growth and thrip control is required to minimise damage.

Cooling

In the summer and in warm and wet autumns, cabbages have a very high post-harvest respiration rate, especially in bulk bins. Unless cooled rapidly soon after harvesting, cabbage will heat up and quickly become discoloured. Therefore, delays between harvesting and the commencement of cooling should be minimised. Causes of cabbage deterioration are dehydration, microbiological attack and physiological changes, including browning of the butt. All are temperature related, therefore, cooling immediately after harvest, followed by “cool” chain distribution, is the most effective means of preserving quality and shelf life.

Cooling rate

Equipment should be capable of reducing cabbage temperature down to a minimum of 1-2°C in 12 hours. Faster cooling rates are unnecessary and require very expensive cooling equipment.

Cabbages should be held in conditions where the relative humidity is higher than 95% and this should be maintained right through to the retail point of sale.

Cooling equipment

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

Wet air coolers with positive ventilation such as ice bank coolers are ideal. Other suitable systems available use a water to air heat exchange or inject a fine moisture mist into the cooling air as in the Hydrair method, e.g., 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, cabbage should be held at the target temperature; this often involves a holding store. If the cabbage need pre-packaging, they should be taken out of the primary cooling equipment, passed through the packhouse, then re-cooled prior to despatch.

RESIDUES AND CONTAMINANTS

Red Tractor Farm Assurance Fresh 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.
APPENDIX 1: MINOR PESTS OF LEAF AND FLOWERHEAD BRASSICAS

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, vegetable brassicas are rarely damaged they are however effective hosts on which the nematode can increase 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 yield. 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 over-cropping with brassica crops. Routine treatment is rarely justified.

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

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

**Cabbage seed weevil (Ceutorhynchus assimilis)**

In recent years large numbers of adult cabbage seed weevils have arrived on brassica crops in some localities in mid-summer. Weevils can damage the mature crop by feeding on the spear or outer leaves and contaminate vegetable brassicas 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 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 attacking 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 the size of heads.

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 will give some control if applied as soon as serious adult feeding is seen, or when larval damage is noted.

**Flea beetles (Phyllotreta spp.)**

Most problematic 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, use pyrethroids for control.

**Leatherjackets (Tipula spp.)**

Leather jackets 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 lay. If early ploughing is not possible, seek advice on potential risk.

**Turnip gall weevil (Ceutorhynchus pleurostigma)**

A localised and sporadic pest frequently found in southwest England. It attacks late-sown or late-planted cabbage, the legless grubs 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/set aside.

Plough early with additional cultivations if wireworm damage is anticipated. Seek advice on degree of risk if in doubt. Use of pheromone traps can help ascertain risk.

**Swede midge (Contarinia nasturii)**

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 and one of the later ones may attack side shoots. 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 points.

At present no chemical has approval for the control of swede midge, however, midge larvae control has been observed when pyrethroids have been used for caterpillar control.
## APPENDIX 2: FERTILISER REQUIREMENTS FOR CABBAGES (KG/HA)

Based on DEFRA Fertiliser Recommendations (RB209)

<table>
<thead>
<tr>
<th>Nutrient (kg/ha)</th>
<th>Soil Index P, K, Mg or SNS level</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen(^b)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collards pre-December 31(^st)</td>
<td></td>
<td>210</td>
<td>190</td>
<td>180</td>
<td>160</td>
<td>140</td>
<td>90</td>
</tr>
<tr>
<td>Collards post-December 31(^st)</td>
<td></td>
<td>310</td>
<td>290</td>
<td>270</td>
<td>240</td>
<td>210</td>
<td>140</td>
</tr>
<tr>
<td>Head cabbage pre-December 31(^st)</td>
<td></td>
<td>325</td>
<td>290</td>
<td>260</td>
<td>220</td>
<td>170</td>
<td>70</td>
</tr>
<tr>
<td>Head cabbage post-December 31(^st)</td>
<td></td>
<td>240</td>
<td>210</td>
<td>180</td>
<td>140</td>
<td>90</td>
<td>0(^a)</td>
</tr>
<tr>
<td>Winter white storage</td>
<td></td>
<td>340</td>
<td>310</td>
<td>280</td>
<td>240</td>
<td>190</td>
<td>90</td>
</tr>
<tr>
<td>Phosphorus(^c) (all types)</td>
<td></td>
<td>200</td>
<td>150</td>
<td>100</td>
<td>50</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Potassium(^c) (all types)</td>
<td></td>
<td>300</td>
<td>250</td>
<td>200 (2-)</td>
<td>150M (2+)</td>
<td>60</td>
<td>0</td>
</tr>
<tr>
<td>Magnesium (all types)</td>
<td></td>
<td>150</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

\(^a\) A small amount of nitrogen may be needed if there is little mineral nitrogen in the 0-30cm of soil.

\(^b\) Nitrogen – on light soils where leaching may occur or when crops are established by direct seeding no more than 100kg N/ha should be applied prior to seeding or transplanting. On retentive soils in drier parts of the country where leaching risk is low and spring planted brassicas are established from modules, more nitrogen can be applied prior to planting. The remainder of the nitrogen requirement should be applied after establishment but before the surface soil dries out to ensure that it is utilised by the crop.

\(^c\) Phosphate and potash requirements are for average crops and it is important to calculate specific phosphate and potash removals based on yields especially for the larger yielding cabbage crops (see ‘Fertiliser Use for Vegetables’ above).

Notes:

* Large, hearted spring greens can use up to 250kg/ha nitrogen, but the smaller leafy greens needed for “prepacks” may need considerably less. Applications of each top dressing should be in the range of 100-200kg/ha of nitrogen and related mainly to stage of growth, but the potential marketing period and weather conditions should also be considered.

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 levels only maintenance amounts of fertiliser are needed.

### Storage cabbage

For storage cabbage grown on fertile soils the recommendations for nitrogen may need to be decreased in order to reduce the risks of storage losses.

### Post-December 31\(^st\) crops

Apply no more than 100kg N/ha at sowing or transplanting, less if there is risk of frost damage. The remaining nitrogen should be applied to reflect crop growth. Further top dressings of nitrogen will depend on the harvest date and expected yield – some nitrogen will be required to support growth during the winter particularly for crops harvested in late winter. For crops harvested in late spring more of the top-dressing should be left until the beginning of regrowth in spring.

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 – 8th Edition (RB209)’ published by the Stationery Office (ISBN 0 11 243058 9) telephone orders 0870 600 5522 or via the internet at [http://www.tsoshop.co.uk/](http://www.tsoshop.co.uk/). The entire publication can also be downloaded free of charge from [https://www.gov.uk/managing-nutrients-and-fertilisers](https://www.gov.uk/managing-nutrients-and-fertilisers).
APPENDIX 3: GUIDELINES ON MINIMISING PESTICIDE RESIDUES

These guidelines have been produced after consultation between crop stakeholders and the Fresh Produce crop author. They will be developed over the coming seasons as knowledge of 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 in cabbage, and details potential alternative strategies to help minimise residue detection. Residues are rarely found in cabbage at > 10% of the MRL.

<table>
<thead>
<tr>
<th>Active ingredient</th>
<th>Target: pest, disease, weed</th>
<th>Current position</th>
<th>Suggested guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>pyrethroids</td>
<td>Caterpillars</td>
<td>Residues found in &lt; 5% of samples</td>
<td>Most pyrethroids have a zero harvest interval. However, application within a day of harvest can lead to detectable residues. Whilst these residues are well within the current MRLs it is advisable to avoid the application of these insecticides within 3 days of harvest</td>
</tr>
<tr>
<td>azoxystrobin, difenconazole, prothioconazole, tebuconazole, boscalid, pyraclostrobin</td>
<td>Ringspot, Alternaria, White Blister and Mildew</td>
<td>Residues detected in 5-10% of samples</td>
<td>Where possible avoid applying these fungicides to crops after the end of October as low light levels and temperatures can reduce degradation increasing the likelihood of residues. Tebuconazole and boscalid containing products are more likely to leave residues than other listed products so consider alternatives to these two actives</td>
</tr>
<tr>
<td>metalaxyl-M, iprodione</td>
<td>Storage cabbage, control of Botrytis and Phytophthora</td>
<td>Residues detected in circa 30% of samples</td>
<td>Post-harvest drenches commonly leave residues. Only treat crops targeted for very long term storage</td>
</tr>
</tbody>
</table>

Notes:

Dithiocarbamate residues can be found in crops where no actives of this group have been applied this is explained by naturally occurring products within all brassicas which cannot currently be differentiated during residue analysis.
Certification Bodies

Your routine point of contact with the Scheme is through your Certification Body. Certification Bodies are licensed by Red Tractor to manage membership applications and to carry out assessment and certification against the Standards. The table below shows which Certification Bodies apply to each enterprise.

<table>
<thead>
<tr>
<th>Certification Body</th>
<th>Beef and Lamb</th>
<th>Dairy</th>
<th>Combinable Crops and Sugar Beet</th>
<th>Fresh Produce</th>
<th>Pigs</th>
<th>Poultry</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSF</td>
<td>✓</td>
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<tr>
<td>Kiwa PAI</td>
<td>✓</td>
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<tr>
<td>SAI Global</td>
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<tr>
<td>NIFCC (Northern Ireland)</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>QWFC (Wales)</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

Kiwa PAI
The Inspire,
Hornbeam Square West, Harrogate,
North Yorkshire HG2 8PA
Tel: 01423 878878
Email: paienquiries@kiwa.co.uk
Web: www.kiwa.co.uk/pai

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

SFQC Ltd
Royal Highland Centre,
10th Avenue, Inglinton,
Edinburgh EH28 8NF
Tel: 0131 335 6605
Email: reductorator@sfqc.co.uk
Web: www.sfqc.co.uk

NIFCC (Northern Ireland)
Lissue House,
31 Ballinderry Rd, Lisburn,
Northern Ireland BT28 2SL
Tel: 028 9263 3017
Email: info@nifcc.co.uk
Web: www.nifcc.co.uk

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