



Assured Produce

Crop Specific Protocol

RADISH

(CROP ID: 46)



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Acknowledgements	4
1 General introduction	5
2 Planning and records	5
3 Site selection	5
3.1 Site history	5
3.2 Crop rotation	6
4 Site management	6
5 Variety selection	6
6 Nutrition	6
7 Irrigation	6
8 Crop protection	6
8.1 The basic approach to crop protection	6
8.2 Plant protection product choice	7
8.3 Advice on the use of pesticides	7
8.4 Application of pesticides	7
8.5 Records of application	7
8.6 Protective clothing/equipment	7
8.7 Pesticide storage	8
8.8 Empty pesticide containers	8
8.9 Pesticide residues in fresh produce	8
8.10 Pest, disease and weed control	8
9 Harvesting and preparation for market	11
9.1 Hygiene	11
9.2 Post-harvest treatments	11
9.3 Post-harvest washing	11
9.4 Harvesting	11
10 Pollution control and waste management	12
11 Energy efficiency	12
12 Health and Safety	12
13 Conservation	12
Appendix 1 Typical nutrition requirement for Radish	13
Appendix 2 Insecticides currently approved for use on Outdoor Radish	14

Appendix 3 Fungicides currently approved for Outdoor Radish	15
Appendix 4 Pre-drilling herbicides which can be used on Outdoor Radish	16
Appendix 5 Specific off-label approvals for Outdoor Radish	17
Appendix 6 Control Points: Radish	18

Acknowledgements

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Preface

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

It is advisable to read the generic protocol first before reading this crop specific protocol.

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

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

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

Disclaimer and trade mark acknowledgement

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

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

Notes:

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

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

There may be changes for the following reasons:

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

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

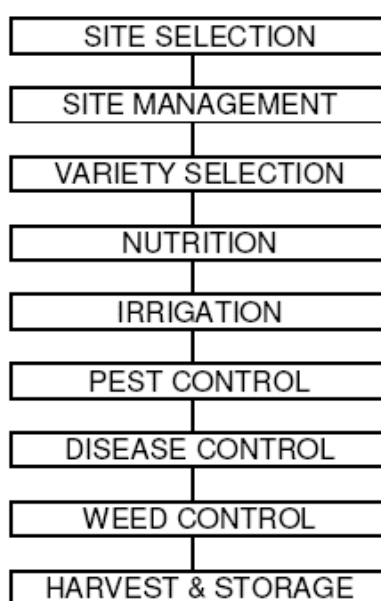
For pesticides on-label, only active substances are shown.

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

1 General introduction

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

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



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

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

2 Planning and records

See Generic Protocol.

3 Site selection

3.1 Site history

Soil type

Radishes grow well on a variety of soil types. Light textured, well-drained organic or sandy soils generally produce good quality roots that lift easily. Soils with high organic or peat content are capable of producing

crops that have excellent colour and skin finish. Soils with heavy texture and high clay content are subject to waterlogging, not suitable and should be avoided.

3.2 Crop rotation

As Radishes have a very short growing period, several crops can be grown on the same piece of land during one season. However, such intensive cropping can lead to problems in respect of pest and disease carry over. It is essential to avoid building up disease problems such as club root and scab. So as long a rotation as the land base permits must be practised.

4 Site management

See Generic Protocol.

5 Variety selection

See Generic Protocol.

6 Nutrition

All soils must be sampled and analysed for major elements such as phosphate, potash and magnesium. Typical nutrition requirements are given in Appendix 1.

It is essential that the pH of each field is established prior to drilling. Liming materials must be applied with extreme care, as over-liming will encourage scab that seriously affects the quality of the finished product. Excessive applications of lime can also 'lock up' elements such as manganese, making them unavailable to the plant.

Care must be taken to apply only the minimum amount of nitrogen needed for such a short-term crop. This is especially important where Bunched Radish is grown, as over application of nitrogen leads to excess top growth and encourages leaf diseases such as downy mildew.

It is important to monitor the crops nutritional status throughout its life. This can be readily done by the use of leaf tissue analysis.

7 Irrigation

As the Radish crop is often grown on light textured soil types, irrigation is frequently needed to facilitate germination: further irrigation may well be required right up to harvest.

Where scab is likely to be a problem, it is important that the crop is not allowed to become dry at bulb initiation, as this will increase the risk of this disease.

Run off during irrigation must be avoided at all times. Boom type irrigators will often provide the most even and accurate distribution of water and should be used when cropping radish. The use of a neutron probes/potentiometers are of little use in the radish crop as the growing cycle is so short and the effective rooting depth is just a few centimeters.

8 Crop protection

8.1 The basic approach to crop protection

It is important to minimise pesticide application, especially on such a short-term crop such as Radish. Unlike

many crops, there is not a particularly good choice in respect of disease resistant cultivars. Several new cultivars have good resistance to *Fusarium* but this disease largely affects only the indoor crop.

Good management and planning

Several factors can contribute to good cultural practice, these include the following:

- a. *Establishing good cultivation techniques, especially in respect of firm level seedbed.*
- b. *Ensuring nutrient availability through accurate application of major and minor elements in conjunction with soil and leaf tissue analysis.*
- c. *Execution of good field hygiene, especially the rapid disposal of trash .*
- d. *Maximising the use of available irrigation to promote good germination and assist even and healthy growth and reduce diseases such as scab.*
- e. *Establish the need to take corrective action by regular monitoring to thresholds where established. Trained staff should carry this out. The effect of prevailing conditions should also be taken into consideration.*

Corrective action

- a. Where corrective action is required, additional biological and natural methods of pest and disease control (where available) should be considered first.
- b. If chemical control is needed, the following points should be considered, whilst ensuring effective control is achieved:
 - use the least toxic and least persistent product.
 - use the most selective product to reduce the impact on naturally occurring beneficial organisms.
 - use the minimum effective dose rate.
 - use appropriate application methods with effectively maintained equipment, and spot treating wherever possible.

Field margins can provide a reservoir of insect predators and parasites, including ladybird larvae, hoverflies, ground beetles, parasitic wasps etc. Care must be taken to avoid spray drift into these areas.

8.2 Plant protection product choice

See Generic Protocol.

8.3 Advice on the use of pesticides

See Generic Protocol.

8.4 Application of pesticides

See Generic Protocol.

8.5 Records of application

See Generic Protocol.

8.6 Protective clothing/equipment

See Generic Protocol.

8.7 Pesticide storage

See Generic Protocol.

8.8 Empty pesticide containers

See Generic Protocol.

8.9 Pesticide residues in fresh produce

See Generic Protocol.

8.10 Pest, disease and weed control

8.10.1 Pest control

8.10.1.1 Aphids

Aphids of various species attack Radish from time to time. Attacks are more commercially important on bunched radish where leaf quality needs to be retained. It is most important that aphid numbers are monitored frequently as although attacks are usually very light and do not warrant treatment, very occasionally infestations may reach quite serious proportions so requiring treatment. Light infestations of aphids are usually controlled by natural predators and parasites such as parasitic wasps.

8.10.1.2 Cabbage root fly (*Delia brassicae*)

This is by far the most serious pest of Radish. Crops can be affected by the larvae of the cabbage root fly from early May until well into the autumn. The roots are damaged and even light attacks can render the product unmarketable.

There are several generations each year and there is often an overlap in the generations which results in most drillings throughout the late spring, summer and autumn being affected. Only very the early spring drillings, which are generally covered with protective fleece are unaffected.

Insecticides have to be applied at the time of drilling in order to offer effective control of cabbage root fly and to adhere to the harvesting interval for the pesticide.

At the present time, there is no seed treatment recommended for use on radish. However, it is hoped that a seed treatment will shortly become available which should lead a significant reduction in overall chemical application.

Forecasting: Traps are available which will selectively catch adult flies. These traps, used in conjunction with the computer prediction model available from HRI, give reliable information on the development of the next generation of cabbage root fly larvae.

Cultural control: *A firm, consolidated seedbed will help minimise damage during light attacks. Covering with a fine mesh netting as soon as the radish are drilled will exclude cabbage root flies adults, thus preventing egg-lay.*

Chemical control: Chlorpyrifos, applied to the seedbed immediately after drilling, will give a high level of control of cabbage rot fly.

Cabbage stem weevil

This is an occasional and local problem. Damage occurs when the larvae tunnel in the leaf stalks and can be particularly severe in mid to late May and into June. Heavy infestations can reduce yields as plants become deformed. Although adults over winter in field margins, it has been suggested that the increase in the acreage of oil seed rape that has been grown in recent years has contributed to the abundance of this pest.

Cultural control: *Avoid fields which are adjacent to oil seed rape crops.*

Chemical control: A specific SOLA has been obtained by HDC on behalf of Radish growers, based on lambda-cyhalothrin.

8.10.1.4 Flea beetles

During very dry periods some leaf damage may be observed when flea beetles make small holes in the Radish leaves. As the crop grows, these holes expand and become more obvious. There is no chemical measure specifically recommended for flea beetle control in Radishes.

Cultural control: *Damage from flea beetle can be greatly reduced by keeping the crop moist. The use of a fine mesh thrip netting will greatly reduce the incidence of this pest.*

Chemical control: Currently there are no approved pesticides specifically recommended for flea beetle control. However, an application of lambda-cyhalothrin when used for cutworms or cabbage stem weevil, will give incidental control of this pest.

8.10.1.5 Slugs

Occasional grazing by slugs may take place, especially during damp conditions, , although as radish is grown mainly on very light textured or organic soils, slugs are not normally a big problem.

Cultural control: *Avoid fields where it is suspected there may be a slug problem. Slug traps can be put out prior to drilling to estimate the population. Many slug pellets are damaging to the ground beetles which attack the larvae of cabbage root fly so overall applications of slug pellets are to be avoided. A firm seedbed will also help to reduce damage.*

8.10.2 Disease control

8.10.2.1 Club root (*Plasmodiophora brassicae*)

This is a most serious disease of brassicas and Radish can be badly affected if the crop is grown in infected soil. The roots become severely distorted and are unsaleable. The fungus can survive in the soil for long periods. Excessive soil moisture and low pH favour infection. There is no chemical control that is effective.

Cultural control: Avoid growing on land where there has been a history of the disease or is badly drained. Be aware that raising the pH above 6.5 may well encourage scab.

8.10.2.2 Downy mildew (*Peronospora parasitica*)

Downy mildew can affect both the foliage and root of Radish. It can be extremely serious if conditions favour the disease ie. during cool, humid periods. Small yellow spots appear on the leaf surface and a white fluffy mould appears on the under surface of the leaves. The spores that wash down from the leaves affect the roots. The root is disfigured by black spotting which renders the root unmarketable.

Cultural control: *There are no resistant varieties. Avoid overwatering during warm, still periods because it can encourage the disease.*

Chemical control: Applications of fungicides based on propamocarb hydrochloride will offer a degree of control. Products based on metalaxyl-M, applied for white blister control, will offer incidental control of the disease. Azoxystrobin may also give incidental reduction of mildew.

8.10.2.3 Fusarium (*Fusarium oxysporum*)

Although this is a disease associated with indoor radish, it may occasionally be seen infecting outdoor radish during hot summers. The lower leaves yellow and affected leaves drop off. In severely affected crops, the Radish may lose all their leaves. The disease is known to survive in the soil for several years. There are some resistant varieties available.

8.10.2.4 Scab (*Streptomyces scabies*)

This soil-borne fungus is encouraged by soils that have a high pH. Often symptoms appear, close to harvest, and express themselves as whitish grey scale-like spots on the root. As the spots expand, the Radish often becomes soft and associated rotting takes place.

Cultural control: *Avoid over-liming as the fungus thrives in alkaline conditions. Avoid fields with a history of the disease.*

8.10.2.5 White blister (*Albugo candida*)

Sometimes misleadingly referred to as white rust, this disease affects the foliage and is particularly important on Bunched Radish. The disease appears as raised white blisters and can spread rapidly from an initial infection. In severe cases, the leaves are distorted.

Cultural control: *There is no effective cultural control but good crop hygiene after harvest will help reduce the spread of the disease.*

Chemical control: Products containing metalaxyl-M are very effective at controlling white blister. A specific 'off-label' approval was secured in 1995 following work undertaken by the HDC. (See Appendix 5).

8.10.2.6 Other diseases

There are other diseases which affect Radish. These diseases include wirestem (*Rhizoctonia solani*), black root (*Aphanomyces raphani*) and damping-off (*Pythium* spp). A SOLA exists for the use of Basilex (tolclofos-methyl) for use on crops outdoors grown with or without fleece. This chemical will offer a degree of control of these diseases.

These diseases are often difficult to distinguish from one another without the help of a plant pathologist. Wirestem and damping off tend to be encouraged by damp cool conditions, whereas the development of black root is encouraged by high temperatures.

Good ground cultivations which encourage free rooting and adequate drainage help reduce the risk of these soil borne diseases. Very intensive rotations, especially when accompanied by poor drainage will encourage all three diseases.

8.10.3 Weed control

There are no residual or contact post crop emergent herbicides approved for use in Radish. There are pre drilling contact herbicides available and these are listed in Appendix 4. As Radish usually outgrows weed competition because it is fast growing; it is only usually early in the season when weeds represent a threat to the crop. The problem of early weed competition can often be overcome by using a "stale seed bed" technique.

9 Harvesting and preparation for market

9.1 Hygiene

See Generic Protocol.

9.2 Post-harvest treatments

See Generic Protocol.

9.3 Post-harvest washing

Preparation for market

Freshly harvested Radishes should be placed in a "soak tank" immediately on reaching the packhouse, after which, they pass on to final washing and rinsing. The washing/grading line should be capable of handling a rapid throughput. The water used for this operation must be of a potable standard. Consideration should be given to cleanliness and conservation of water used for washing harvested produce (See Generic Protocol 9.3.1)

The washing area should be separated from the packing line.

Water supply

Water can be drawn from the public mains or other satisfactory sources under the Water (Water Quality) Regulations, 1989. Routine microbiological samples of non-mains water should be undertaken. The final rinse water should always be with water of a potable standard.

Disposal

Disposal systems must deal with:

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

Waste washing water should be disposed of in a manner that avoids pollution of water courses.

There are statutory powers to prevent the pollution of underground water by discharge of effluent. Underground pollution can be traced to land used for disposal of solid or liquid waste. Pollution of streams and water supplies derived from wells, springs and boreholes can lead to action by the Environment Agency or local water company.

Both screening and sedimentation are recommended as methods of separating solids from water.

9.4 Harvesting

Bunched Radishes are harvested by hand. Harvesting in the early morning when the temperature is cooler will often help to preserve shelf life. Pulled loose Radishes should not be exposed to hot sun otherwise serious deterioration takes place.

As with Bunched Radish, Radishes destined for prepacking, whether being harvested by machine or by hand, should be transported to the packhouse as soon as possible after lifting.

Measures should be taken to avoid deterioration and damage of the product during harvesting, washing and

storage.

10 Pollution control and waste management

See Generic Protocol.

11 Energy efficiency

See Generic Protocol.

12 Health and Safety

See Generic Protocol.

13 Conservation

See Generic Protocol.

Appendix 1 Typical nutrition requirement for Radish

Nutrient (kg/ha)	Soil Index					
	0	1	2	3	4	4+
Nitrogen	110	60	20	a	a	a
Phosphate (as P ₂ O ₅)	175	125	75	25M	nil	nil
Potash (as K ₂ O)	250	200	150(2-) 100(2+)	50M	nil	nil
Magnesium (as MgO)	150	100	nil	nil	nil	nil

Notes:

a. A small amount of nitrogen may be needed if SMN levels are low in the top 10-30cm of soil

It will not usually be necessary to top up levels of phosphate, potash and magnesium for subsequent crops. However soil analysis will confirm whether further nutrients are required.

Further top dressings of nitrogen will be required for following crops on the same land. Amounts will vary between 40 - 75 kg/ha according to soil type and time of year, with less being needed during the Summer months when soil mineralisation is higher. Too much nitrogen, applied to Bunched Radish in particular, will encourage excessive top growth and make the plant more susceptible to certain diseases, such as downy mildew and physiological disorders such as root pinking.

Appendix 2 Insecticides currently approved for use on Outdoor Radish

Active Ingredient	Product Features	LERAP Category	Harvest Interval ⁽¹⁾	MRL (mg/kg)
chlorpyrifos ⁽²⁾	a contact and ingested OP insecticide. Dangerous to fish.	A	21 days	0.20
lambda-cyhalothrin ⁽²⁾	a contact and ingested pyrethroid insecticide. Dangerous to bees and fish.	A	7 days	0.1
nicotine	a general purpose non-persistent, contact alkaloid insecticide. Dangerous to fish.	none stated	2 days	none set
pirimicarb ⁽²⁾	a contact, fumigant and trans-laminar carbamate insecticide. Dangerous to fish.	none stated	3 days	0.5 (draft mrl)

Notes:

⁽¹⁾ or latest time of application

⁽²⁾ SOLA - see Appendix 5 for the specific product and expiry dates

Appendix 3 Fungicides currently approved for Outdoor Radish

Active Ingredient	Product Features	LERAP Category	Harvest Interval ⁽¹⁾	MRL (mg/kg)
cupric ammonium carbonate	Croptex Fungex (seedling treatment only)	none stated	N/S	N?S
mancozeb + metalaxyl M ⁽²⁾	a systemic and protectant fungicide. Specifically to be used for the control of white blister.	none stated	14 days	0.05 (dithiocarbamates) 0.01
propamocarb hydrochloride ⁽²⁾	a translocated protectant carbamate fungicide.	none stated	14 days	10.00
tolclofos-methyl	a protectant organo-phosphorus fungicide for the control of soil-borne diseases	B	N/S	0.1 (draft)
Potassium hydrogen Carbonate	Potassium bicarbonate Food grade only, commodity substance	None stated	N/S	N/S
Thiram	Seed treatment	None stated	Seed treatment	0.05 (dithiocarbamates)
Azoxystrobin ⁽²⁾	A strobularin fungicide, do not use consecutive applications	None stated	7 days	0.2

Notes:

⁽¹⁾ or latest time of application

⁽²⁾ SOLA - see Appendix 5 for the specific product and expiry dates

Not all products containing these active ingredients may be currently approved for use on radish. As label recommendations are revised regularly, read a current label before use Appendix 4 Pre drilling herbicides which can be used on outdoor radish.

Appendix 4 Pre-drilling herbicides which can be used on Outdoor Radish

Active ingredient	Product features	MRL
Diquat	A non-selective, contact, non-residual herbicide	None set
glufosinate ammonium	A non selective, non-residual contact herbicide.	None set
glyphosate	A translocated non-residual herbicide	0.1

+++ The final use date for products containing paraquat was the 31st August 2008. After this date the use of any product containing paraquat is illegal.

Appendix 5 Specific off-label approvals for Outdoor Radish

Number	Product Name	Active Ingredient	Expiry Date
1298/01	Aphox [®]	pirimicarb	31/12/08
0026/08	Govern	chlorpyrifos	31/12/13
0214/02	Basilex	tolclofos-methyl	31/12/13
3757/06	Clayton Lanark	lambda-cyhalothrin	13/11/09
1288/07	Cleancrop Silo	lambda-cyhalothrin	13/11/09
0235/05	Cyren	chlorpyrifos	31/12/13
1391/03	Dursban WG [®]	chlorpyrifos	31/12/13
2030/99	Filex [®]	propamocarb hydrochloride	31/12/13
1610/01	Fubol Gold WG [®]	mancozeb + metalaxyl M	31/12/13
0731/06	Hallmark with Zeon Technology [®]	lambda-cyhalothrin	13/11/09
1586/06	Parapet	chlorpyrifos	31/12/13
2947/07	Proplant	propamocarb hydrochloride	31/12/13
1746/05	Phantom	pirimicarb	31/12/13
1448/08	Amistar	Azoxystrobin	31/12/11

Notes:

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

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

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

Appendix 6 Control Points: Radish

CS.46 RADISH

CS.46.1 Growers should dispose of waste washing water in a manner that avoids pollution of water courses

- Protocol reference: Section 9.3

CS.46.2 Measures should be taken to avoid deterioration and damage of the product during harvesting, washing and storing

- Protocol reference: Section 9.4