Sweet corn information kit

Reprint – information current in 2005

REPRINT INFORMATION – PLEASE READ!

For updated information please call 13 25 23 or visit the website www.deedi.qld.gov.au

This publication has been reprinted as a digital book without any changes to the content published in 2005. We advise readers to take particular note of the areas most likely to be out-of-date and so requiring further research:

- Chemical recommendations—check with an agronomist or Infopest www.infopest.qld.gov.au
- Financial information—costs and returns listed in this publication are out of date. Please contact an adviser or industry body to assist with identifying more current figures.
- Varieties—new varieties are likely to be available and some older varieties may no longer be recommended. Check with an agronomist, call the Business Information Centre on 13 25 23, visit our website www.deedi.qld.gov.au or contact the industry body.
- Contacts—many of the contact details may have changed and there could be several new contacts available. The industry organisation may be able to assist you to find the information or services you require.
- Organisation names—most government agencies referred to in this publication have had name changes. Contact the Business Information Centre on 13 25 23 or the industry organisation to find out the current name and contact details for these agencies.
- Additional information—many other sources of information are now available for each crop. Contact an agronomist, Business Information Centre on 13 25 23 or the industry organisation for other suggested reading.

Even with these limitations we believe this information kit provides important and valuable information for intending and existing growers.

This publication was last revised in 2005. The information is not current and the accuracy of the information cannot be guaranteed by the State of Queensland.

This information has been made available to assist users to identify issues involved in sweet corn production. This information is not to be used or relied upon by users for any purpose which may expose the user or any other person to loss or damage. Users should conduct their own inquiries and rely on their own independent professional advice.

While every care has been taken in preparing this publication, the State of Queensland accepts no responsibility for decisions or actions taken as a result of any data, information, statement or advice, expressed or implied, contained in this publication.

Queensland Government

PICTURE GUIDE

Sweet corn

problem solver & beneficial identifier

Main authors

Ross Wright [1]
John Duff [1]
Peter Deuter [1]
Bronwyn Walsh [1]
Tony Napier [2]
Lionel Hill [4]
Rob Dimsey [3]
Stewart Learmonth [5]

Contributing authors

Iain Kay [1]

Brendan Nolan [1]

Coordinating author

Jerry Lovatt [1]

[1]DPI&F Queensland, in collaboration with Departments of Primary Industries in [2]NSW, [3]Victoria, [4]Tasmania, and [5]Western Australia Department of Agriculture

Sweet corn problem solver & beneficial identifier

First published 2004

QI04008

National Library of Australia Cataloguing-in-Publication

PICTURE GUIDE: Sweet corn problem solver & beneficial identifier.

Includes index.

ISBN 0 7345 0264 8

1. Sweet corn - Diseases and pests - Control - Australia. 2. Sweet corn - Australia - Diseases and pests - Identification. 3. Sweet corn - Australia. I. Wright, Ross. II. Kay, Iain. III. Nolan, Brendan. IV. Lovatt, J. L. (Jeremy Leighton), 1948- . V. Queensland. Dept. of Primary Industries and Fisheries.

635.6720994

Enquiries should be addressed to:

Department of Primary Industries and Fisheries
Bookshop
GPO Box 46
80 Ann Street
Brisbane 4001 Qld Australia

Free call: 1800 816 541 Ph: (07) 3239 3163
Fax: (07) 3239 6509
Int Code: + 61 7
Email: callweb@dpi.qld.gov.au
Web:www.dpi.qld.gov.au/agrilink

IMPORTANT NOTE

The companion book, ***GROWING GUIDE: Sweet corn grower's handbook*** takes you step-by-step from planting to marketing sweet corn in Australia.

References to the *Chemical Handy Guide* and *Key Issues* can be found in the GROWING GUIDE book.

Please consult local information before applying information included here to other sweet corn growing areas.

Acknowledgements

The authors are grateful for information and technical advice provided by Jason Olsen, Department of Primary Industries and Fisheries, Sandra McDougall, NSW Department of Primary Industries and Peter Ridland and Neville Fernando, Department of Primary Industries, Victoria.

Photographs for the *Problem solver and beneficial identifier* were kindly provided by the authors; Bernie Franzmann, Chris Freebairn, David Ironside, Tom Passlow, Brad Scholz, John Turner and Jozef Wessels, Department of Primary Industries and Fisheries; Ross Gilbert and Andrew Watson, NSW Department of Primary Industries; and the authors and editors of the following publications:

- *A guide to the identification and control of insect pests in maize crops grown in the Ord River Irrigation Area*, Stewart Learmonth, (1987), Department of Agriculture, Western Australia.
- *A handbook of plant diseases in colour, Volume 2, Field crops*, N.T. Vock (ed), (1978), Department of Primary Industries, Brisbane.
- *Diseases of vegetable crops*, Denis Persley (ed), (1994), Department of Primary Industries, Brisbane.
- *Hungry crops: a guide to nutrient deficiencies in field crops,* N.J. Grundon, (1987), Department of Primary Industries, Brisbane.
- *Insect pests of field crops*, G.A. Swaine and D.A. Ironside (eds), (1983), Department of Primary Industries, Brisbane.
- *Insect pests of fruit and vegetables, (2nd edition),* G.A. Swaine, D.A. Ironside and R.J. Corcoran (eds), (1991), Department of Primary Industries, Brisbane.
- *Plant nutrient disorders 4, Pastures and field crops*, R.G. Weir and G.C. Cresswell, (1994), New South Wales Agriculture, Sydney.

We also thank Loraine Chapman for her many publishing and desktopping skills, and her wizardry with digitising and editing the photographs in this book.

About the authors

Ross Wright is a Senior Horticulturist at the DPI&F Bowen Horticulture Research Station in Queensland. Ross has 35 years experience in the agronomy and plant improvement of a range of vegetable crops. His experience in sweet corn crops has involved research and development work in plant improvement, crop agronomy and nutrition, crop scheduling, weed control and pest and disease management.

Peter Deuter is a Principal Horticulturist with DPI&F. He has 32 years experience in a wide range of fruit and vegetable crops and many years experience in all aspects of sweet corn agronomy. Peter is based at Gatton Research Station and leads the national IPM in sweet corn project funded by Horticulture Australia.

Tony Napier is a District Horticulturist with NSW Department of Primary Industries at Yanco Agricultural Institute. He has 14 years experience in horticulture including pest management, agronomy and disease management of sweet corn. He also worked as a Field Officer for a vegetable processing company and as a Production Agronomist for a seed company.

Rob Dimsey is a Senior Horticulturist with the DPI in Victoria. He has 23 years experience in a wide range of fruit and vegetable crops in several regions in Victoria. Rob has been based at Bairnsdale in Eastern Victoria for 13 years. His experience in sweet corn has involved work based on industry and state funded projects covering aspects of agronomy, cultivars, nutrition and IPM.

John Duff is an Entomologist with the DPI&F at the Gatton Research Station. He has been working in vegetable Integrated Pest Management for over seven years in brassica, sweet corn, lettuce and green bean crops.

Bronwyn Walsh is an Entomologist with the DPI&F and based at the Gatton Research Station for nine years. She has expertise in developing integrated pest management systems in a range of vegetable crops including sweet corn, brassicas and potatoes. Her other research has been with thrips and other horticultural pests.

Lionel Hill commenced work with the Tasmanian Department of Primary Industries, Water and Environment in 1985 as a Regional Entomologist servicing the vegetable crops of north-western Tasmania. Since then his role has broadened considerably but he continues to work with agronomists from the growing private sector to bring new ideas to local growers.

Stewart Learmonth is a Research Entomologist with the WA Department of Agriculture, based at Manjimup in south-west WA. He has 30 years experience in economic entomology in both temperate and tropical zones and has been involved with assisting sweet corn growers adopt IPM principles for protecting sweet corn crops, with an emphasis on pest monitoring.

Jerry Lovatt is a Senior Information Extension Officer with the DPI&F Bundaberg Research Station in Queensland. Jerry has 37 years experiences working at six centres around Queensland where he has accumulated a wealth of knowledge about Queensland horticulture, particularly vegetables. Jerry joined the Agrilink project team in 1993 and has been responsible for the development of eight information packages for vegetable crops.

Contents

Every crop will inevitably have a problem or two. The key to dealing with problems is prompt identification, and where appropriate, prompt treatment. This section helps you with both these decisions. The common problems are shown in a series of pictures, grouped according to the main symptom. From the contents, find the symptom that best fits your problem. On that page you will find the causes, and management options if there are any. This book also contains coloured photographs of many of the natural enemies of these pests.

The companion book, *Sweet corn grower's handbook*, gives more detailed information on the major diseases, pests (and their natural enemies), and how to manage them in an integrated way.

Natural enemies: Parasitoids and predators in sweet corn

Poor plant establishment

Poor germination

Upper: poor germination in foreground. Lower: good germination.

Cause. Poor seed quality, probably because the seed is too old, can also cause poor germination. Check with your seedsman for the correct storage conditions for the seed.

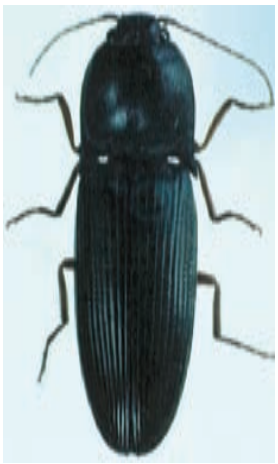
Seeds planted too deep particularly early in the season when soil temperature is low. Soil temperature too low for good emergence. Poorly prepared seedbed. The African black beetle, wireworms (true and false) and the black field cricket can cause poor germination. Mice dig up and eat seed resulting in a poor plant stand.

Management. Check the age and germination of seed before planting. Ensure soil temperature is adequate and that seed is not planted to deep early in the season. Seedbed must be of a fine tilth to ensure good soil contact with the seed. Check soil for insect larvae. If mice are the problem, apply a registered mouse bait as directed on the label.

Soil crusting

Cause. Some soil types, for example alkaline clay soils high in sodium, develop firm crusts, particularly after rain or irrigation.

Management. Ensure soil is well prepared. Grow cover crops to improve soil structure. Apply regular, light irrigations after planting to help seedlings emerge.



Wireworms and false wireworms

Upper: wireworm (20 mm). Left: adult wireworm (25 mm). Right: false wireworm (adult 10 mm; larva 20 to 50 mm).

Cause. Larvae of wireworms, the click beetle, *Agrypnus* spp., and larvae and adults of species of false wireworms *Gonocephalum* and *Pterohelaeus*. Larvae normally feed on rotting plant material, but will also attack germinating seeds. Larvae tunnel into seed, feed on small roots and bore into the base of the plant. False wireworm adults chew the stems of seedlings at or above ground level. Worse in winter and spring. They are minor and infrequent pests, mainly in heavy black soils. They can also occur when a crop has been planted immediately following pasture or a lucerne crop.

Management. Sample soil to check numbers of larvae. If it is likely to be a problem don't immediately follow pasture with sweet corn crops. Treat seed with an appropriate chemical from the *Chemical Handy Guide*.

Black field earwig

Left: adult (15 mm), left & nymphs. Right: damage.

Cause. Adults and nymphs of the black field earwig *Nala lividipes*. They usually feed on decaying stubble but also eat newly sown and germinating seed and the roots of crops. They are minor and infrequent pests, mainly in heavy black soils.

Management. Prepare ground so that germination is as even and rapid as possible. Use beetle bait or germinating seed baits to determine their presence and apply an appropriate chemical bait from the *Chemical Handy Guide* if necessary.

Crickets

Upper left: chewed prop roots. Upper right: black field cricket adult (25 mm) right & nymphs. Lower: mole cricket (30 mm).

Cause. Feeding by adults and nymphs of the black field cricket *Teleogryllus* spp. and mole crickets *Gryllotalpa* spp. Field crickets feed on the above-ground parts of the plant including prop roots, while the mole cricket feeds on below ground parts. Worse in summer. Crickets also chew holes in thin plastic drip irrigation tape.

Management. Place baits in the field before planting, and in the crop if crickets are a problem. Refer to the *Chemical Handy Guide* for appropriate chemicals. Use a heavier gauge drip tape if tape is being damaged.

White grubs

Cause. Larvae of *Anoplognathus*, *Antitrogus*, *Lepidiota, Repsimus* and *Rhopaea* species grow up to 50 mm long. White grubs are larvae of scarab beetles, for example Christmas beetle, cane grub and pasture grub. Mature larvae do most of the damage and are usually present in winter and spring. Female beetles prefer to lay eggs in soils with high levels of organic matter.

Management. Prepare the land thoroughly to expose grubs to birds and mechanical injury, and reduce levels of organic matter.

African black beetle

Left: adult (15 mm). Right: larva (25 mm).

Cause. The adult stage of the African black beetle, *Heteronychus arator*. They chew the stem near ground level. The larval stage may affect seedlings by chewing the roots and the stem below ground level. Worse in poorly prepared pasture blocks.

Management. Grass based pasture is most likely to be infested with African black beetle. Prepare the land thoroughly before planting to reduce insect populations.

Uneven plant stand

Poor water distribution

Note stunted plants (lower centre).

Cause. Uneven water application.

Management. Ensure irrigation is set up to distribute water evenly, especially over ends and outer edges of blocks. Drip irrigation will reduce this problem.

Uneven plant stand

Upper: uneven plant stand. Lower: change in soil type.

Cause. Several things can cause this including:

- **Changes in soil type**. Different soil types require different management.
- **Uneven planting depth.** If seed is planted too deep it will take longer to emerge resulting in an uneven crop. Poor soil preparation makes it difficult to maintain an even planting depth.
- **Early plant death.** Plants are stunted, grow slowly and die when around 45 cm tall or less. This is caused by poor seed quality and fungal infection of seed such as *Fusarium* spp. or *Penicillium* spp. It can be made worse by low soil temperature, planting too deep early in the season or using old seed.
- **Root lesion nematode**. These can also result in death of young plants, particularly at high soil temperatures (around 30° C). Infection with this nematode can also allow entry of fungal pathogens which weaken and may kill plants.

Management. This varies for each condition.

- **Changes in soil type**. If blocks cover different soil types, different management, for example fertiliser and water management may be needed.
- **Uneven planting depth.** Make sure the planter is set up to plant at a constant depth. Plant into an even, well prepared seedbed.
- **Early plant death.** Use good quality seed which has been treated with an appropriate seed dressing, ensure soil temperatures are adequate and avoid planting too deep, especially early in the season.
- **Root lesion nematode.** Crop rotation is the best long term solution for nematode control.

Stem rots near the ground

Cause. Damping-off caused by soil-borne fungi such as *Pythium* spp., *Fusarium* spp., *Sclerotium rolfsii* or *Rhizoctonia solani*. These fungi occur naturally in the soil and are also carried over on undecomposed plant residue. Worse when the soil is too wet, in hot humid weather, and when plants are stressed or growing poorly.

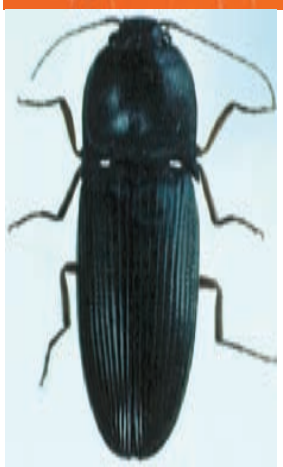
Management. Improve land preparation to ensure organic matter is completely broken down. Do not plant too deep.

Seedlings chewed off at ground level

Plants chewed off at ground level

Cause. Cutworms (up to 40 mm long), larvae of the *Agrotis* species moth. The larvae curl up and hide in the soil during the day and feed at night. Areas that were weedy just before planting are most affected. Other hosts include a wide range of crops and weeds. They are a minor and infrequent pest, more common from spring to autumn.

Management. Cultivate to remove weed growth well before planting. Cultivation exposes larvae and pupae to predators, for example birds. Spray with an appropriate chemical from the *Chemical Handy Guide*.



Stems chewed around ground level

Upper: wireworm (20 mm). Left: adult wireworm (25 mm). Right: false wireworm (adult 10 mm; larva 20 to 50 mm).

Cause. Larvae of wireworms, the click beetle, *Agrypnus* spp., and larvae and adults of species of false wireworms *Gonocephalum* and *Pterohelaeus*. Larvae normally feed on rotting plant material, but will also attack germinating seeds. Larvae tunnel into seed, feed on small roots and bore into the base of the plant. False wireworm adults chew the stems of seedlings at or above ground level. Worse in winter and spring. They are minor and infrequent pests, mainly in heavy black soils.

Management. Cultivate well before planting. Sample soil or use germinating seed baits to check larvae numbers. Treat seed with an appropriate chemical from the Chemical Handy Guide.

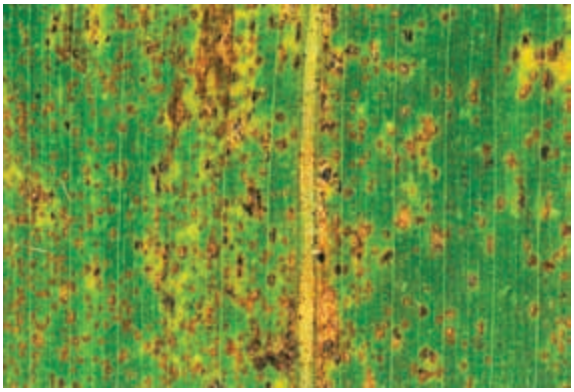
Spots or blotches on leaves

Reddish brown pustules

Note spots occur on both upper and lower leaf surfaces.

Cause. Common rust caused by the fungus *Puccinia sorghi*. Survives on sweet corn and maize plant residues and volunteer plants. Spores can be spread a long way by wind. Worse in warm, humid weather. Some varieties are very susceptible to rust.

Management. Good farm hygiene, destroy old crops and volunteer plants. Plant resistant varieties, particularly late in the season when the disease is more likely to be serious. Do not plant crops to mature in warm, humid weather. If available, spray with an appropriate chemical from the *Chemical Handy Guide*.

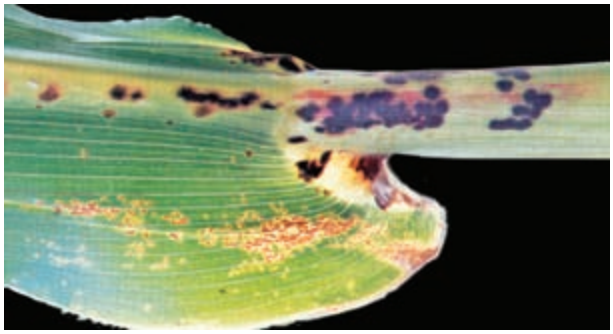


Polysora (tropical) rust

Note spots occur only on the upper leaf surface.

Cause. The fungus *Puccinia polysora*. Survives on sweet corn and maize plant residues and volunteer plants. Spores can spread a long way by wind. Worse in warm, humid weather in north Queensland.

Management. Good farm hygiene, destroy old crops and volunteer plants. Plant resistant varieties. Do not plant crops to mature in warm, humid weather. If available, spray with an appropriate chemical from the *Chemical Handy Guide*.



Brown spot

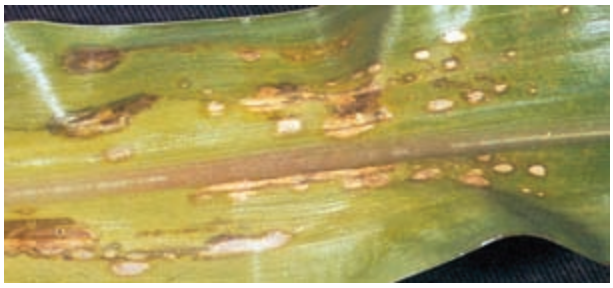
Cause. The fungus *Physoderma maydis*, it is also called maydis leaf blight. It survives on residue in the soil and spores are spread by wind, rain and insects. Infection occurs in damp, sheltered sites such as leaf axils and leaf whorls. It is very common on the Atherton Tableland in north Queensland.

Management. Good farm hygiene, destroy old crops and volunteer plants. Use a good crop rotation.

Long grey/green spots

Cause. Turcicum leaf blight caused by the fungus *Exserohilum turcicum*. Also known as northern corn leaf blight (NCLB) and northern leaf blight (NLB). Survives on sweet corn and maize plant residues and volunteer plants. Spores are spread by wind and rain. Worse in warm, wet weather. Some varieties are very susceptible.

Management. Good farm hygiene, destroy old crops and volunteer plants. Plant resistant varieties. Do not plant crops to mature in warm, wet weather. If possible plant new crops upwind of old crops. Spray with an appropriate chemical from the *Chemical Handy Guide*.



Manganese (Mn) toxicity

Cause. High levels of soluble manganese in acid soil. It occurs in waterlogged soil when poor aeration changes unavailable manganic ions to manganous ions which are taken up by the plant. Symptoms appear first in older leaves.

Management. Use lime or dolomite to raise soil pH to 6.0 to 6.5. Prepare soil well to reduce the risk of waterlogging.

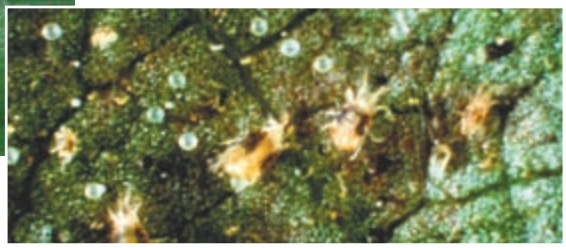
Bleached and speckled leaves

Mite damage

Upper: Mite damage to upper surface. Lower: Mite damage to under surface. Below: Two-spotted mite adult (0.5 mm).

Cause. Feeding by mites, usually the two-spotted mite *Tetranychus urticae*. They produce a fine web on the underside of the leaf and yellow stippling of the upper surface. Mites are spread from old crops and weeds. Worse in warm, dry weather.

Management. Good farm hygiene, destroy old crops and volunteer plants. Spray with an appropriate chemical from the *Chemical Handy Guide*.



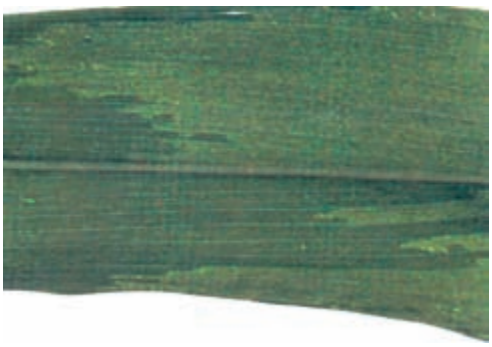
Boron (B) deficiency

Upper: broken, creamy yellow streaks. Lower: symptoms may look similar to virus infection.

Cause. Insufficient boron available to the plant. Common in alkaline or strongly acid sandy soils, particularly in cold weather. Symptoms appear first on younger leaves which are paler, shorter and more erect. Boron deficiency reduces the number and size of ears and affects pollination resulting in blank areas on the cob.

Management. Do a soil analysis six to eight weeks before planting and apply boron to the soil if required. Adjust pH to around 6.5. If necessary during the crop, apply two or three foliar sprays of Solubor at 250 g/100 L, two weeks apart starting two weeks after emergence.

Stripes on leaves



Pale yellow striping

Note the distinct borders between infected and healthy areas.

Cause. Java downy mildew caused by the fungus *Peronosclerospora maydis*. This disease is systemic and plants are infected soon after emergence. They become resistant to infection as they get older. Infection comes from plume sorghum (*Sorghum plumosum*) growing near the crop. It occurs in drier areas of north Queensland and can cause severe losses.

Management. Treat seed with an appropriate chemical from the *Chemical Handy Guide* before planting.

Maize stripe

Cause. Maize stripe virus, spread by the maize planthopper (*Peregrinus maidis*). It is carried over on volunteer maize plants, sorghum and wild sorghums. It is common but rarely serious.

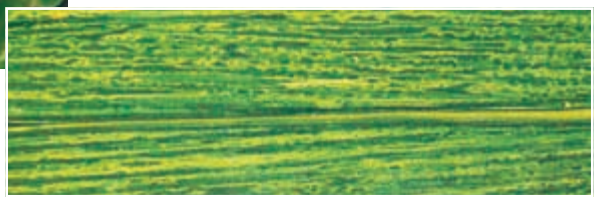
Management. Control is rarely warranted. No resistant varieties are available.

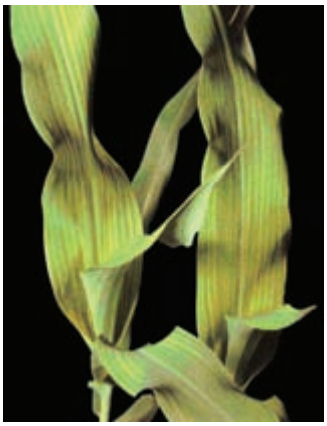
Johnson grass mosaic virus (JGMV)

Left: damage to plant. Below: close-up of symptoms.

Cause. Johnson grass mosaic virus. It is spread by aphids in a very short feeding period. Johnson grass (*Sorghum halepense*) is the main perennial host, but it is also carried over on forage and grain sorghum crops. Worse in late season crops. Early infection causes stunting and serious yield losses.

Management. Plant resistant varieties, for example a tropical hybrid such as Hybrix 5 (note: this variety is not suitable for temperate areas). Do not plant susceptible varieties late season.





Note chlorosis between veins of young leaves

Iron (Fe) deficiency

Cause. Insufficient iron available to the plant. Worse in sandy and waterlogged soils, and calcareous soil where high pH makes iron unavailable to the plant. Acid soils high in soluble manganese, zinc, copper or nickel will reduce iron uptake. Symptoms appear in the younger leaves.

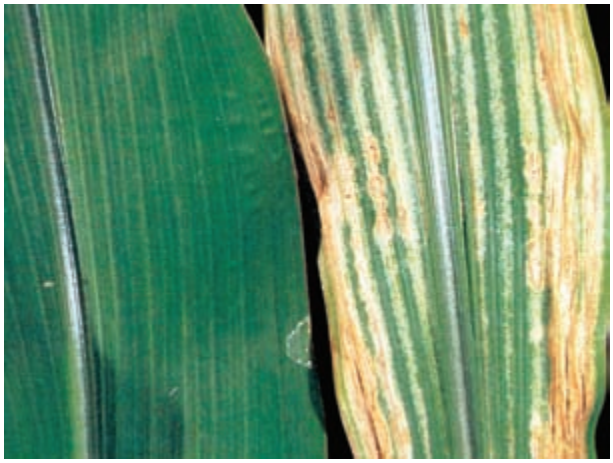
Management. Apply iron chelate or sulfate as a 100 g/100 L foliar spray two to three weeks after emergence.

Magnesium (Mg) deficiency

Left: note brown tips and yellow striations on leaves. Right upper: close-up of brown discolouration symptom. Right lower: healthy leaf.

Cause. Insufficient magnesium available to the plant, more likely in acid, sandy soils. Excessive applications of calcium and potassium can make magnesium unavailable to the plant, as can a low soil pH.

Management. Do a soil analysis six to eight weeks before planting. Apply dolomite instead of lime if pH is low. Magnesium sulfate, applied to the point of run-off at 1 kg/100 L of water, is normally satisfactory. This treatment has a rapid short term response and repeat applications may be needed. Refer to *Nutrition* in Chapter 4 of the *GROWING GUIDE* for more details.



Manganese (Mn) deficiency

Left: healthy leaf. Right: white and brown inter-veinal lesions.

Cause. Insufficient manganese available to the plant. A high soil pH can cause this.

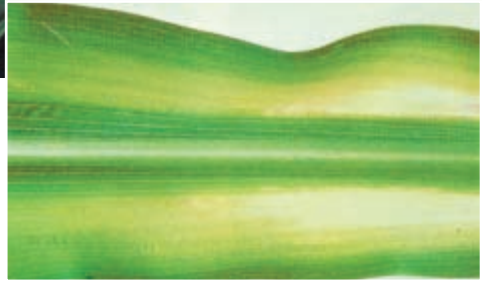
Management. Apply foliar spray of manganese sulfate at 500 g/100 L two to three weeks after emergence.

Zinc (Zn) deficiency

Left: note broad, creamy, chlorotic bands near base and mid-leaf areas and compressed growth. Inset: close-up.

Cause. Insufficient zinc available to the plant. Occurs in high pH soils, leached sandy soils, levelled soils where sub-soil is exposed, and where heavy applications of phosphorus reduces zinc uptake. Symptoms appear first in younger leaves.

Management. Applying 20 to 30 kg/ha of zinc sulfate monohydrate or 40 kg/ha of zinc sulfate heptahydrate before planting is the best control. Zinc sulfate heptahydrate can also be applied at 200 to 250 g/100 L, as three or four foliar sprays, one week apart starting one to two weeks after emergence.



Yellowing of leaves

Nitrogen (N) deficiency

Upper: healthy leaves (left); pale, narrow, deficient leaves (right). Lower: healthy leaf (top); pale green leaves showing yellow and brown chlorosis

Cause. Insufficient nitrogen available to the plant. Occurs in soils low in organic matter, leached sandy soils and heavily cropped and waterlogged soils. Heavy rain or excess irrigation can leach nitrogen below the root zone.

Management. Use cover crops to increase soil organic matter. Apply adequate nitrogen before tasselling. Use soil, leaf or sap tests. Refer to *Nutrition* in Chapter 4 of the *GROWING GUIDE* for details.

Potassium (K) deficiency

Note pale yellow and brown tips and margins of older leaves.

Cause. Insufficient potassium available to the plant. Occurs in soils low in organic matter. Excessive applications of calcium or magnesium can make potassium unavailable to the plant. Heavy rain or excess irrigation can leach potassium below the root zone. Symptoms appear first in older leaves.

Management. Use cover crops to increase soil organic matter. Test soil before planting to get an accurate guide to the potassium requirement. If K is low, apply a side dressing. Use soil, leaf or sap tests. Refer to *Nutrition* in Chapter 4 of the *GROWING GUIDE* for details.

Molybdenum (Mo) deficiency

Deficient plant (left); healthy plant (right).

Cause. Insufficient molybdenum available to the plant. Worse in acid soils. Most severe in the seedling stage.

Management. Take a soil sample about eight weeks before planting and apply lime or dolomite to raise soil pH if necessary. Apply a foliar spray of sodium molybdate at 60 g/100 L, two weeks after emergence and again two weeks later if necessary.

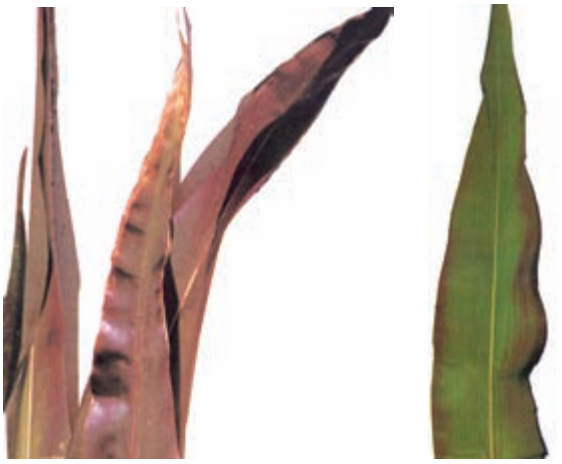
Sulfur (S) deficiency

Left: deficient plants. Below: healthy leaf (left); deficient leaf (right).

Cause. Insufficient sulfur available to the plant. Deficiency occurs in soils low in organic matter and leached acid soils. Plants are also stunted. Symptoms appear first in young leaves.

Management. Use cover crops to increase soil organic matter. Sample soil about eight weeks before planting and if necessary apply elemental sulfur or gypsum as required before planting.

Purpling of leaves



Phosphorus (P) deficiency

Some varieties show strong purpling (left), and other varieties show purpling on the margins (right).

Cause. Insufficient phosphorus available to the plant. Deficiency occurs in soils low in organic matter, soils high in iron (Fe) which ties up P in less available forms, and badly eroded soils. Symptoms appear first in older leaves.

Management. Use cover crops to increase soil organic matter. Take a soil sample about eight weeks before planting and apply phosphorus as required before planting. Use soil, leaf or sap tests. Refer to *Nutrition* in Chapter 4 of the *GROWING GUIDE* for details.

Death of lower leaves

Water stress

Note death of older leaves.

Cause. Insufficient water.

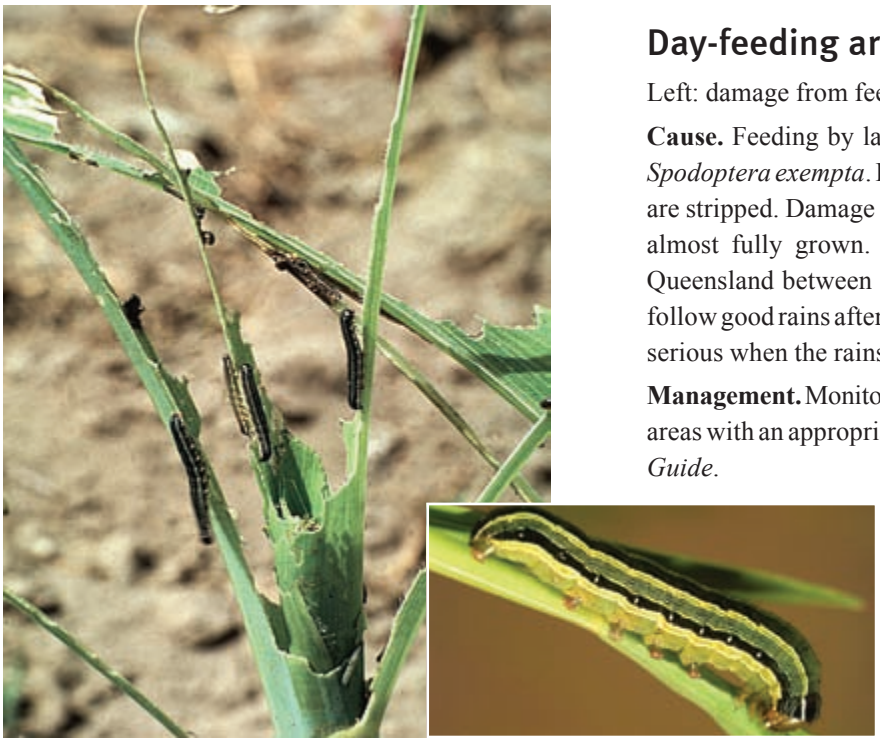
Management. Irrigate. Use a scheduling device to ensure adequate water is applied before plants are stressed.

Chewed leaves

Cutworm

Cause. Cutworms (up to 40 mm long), larvae of the *Agrotis* species moth. Young cutworm caterpillars climb plants and skeletonise the leaves or eat small holes in them. The older larvae may also climb to browse or cut off leaves, but they commonly cut through stems at ground level and feed on the top growth of the felled plants. The larvae curl up and hide in the soil during the day and feed at night. Areas that were weedy just before planting are most affected. They are a minor and infrequent pest, more common from spring to autumn.

Management. Cultivate to remove weed growth well before planting. Spray with an appropriate chemical from the *Chemical Handy Guide*.



Day-feeding armyworm

Left: damage from feeding larvae. Inset: close-up of larva.

Cause. Feeding by larvae (up to 35 mm long) of the moth *Spodoptera exempta*. Leaves up to 450 mm from ground level are stripped. Damage may not be noticed until the larvae are almost fully grown. It is important at times in northern Queensland between late December and March. Outbreaks follow good rains after a drought period and appear to be more serious when the rains are late.

Management. Monitor the crop and if necessary spray infested areas with an appropriate chemical from the *Chemical Handy Guide*.

Red shouldered leaf beetle

Cause. Feeding by *Monolepta australis*. These 6 mm long beetles appear in swarms from spring to autumn, particularly after rain. They can cause severe damage but are sporadic.

Management. Monitor the crop and spray infested areas as soon as possible with an appropriate chemical from the *Chemical Handy Guide*.

Heliothis

Left: heliothis moth (20 mm long) and grub damage. Right: larva (40 mm).

Cause. Larvae of the moth, *Helicoverpa armigera*. They feed on leaves then move to silks and cobs. Heliothis is the most serious pest of sweet corn. Highest numbers occur in warmer months, they are uncommon in southern Australia in winter.

Management. Biological options are available, see the IPM strategy in Chapter 4 of the *GROWING GUIDE*. If necessary spray with an appropriate chemical from the *Chemical Handy Guide*.

Leaf grazing and window-paneing

Left: blighting symptom. Right: window-paning and holes.

Cause. Larvae of the heliothis and day-feeding armyworm moths. The grubs sometimes create 'window panes' by grazing from one side of the leaf and leaving only the clear outer surface on the other side. Severe feeding gives the plant a blighted appearance.

Management. Monitor the crop and determine what is causing the problem. Biological options are available for heliothis, see the IPM strategy in Chapter 4 of the *GROWING GUIDE*. If necessary spray with an appropriate chemical from the *Chemical Handy Guide*.

Armyworms

Left: Moth about 20 mm long. Right: larva (35 mm).

Cause. Larvae of the *Mythimna* spp. and in Tasmania, *Persectania* spp. moths. They feed in the whorls and tassels and can be found on silks. More common in spring in the Lockyer Valley and Victoria. Usually a minor problem but serious outbreaks can occur. Some species feed at night.

Management. They may be heavily parasitised, so monitor, both during the day and at night, and only spray if necessary. Use an appropriate chemical from the *Chemical Handy Guide*.

Holes in leaves

Black field earwig

Left: the damage was done before emergence. Right: earwig adult–15 mm (left) and nymphs (right).

Cause. Adults and nymphs of the black field earwig *Nala lividipes*. They usually feed on decaying stubble but also eat newly sown and germinating seed and the roots of crops. They are minor and infrequent pests, mainly in heavy black soils.

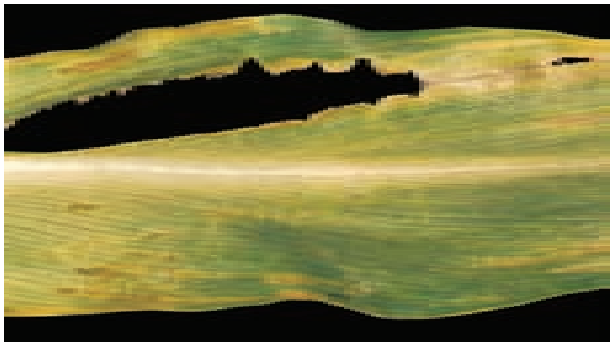
Management. Prepare ground so that germination is as even and rapid as possible. Use beetle bait or germinating seed baits to determine their presence and apply an appropriate chemical bait from the *Chemical Handy Guide* if necessary.

Heliothis

Left: damage to plant. Right: note grub in whorl of corn.

Cause. Larvae of the moth, *Helicoverpa armigera*. They feed on the leaves before moving onto the silks and cobs. Heliothis is the most serious pest of sweet corn.

Management. Biological options are available, see the IPM strategy in Chapter 4 of the *GROWING GUIDE*. If necessary spray with an appropriate chemical from the *Chemical Handy Guide*.



Calcium (Ca) deficiency

Cause. Low calcium levels in the soil. Worse in acid sandy soils and soils high in sodium (Na). High levels of potassium, magnesium and sodium can induce a calcium deficiency. Symptoms appear first and are more severe in young leaves.

Management. Do a soil analysis six to eight weeks before planting. Apply lime instead of dolomite if pH is low. Do not apply high rates of potassium or magnesium, or acidifying fertilisers for example, sulfate of ammonia. Refer to *Nutrition* in Chapter 4 of the *GROWING GUIDE* for details.

Deformed and twisted leaves

Wallaby ear

Upper left: infected plant (left), healthy (right). Upper right: close-up of leaf symptom. Below: leafhoppers 3 mm long.

Cause. The effects of a toxin injected by maize leafhoppers (*Cicadulina bimaculata*). In susceptible plants, infestations of more than 15 per plant can cause symptoms. The leafhoppers are more common in summer. Some varieties are less susceptible than others.

Management. Plant resistant varieties. Do not plant summer crops in coastal areas in Queensland and NSW. Spray young plants with an appropriate chemical from the *Chemical Handy Guide*.

Leaves roll inwards

Stressed plant on left.

Cause. Water stress due to poor irrigation management or under conditions of extreme heat.

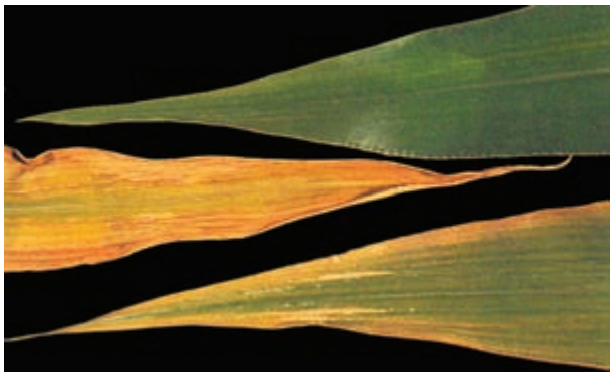
Management. Improve irrigation management. Use an irrigation scheduling device, for example tensiometers or capacitance probes.

Herbicide damage

Cause. Some varieties have a lower tolerance than others to the herbicide EPTC. Stunted plants and deformed leaves appear with normal plants in the row.

Management. Use recommended rates of herbicide. Test new varieties before treating large blocks with EPTC. Do not plant for seven days after application.

Death of leaf tips and margins



Potassium (K) deficiency

Healthy leaf (top)

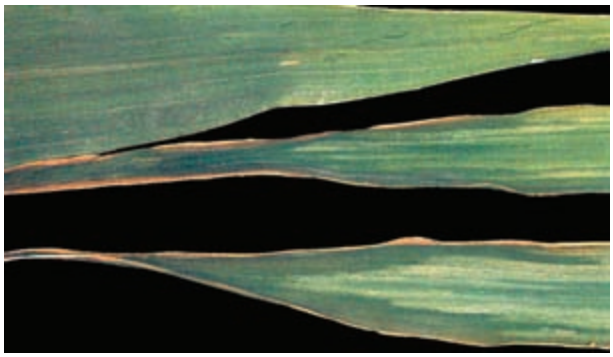
Cause. Insufficient potassium available to the plant. Occurs in low organic matter soils. Excessive applications of calcium and magnesium can make potassium unavailable to the plant. Heavy rain or excess irrigation can leach potassium below the root zone. Symptoms appear first in older leaves.

Management. Use cover crops to increase soil organic matter. Test soil before planting to get an accurate guide to the potassium requirement. If K is low, apply a side dressing. Use soil, leaf or sap tests. Refer to *Nutrition* in Chapter 4 of the *GROWING GUIDE* for details.

Salt damage

Cause. High levels of salt (sodium chloride, (NaCl)) in the soil. Damage first appears in the tips and margins of older leaves. Worse where high levels of sodium and chloride occur in the soil or water.

Management. Use water with a conductivity below 1.5 deciSiemens per centimetre. Apply gypsum and leach the sodium and chloride below the root zone. Where use of water with high levels of salts is unavoidable irrigate in the evening not during the day.

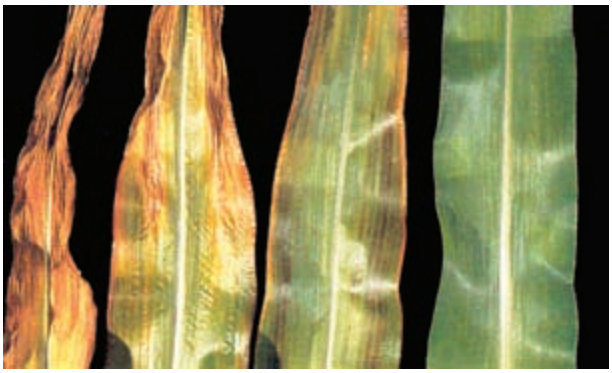


Manganese (Mn) toxicity

Healthy leaf (top).

Cause. High levels of soluble manganese in acid soil. It occurs in waterlogged soil when poor aeration changes unavailable manganic ions to manganous ions which are taken up by the plant. Symptoms appear first in older leaves then spread to young leaves.

Management. Use lime or dolomite to raise soil pH to 6.0 to 6.5. Prepare soil well to reduce the risk of waterlogging.

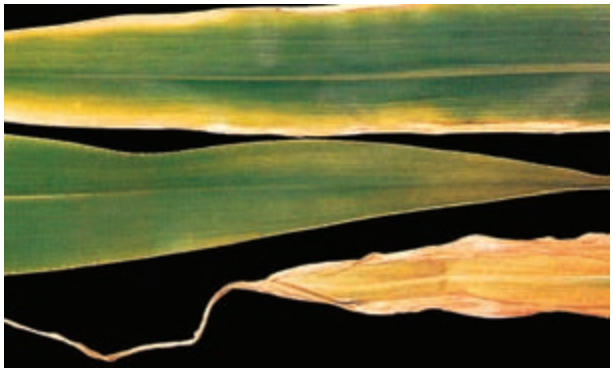


Phosphorus (P) deficiency

Healthy leaf on right.

Cause. Insufficient phosphorus available to the plant. Deficiency occurs in soils low in organic matter, soils high in iron (Fe) which tie up P in less available forms, and badly eroded soils. Symptoms appear first in older leaves.

Management. Use cover crops to increase soil organic matter. Take a soil sample about eight weeks before planting and apply phosphorus as required before planting. Use soil, leaf or sap tests. Refer to *Nutrition* in Chapter 4 of the *GROWING GUIDE* for details.



Copper (Cu) deficiency

Healthy leaf in middle.

Cause. Insufficient copper available to the plant. Occurs in alkaline sands and leached acid soils low in copper. Ears are small with few kernels and in severe cases plants may die. Symptoms appear first in young leaves.

Management. Take a soil sample about eight weeks before planting and apply copper to the soil before planting as recommended. Foliar applications of copper can be applied four to six weeks after emergence and then as required.

Sticky coating on leaves

Aphids

Cause. Secretions produced by aphids, for example corn aphid *Rhopalosiphum maidis*. Sometimes a black mould grows on these sticky secretions.

Management. It is very difficult to control aphids in the wrapper leaves of the cob. Spray with an appropriate chemical from the *Chemical Handy Guide*.

Galls on stems

Boil smut

Cause. The fungus *Ustilago zeae*. It attacks any actively growing, above-ground part of the plant to form swellings referred to as boils, blisters or galls. Mature galls up to 200 mm in diameter, release the spores. Spores can be spread by wind; water splash; with seed or stock food; and in soil on clothes, vehicles, machinery and animals. It may survive in the soil for many years. It is usually sporadic and minor but can occasionally be severe.

Management. Specific control measures are not warranted. Most hybrids have at least a reasonable level of resistance to boil smut.

Damaged stems

Brown spot

External (left); internal (right).

Cause. The fungus *Physoderma maydis*, it is also called maydis leaf blight. It survives on residue in the soil and spores are spread by wind, rain and insects. Infection occurs in damp, sheltered sites such as leaf axils and leaf whorls. It is very common on the Atherton Tableland in north Queensland.

Management. Good farm hygiene, destroy old crops and volunteer plants. Use a good crop rotation.

Holes in stems

Cause. Larvae of the yellow peach moth *Conogethes punctiferalis*. The larvae bore into the stem, leaving webbing and excreta. Other hosts include maize, sorghum, cotton, citrus, peach, custard apple, papaw and mango. A minor pest most common in summer and autumn in Queensland and coastal NSW.

Management. Difficult to control because they bore into the plant where sprays can't reach them. Ensure good farm hygiene, destroy old crops and volunteer plants. If necessary spray with an appropriate chemical from the Chemical Handy Guide.

Stunted plants

Wallaby ear

Left: stunted plants beside healthy plants. Below: note stiff, erect leaves.

Cause. The effects of a toxin injected by 3 mm long maize leafhoppers (*Cicadulina bimaculata*). The leafhoppers are more common in summer. Some varieties are less susceptible than others.

Management. Plant resistant varieties. Do not plant summer crops in coastal areas. Spray young plants with an appropriate chemical from the *Chemical Handy Guide*.

Johnson grass mosaic virus (JGMV)

Left: susceptable variety (front), resistant variety (back). Below: close-up of infected plant.

Cause. Johnson grass mosaic virus. It is spread by aphids in a very short feeding period. Johnson grass (*Sorghum halepense*) is the main perennial host, but it is also carried over on forage and grain sorghum crops. Worse in late season crops. Early infection causes stunting and serious yield losses.

Management. Plant resistant varieties, for example a tropical hybrid such as Hybrix 5 (note: this variety is not suitable for temperate areas). Do not plant susceptible varieties late season.

Herbicide damage

Cause. Some varieties have a lower tolerance than others to the herbicide EPTC. Stunted plants and deformed leaves appear with normal plants in the row.

Management. Use recommended rates of herbicide. Test new varieties before treating large blocks with EPTC. Do not plant for seven days after application.

Nitrogen (N) deficiency

Cause. Insufficient nitrogen available to the plant. Occurs in soils low in organic matter, leached sandy soils and heavily cropped and waterlogged soils. Heavy rain or excess irrigation can leach nitrogen below the root zone. Symptoms appear first in old leaves.

Management. Use cover crops to increase soil organic matter. Apply adequate nitrogen before tasselling. Use soil, leaf or sap tests. Refer to *Nutrition* in Chapter 4 of the *GROWING GUIDE* for details.

Stunted plants

Phosphorus (P) deficiency

Left: deficient plants (left); healthy (right). Right: deficient.

Cause. Insufficient phosphorus available to the plant. Deficiency occurs in soils low in organic matter, soils high in iron (Fe) which tie up P in less available forms, and badly eroded soils. Symptoms appear first in old leaves.

Management. Use cover crops to increase soil organic matter. Take a soil sample about eight weeks before planting and apply phosphorus as required before planting. Use soil, leaf or sap tests. Refer to *Nutrition* in Chapter 4 of the *GROWING GUIDE* for details.

Potassium (K) deficiency

Cause. Insufficient potassium available to the plant. Occurs in soils low in organic matter. Excessive applications of calcium and magnesium can make potassium unavailable to the plant. Heavy rain or excess irrigation can leach potassium below the root zone. Symptoms appear first in old leaves.

Management. Use cover crops to increase soil organic matter. Test soil before planting to get an accurate guide to the potassium requirement. If K is low, apply a side dressing. Use soil, leaf or sap tests. Refer to *Nutrition* in Chapter 4 of the *GROWING GUIDE* for details.

Calcium (Ca) deficiency

Left: short, stout, deficient plant. Right: hole symptom.

Cause. Low calcium levels in the soil. Worse in acid sandy soils and soils high in sodium (Na). High levels of potassium, magnesium and sodium can induce a calcium deficiency. Symptoms appear first in old leaves.

Management. Do a soil analysis six to eight weeks before planting. Apply lime instead of dolomite if pH is low. Do not apply high rates of potassium or magnesium, or acidifying fertilisers for example, sulfate of ammonia. Refer to *Nutrition* in Chapter 4 of the *GROWING GUIDE* for details.

Magnesium (Mg) deficiency

Cause. Insufficient magnesium available to the plant, for example in acid, sandy soils. Excessive applications of calcium and potassium can make magnesium unavailable to the plant, as can a low soil pH. Symptoms appear first in old leaves.

Management. Do a soil analysis six to eight weeks before planting. Apply dolomite instead of lime if pH is low. Magnesium sulfate, applied to the point of run-off at 1 kg/100 L of water, is normally satisfactory. This treatment has a rapid short term response and repeat applications may be needed. Refer to *Nutrition* in Chapter 4 of the *GROWING GUIDE* for more details.

Boron (B) deficiency

Note short, stout, oval stalk and short, pale, erect leaves.

Cause. Insufficient boron available to the plant. Common in alkaline or strongly acid sandy soils, particularly in cold weather. Boron deficiency reduces the number and size of ears and affects pollination resulting in blank areas on the cob. Symptoms appear first in young leaves.

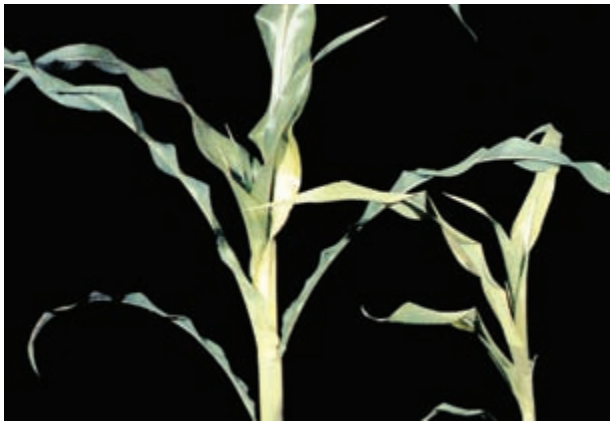
Management. Do a soil analysis six to eight weeks before planting and apply boron to the soil if required. Adjust pH to around 6.5. If necessary during the crop, apply two or three foliar sprays of Solubor at 250 g/100 L, two weeks apart starting two weeks after emergence.

Iron (Fe) deficiency

Note pale, yellow-green leaves.

Cause. Insufficient iron available to the plant. Worse in sandy and waterlogged soils, and calcareous soil where high pH makes iron unavailable to the plant. Acid soils high in soluble manganese, zinc, copper or nickel will reduce iron uptake. Symptoms appear in the younger leaves.

Management. Apply iron chelate or sulfate as a 100 g/100 L foliar spray two to three weeks after emergence.



Manganese (Mn) deficiency

Healthy plant (left), deficient (right).

Cause. Insufficient manganese available to the plant. A high soil pH can cause this.

Management. Apply foliar spray of manganese sulfate at 500 g/100 L two to three weeks after emergence.

Zinc (Zn) deficiency

Left: deficient (left); healthy (right). Inset: note broad, creamy white chlorotic bands near base and mid-leaf, and compressed growth.

Cause. Insufficient zinc available to the plant. Occurs in high pH soils, leached sandy soils, levelled soils where sub-soil is exposed and where heavy applications of phosphorus reduces zinc uptake. Symptoms appear first in younger leaves.

Management. Applying 20 to 30 kg/ha of zinc sulfate monohydrate or 40 kg/ha of zinc sulfate heptahydrate before planting is the best control. Zinc sulfate heptahydrate can also be applied at 200 to 250 g/100 L, as three or four foliar sprays, one week apart starting one to two weeks after emergence.

Stunted plants

Salt damage

Note shorter, more erect leaves and rolled-in leaf margins.

Cause. High levels of salt (sodium chloride (NaCl)) in the soil. Damage first appears in the tips of older leaves. Worse where high levels of sodium and chloride occur in the soil or water.

Management. Use water with a conductivity below 1.5 deciSiemens per centimetre. Apply gypsum and leach the sodium and chloride below the root zone. Where use of water with high levels of salts is unavoidable irrigate in the evening not during the day.

Problems with tassels

Large grubs in tassels

Cause. Larvae from moth eggs laid on leaves in the whorl. May be heliothis, *Helicoverpa* spp., or armyworms, *Mythimna* or *Spodoptera* spp. They may drop onto cobs or silks and cause damage there. Some species feed at night.

Management. Monitor tassels and use soft options to avoid disrupting the population of beneficial insects. Increase frequency of monitoring and also monitor at night. Control to help reduce the next generation. If necessary, spray with an appropriate chemical from the Chemical Handy Guide.

Head smut

See facing page

Problems with silks

Silks pull out of cobs

Note most silks have been chewed through.

Cause. Larvae of the heliothis moth, *Helicoverpa armigera*, feeding on the silks early in cob development. Heliothis is the most serious pest of sweet corn. The highest numbers occur in the warmer months, they are uncommon in southern Australia in winter.

Management. A wide range of chemicals is registered to control heliothis, however they are difficult to control at this stage. Spray with an appropriate chemical from the Chemical Handy Guide.

Small cream to white spheres on silks and flag leaves of cob

Top: black parasitised egg. Lower left: eggs on silk. Lower right: close-up of heliothis egg (0.4 mm) on silk.

Cause. Eggs laid by the heliothis moth, *Helicoverpa armigera*. It is more common in the first week of silking. The highest numbers occur in the warmer months, they are uncommon in southern Australia in winter.

Management. This is the critical stage for heliothis management. Time sprays to coincide with egg hatch. This targets larvae before they reach the cob. When choosing sprays consider the amount of beneficial activity and the effect of the spray on the beneficials present, see Chapter 4 of the *GROWING GUIDE*. If necessary apply an appropriate chemical from the *Chemical Handy Guide*.

Problems with cobs

Boil (common) smut

Left: early stage. Right: late stage.

Cause. The fungus *Ustilago zeae*. It attacks any actively growing, above-ground part of the plant to form swellings referred to as boils, blisters or galls. Mature galls up to 200 mm in diameter, release the spores. Spores can be spread by wind; water splash; with seed or stock food; and in soil on clothes, vehicles, machinery and animals. It may survive in the soil for many years. It is usually sporadic and minor but can occasionally be severe.

Management. Specific control measures are not warranted. Most hybrids have at least a reasonable level of resistance to boil smut.

Head smut

Left: cob symptom. Right: tassel symptom.

Cause. The fungus *Sphacelotheca reiliana*. It remains viable in the soil indefinitely and infects germinating seed and young seedlings. It grows within the plants as they mature and may not become evident until heads start to dry out. It can cause unthriftiness in developing plants, making them more susceptible to other problems.

Management. This disease should not become a major problem in crops grown well in pathogen free soil. In cool dry weather avoid planting paddocks that are known to be infested. Make sure the seed source is clean as the fungus can be carried on seed.

Problems with cobs

Fusarium cob rot

Upper: maize infection. Lower: early infection on sweet corn.

Cause. Various species of fusarium fungi including *Fusarium verticillioides* (previously *moniliforme*). Entire cobs or scattered kernels within the cob may rot. A white-to-pink or salmon coloured mould appears on infected kernels. Cob rots develop through infection of the silks by spores, or the symptomless growth of the fungus through the plant. Insects damage to kernels may allow the fungus to enter the cob. Often only a small percentage of the cob is affected, but when the infection is severe total crop loss can occur. Worse in warm, wet weather 2 to 3 weeks after silking.

Management. Plant varieties that have shown resistance to cob rot. Hybrids with long husks that tightly enclose the silk channel opening of the ears show some resistance. Husks that prevent or delay entry of insects are partly responsible for resistance. Early plantings are usually less likely to get the disease.

Tip of cob extends through husk

Cause. This is usually a varietal problem, some varieties are not prone to this.

Management. Plant varieties that are not prone to this problem. Refer to the article on varieties in Chapter 4 of the *GROWING GUIDE*.

Small black beetles around tip of cob

Note small black beetles near damaged area. Inset: close-up of adult beetle.

Cause. Various beetles, including the 3 mm long dried fruit beetle *Carpophilus* spp., attracted by the fermentation of kernels damaged by heliothis grubs. Numbers increase as tassels shed pollen. Worse in summer and in IPM crops.

Management. Cobs may be saleable if trimmed and sold dehusked and pre-packed.

Sticky coating on husk

Note dark aphids and brown, parasitised mummies.

Cause. Secretions produced by aphids, for example corn aphid *Rhopalosiphum maidis*. Sometimes a black mould grows on these sticky secretions.

Management. It is very difficult to control aphids in the wrapper leaves of the cob. Spray with an appropriate chemical from the *Chemical Handy Guide*.

Damage to silks, tips and under wrapper leaves

Upper: damage, frass and larva. Lower left: adult 8 mm long. Lower right: larva (13 mm).

Cause. Feeding by larvae of sorghum head caterpillar, *Cryptoblabes adoceta*. They are found in NSW and southern and coastal Queensland. They contaminate the silks and wrapper leaves, a minor problem for processing and pre-pack cobs.

Management. There have been reports of *Trichogramma* parasitising the eggs. The parasitic wasp *Cotesia* sp. also attacks the caterpillars. Applying pesticides can interfere with an integrated control strategy against heliothis. Before spraying, assess the economic significance of this pest compared with heliothis damage. If necessary apply an appropriate chemical from the *Chemical Handy Guide*.

Holes in side of cobs

Heliothis

Left: hole in outer husk. Right: holes in inner husk.

Cause. Damage by larvae of the heliothis moth, *Helicoverpa armigera*. Cobs are usually not saleable. Heliothis is the most serious pest of sweet corn. The highest numbers occur in the warmer months, they are uncommon in southern Australia in winter.

Management. Difficult to control at this stage. Biological options are available, see the *IPM strategy* in Chapter 4 of the *GROWING GUIDE*. If necessary spray with an appropriate chemical from the *Chemical Handy Guide*.

Yellow peach moth

Upper left: moth (13 mm long). Upper right: close-up of larva. Lower: larva (20 mm) and frass. Note hole in cob (circled).

Cause. Larvae of the yellow peach moth *Conogethes punctiferalis*. The larvae bore into the cob and eat the kernels, leaving webbing and excreta. Other hosts include maize, sorghum, cotton, citrus, peach, custard apple, papaw and mango. A minor pest most common in summer and autumn in Queensland and coastal NSW.

Management. Difficult to control at this stage. Ensure good farm hygiene, destroy old crops and volunteer plants. Spray with an appropriate chemical from the *Chemical Handy Guide*.

Missing and damaged kernels on cobs

Blank areas or unevenly sized kernels

Cause. Poor pollination due to weather conditions such as rain or temperature extremes at silking or silks damaged by grubs. Blank areas can occur anywhere on the cob.

Management. Do not plant crops to silk during periods when adverse climatic conditions can be expected.

Tip blanking (poor tip fill)

Cause. This is may be a varietal problem, some varieties have kernels covering the tip, others do not. It is also caused by stress at pollination or tip fill due to shortage of nutrients, particularly nitrogen or water stress. Most often it will be due to poor pollination due to adverse conditions at pollination such as hot, dry, windy weather or wet weather which will stop pollination and affect germination of the pollen tube. Tip blanking may not be a problem in processing crops.

Management. Plant varieties with good tip fill. Ensure plants have adequate nutrients and are not water stressed at these critical periods. Refer to the article on varieties in Chapter 4 of the *GROWING GUIDE*.

Damaged kernels

Adult (12 mm long) and nymphs.

Cause. Damage caused by feeding by adults and nymphs of the green vegetable bug *Nezara viridula*. They are a sporadic pest that suck out the contents of kernels. Secondary diseases may infect the feeding site. More prevalent when alternate hosts, for example soybeans, are nearby.

Management. Some control by egg parasitoids *Trissolcus basalis*, and the adult parasite *Trichopoda giacomellii*. Applying pesticides can interfere with an integrated control strategy against heliothis. Before spraying, assess the economic significance of this pest compared with heliothis damage. If necessary apply an appropriate chemical from the *Chemical Handy Guide*.

Poor cob development

Effect of zinc on cobs from 0 Zn (top left) to adequate Zn (bottom right).

Cause. Insufficient zinc available to the plant. Occurs in high pH soils, leached sandy soils, levelled soils where sub-soil is exposed and where heavy applications of phosphorus reduces zinc uptake.

Management. Applying 20 to 30 kg/ha of zinc sulfate monohydrate or 40 kg/ha of zinc sulfate heptahydrate before planting is the best control. Zinc sulfate heptahydrate can also be applied at 200 to 250 g/100 L, as three or four foliar sprays, one week apart starting one to two weeks after emergence.

Curved cobs

Cause. Insufficient boron available to the plant. Common in alkaline or strongly acid sandy soils, particularly in cold weather. Boron deficiency reduces the number and size of ears produced and affects pollination causing blank areas on the cob.

Management. Do a soil analysis six to eight weeks before planting and apply boron to the soil if required. Adjust pH to around 6.5. If necessary during the crop, apply two or three foliar sprays of Solubor at 250 g/100 L, two weeks apart starting two weeks after emergence.

Heliothis

Cause. Damage by larvae of the heliothis moth, *Helicoverpa armigera*. Cobs are usually not saleable unless they are trimmed and pre-packed. Heliothis is the most serious pest of sweet corn. The highest numbers occur in the warmer months, they are uncommon in southern Australia in winter.

Management. Biological options are available, see the IPM strategy in Chapter 4 of the *GROWING GUIDE*. If necessary spray with an appropriate chemical from the *Chemical Handy Guide*.

Yellow peach moth

Upper: moth (13 mm long). Lower: larva (20 mm) and frass.

Cause. Larvae of the yellow peach moth *Conogethes punctiferalis*. The larvae bore into the cob and eat the kernels, leaving webbing and excreta. Other hosts include maize, sorghum, cotton, citrus, peach, custard apple, papaw and mango. A minor pest most common in summer and autumn in Queensland and coastal NSW.

Management. Difficult to control at this stage. Ensure good farm hygiene, destroy old crops and volunteer plants. Spray with an appropriate chemical from the *Chemical Handy Guide*.

Postharvest problems

Pale dry husk

Cause. Storing at high temperature and low humidity. Cobs dry out quickly in hot, dry conditions.

Management. Cool cobs as soon as possible after harvest. Store cobs at 0°C and a humidity of 95 to 100%. Hydro-cooling will help prevent this problem.

Dimpled kernels

Cause. Cobs are over mature. Can also be caused by poor storage conditions following harvest.

Management. Inspect cobs regularly to ensure harvesting is done on time. See assessing maturity in Chapter 4 of the *GROWING GUIDE* for details on when to harvest.

Kernel fermentation

Cause. Occurs in the field with supersweet varieties high in sugar when they become over-mature, particularly under warm humid conditions or with rain entering the cob.

Management. Harvest as soon as mature and cool rapidly. Choose varieties less prone to this condition.

Cob damage after harvest and packing

Damaged cobs

Cause. Damage incurred during mechanical harvesting and loading into bins. The kernels in the damaged area shatter and the liquid contents leak out. There is not much immediate colour change, but it becomes more obvious after storage. Cooking cobs by boiling may also accentuate the damage. Varieties with large or prominent kernels appear to be more susceptible to damage than those with narrower, wedge shaped kernels with a more flattened surface on the cob.

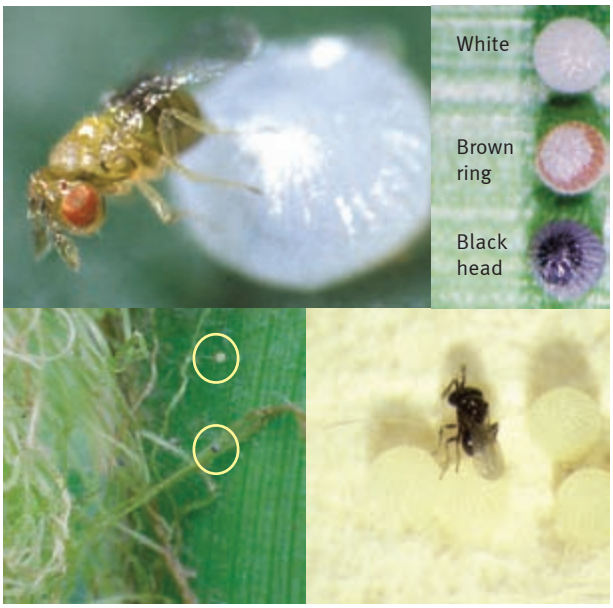
Management. If possible, select varieties which have kernels less susceptible to mechanical damage. Try to eliminate damage points during the harvesting and handling stages prior to packing. Cobs with minor damage may be trimmed and pre-packed depending on where the damage occurs.

Damaged cobs after 7 days storage

Damaged cobs after storage and cooking

Natural enemies: Parasitoids and predators in sweet corn

Egg parasitoids



Heliothis egg parasitoids

Upper: Trichogramma wasp (left), stages of heliothis eggs (right). Lower: healthy (white) and parasitised (black) eggs (left); Telenomus wasp (right).

There are several species of egg parasitoids, the most common is *Trichogramma pretiosum* which is commercially reared. Depending on the season, other species such as *Trichogrammatoidea* spp. and *Telenomus* spp. also occur in sweet corn crops. The adult wasps are all minute, rarely visible when monitoring crops, however the black parasitised eggs can be spotted easily. There is little information on the presence of *Trichogramma* sp. and *Telenomus* spp. in Tasmania but they are considered to be either absent or uncommon.

The egg parasitoids can have a significant impact on heliothis populations if synthetic pesticides are not used. Their populations can be increased by releases.

Green vegetable bug egg parasitoid

Left: wasp emerging from green vegetable bug egg.

Parasites of green vegetable bug include several egg parasitoids, with *Trissolcus basalis* being the most common. These natural enemies have a more significant impact in managing green vegetable bug in sweet corn if the bugs are present early in the crops.

Larval parasitoids

Microplitis

Left: parasitised larva, pupa and wasp.

A parasitoid of heliothis and *Spodoptera* spp. *Microplitis* wasps are distinguishable by their brown pupae. They lay single eggs into young caterpillars. Their larva emerge, killing the caterpillar, and form a brown pupa lightly attached to the dead grub. There is little information on the presence of *Microplitis* in Tasmania but it is considered to be either absent

Parasitised larva and cocoon

Braconid wasp

Upper: Braconid wasp. Lower: cocoons (left); parasitised armyworm and Cotesia larvae (right).

These parasitic wasps lay eggs into larvae of armyworm, heliothis and sorghum head caterpillar. The larvae emerge to pupate, forming white bundles of pupae on the outside of the caterpillar. The dead caterpillar may still be attached to the pupae. One of the common braconid wasps found in sweet corn is *Cotesia* sp.

These larval and aphid parasitoids are often brown or black and very small (less than 6 mm). They look like flying ants or tiny flies. From side on you can see a restricted 'waist'. Female wasps have a 'sting' at the tip of their abdomen, this is the ovipositor that inserts eggs into the host. Another distinguishing feature is that when they are walking on foliage you can often see their antennae quivering and tapping the foliage as they search for chemical traces left by hosts.

Adult Tachinid fly

Eggs on head of host larva

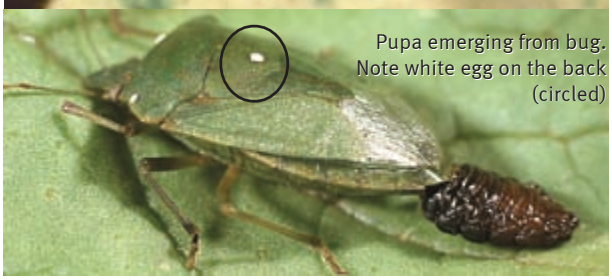
Tachinid fly attacking heliothis larva

Tachinid flies

These parasitic flies are brown/grey/black and slightly bigger than a house fly. They lay a white oval egg on or near caterpillars. The fly larva enters the caterpillar and attaches to the skin, leaving a breathing hole. The maggot grows inside the caterpillar, eventually killing it. It then forms a brown, oval pupal case from which the fly emerges. Tachinid flies have a wide host range including heliothis and armyworms, they are not usually very common.

Parasites

Adult fly



Pupa emerging from bug. Note white egg on the back (circled)

Green vegetable bug parasitic fly

Trichopoda giacomellii is a fly parasite of the adult green vegetable bug. The female lays off-white eggs on the body of the bug which hatch and bore into the bug's body.

These natural enemies have a more significant impact in managing green vegetable bug in sweet corn if the bugs are present early in the crops.

Parasitised bug (left), healthy (right)

Predatory beetles

Three-banded ladybird adult, larva (centre), pupa (on leaf)

White-collared ladybird *Hippodamia variegata*

Ladybirds

Predatory beetles include ladybirds, several species of which can be found in unsprayed sweet corn crops. The white-collared ladybird, *Hippodamia variegata*, is a recent introduction to Australia, and a voracious feeder on aphids. The majority of ladybirds are 4 to 7 mm long, orange or red with a different number and shape of black spots. Their bodies are dome shaped with a hard wing covering. Their eggs and larvae are also prevalent especially when there are aphids present. Eggs (2 mm) are yellow, oval shaped and are laid upright on leaves, usually in a cluster. Larvae (6 to 7 mm long) are black with coloured markings on the back.

Ladybirds are very effective predators of aphids but will also eat moth eggs and small larvae.

Transverse ladybird adults and larva (lower)

Ladybird eggs

Common spotted ladybird; adults and larva (centre)

Predatory bugs

Pirate bug (*Orius*)

Pirate bugs are black and about 3 mm long. Their wings make a black and white cross pattern on their back. If thrips are present they are commonly seen where the leaves wrap around the stem or in the silks. The wingless nymphs are orange and black and go through several stages before becoming adults. Pirate bug eggs are white, oblong and are laid embedded in the leaf, often near the sheath. Pirate bugs are common predators of thrips but also feed on moth eggs, aphids and small caterpillars.

Black mirids

Black mirids move faster than pirate bugs and are larger and thinner than them. They have long antenna and do not have the cross pattern on their back. Their prey includes moth eggs and soft bodied insects.

Bigeyed bug

Note heliothis egg (centre right).

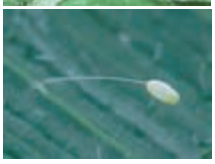
The bigeyed bug *Geocoris* spp. is about 4 to 5 mm long and is distinguishable by its large protruding black eyes. Its body is also black and squatter in shape than the pirate bug. Its prey includes aphids, mites, young caterpillars and moth eggs.

Damsel bug nymph

Damsel bug

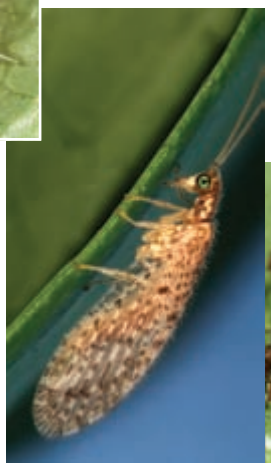
The damsel bug *Nabis kinbergii* is one of the larger predatory bugs, being up to 8 to 12 mm long. It is brown, long and thin, with large eyes and long antenna. Their prey includes soft bodied insects, moth eggs, small larvae and mites.

Green lacewing adult



Green lacewing egg

Green lacewing larva camouflaged with bodies of its victims



Brown lacewing adult

Lacewings

Brown *Micromus* spp. and green *Mallada* spp. lacewings are common in unsprayed sweet corn crops. The larvae and adult brown lacewing are predatory, especially on aphids. The adult brown lacewing has brown wings, larvae are also brown and eggs are laid singly on leaves. Green lacewing adults have green wings and are slightly larger than brown lacewings.

Brown lacewing larva and aphids

Predatory mites

Predatory mites

Predatory mite (left), two-spotted mite (right).

Various predatory mites can occur naturally in unsprayed crops. *Phytoseiulus persimilis* is a predatory mite that can be purchased from beneficial suppliers. Given the right environmental conditions it is a very effective predator of two-spotted mite.

The adult mite is orange and 1 mm long, larger than a two-spotted mite. Their body is pear shaped, appears smooth and almost dome like. Another distinguishing feature is that predatory mites move faster than two-spotted mites.

Spiders

Crab spider (Thomisidae)

Wolf spider (*Lycoa* spp.)

Jumping spider (Salticidae)

Orbweaver spider (*Araneus* and *Agriope* spp.)

Spiders

Three types of spiders are commonly found in sweet corn crops – web spinners, foliage dwellers and soil dwellers. Wolf spiders are common soil predators, whereas the crab spiders, jumping spiders, orb weavers and many others are active predators in plant canopies.

Their impact on pests has not been well documented however spiders represent up to a third of the predators recorded in sweet corn crops. They eat moth eggs, small caterpillars, aphids and thrips.

Minor natural enemies

Hover fly (Syrphidae) adult (right), larva and aphids (left)

Glossy shield bug (*Cermatulus nasalis*) nymph (left); adult bug feeding on a heliothis grub (right)

Minor natural enemies

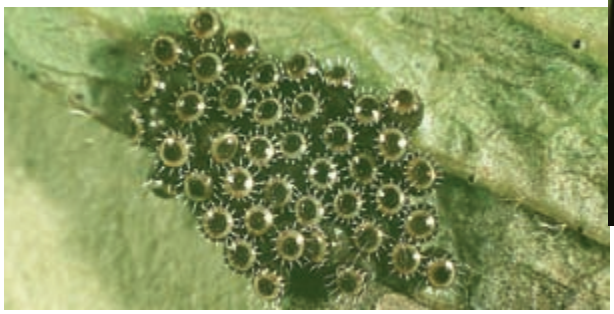
There is a range of minor beneficials belonging to various groups including *Heteropelma*, hover flies, assassin bugs, predatory shield bugs, brown earwigs and pollen beetles (red and blue beetles). Pollen beetles are quite common in southern NSW.

Minor natural enemies

Two-toned caterpillar parasite (*Heteropelma scaposum*)

Red and blue pollen beetle (*Dicranolaius bellulus*)

Common brown earwig (*Labidura truncata*)attacking moth pupa



Spined predatory shield bug (*Oechalia schellenbergii*) adult attacking a caterpillar (above); shield bug egg raft (left)

Assassin bug (*Pristhesancus plagipennis*) nymph (left). Adult assassin bug attacking a heliothis grub (right)

Index

Index