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GROWNOTES™

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TIPS & TACTICS

CEREAL CYST NEMATODE

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Rotations and resistant varieties vital for controlling cereal cyst nematode (CCN)

The threat from cereal cyst nematode (CCN), *Heterodera avenae*, still exists, despite resistant cereal varieties and non-host crop rotations controlling this pest in the past. It is important that growers remain vigilant.

The first signs of CCN infection usually become apparent at early tillering, especially in late sown crops, appearing as patches of stunted yellow plants (Figure 3, page 2). Patches may vary in size from one to hundreds of metres in diameter. Symptoms can be confused with severe nutrient deficiency so inspecting roots for damage is important.

Wheat and barley roots will be 'knotted' (Figure 1 and Figure 2). Oat roots appear 'ropey' and swollen and symptoms may be confused with herbicide damage. Root systems in severely affected plants will be retarded and shallow.

Figure 1. To confirm the presence of CCN, growers should inspect the roots of affected plants. Carefully dig them up (using a spade) and wash them free of soil. Effects from CCN will be apparent: A: Knotting of wheat roots B: Thickened oat roots. (Photos: Hugh Wallwork, SARDI)

KEY POINTS

- Be aware of the risk of cereal cyst nematode (CCN) and monitor paddocks if growing susceptible varieties.
- CCN affects wheat, barley, oat and triticale and can cause yield losses >70% in intolerant varieties.
- CCN is most widely distributed in sandy and clay soils in South Australia and Victoria. It is not regarded as a pest in Queensland nor most of New South Wales but is a problem in some parts of southern NSW and Western Australia.
- Check current cereal disease guides to determine the resistance rating of varieties (see state government websites and National Varieties Trial Online.
- CCN can be identified in spring when the cysts become visible on the roots of affected plants.
- Have your agronomist test paddocks before choosing varieties.
- If you have been growing susceptible cereals, make sure you rotate crops and remain vigilant.
- Once a crop is affected, very little can be done to protect that crop.
- If you had CCN this season, sow a resistant variety or non-host crop next season.

P Level 4 | 4 National Circuit, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604
T +61 2 6166 4500 F +61 2 6166 4599 E grdc@grdc.com.au

Figure 2. CCN-infected root system (left) and healthy root system (right). (Photo: Agriculture Victoria)

Figure 3. CCN patches in wheat. (Photo: Grant Chennells, SARDI)

The CCN life cycle

Nematodes survive from one season to the next in roots and soil as eggs inside protective cysts (Figures 4, 5, 6). Each brown cyst contains approximately 200 to 300 eggs.

During autumn, the cysts hatch following cold temperatures (below 15°C), stimulus from root exudates and moisture in the soil. Hatching over several weeks, the peak hatch occurs about six weeks after the autumn break. Each year only 70–80% of eggs will hatch, regardless of conditions, leaving some in reserve for the next year. These remaining eggs will infect a future host crop if planted.

After hatching, the nematode sets up a fixed feeding site within the plant root, where it completes its life cycle.

Female nematodes remain feeding in the root and gradually swell in the process of producing eggs. The female nematode retains the eggs in its body and, after swelling immensely in size, bursts through the root to attach on the outside surface of the root.

As spring approaches, the female, full of eggs, will now be visible to the naked eye and will be about the size of a pinhead (Figure 5).

The female nematode dies as the crop ripens and forms into a hardened, brown cyst with the eggs inside (Figure 6). Cysts are approximately 1 mm in diameter and remain in the soil until the next season, when the cycle begins again. Cereal cyst nematodes, unlike root lesion nematodes, have only one generation per year.

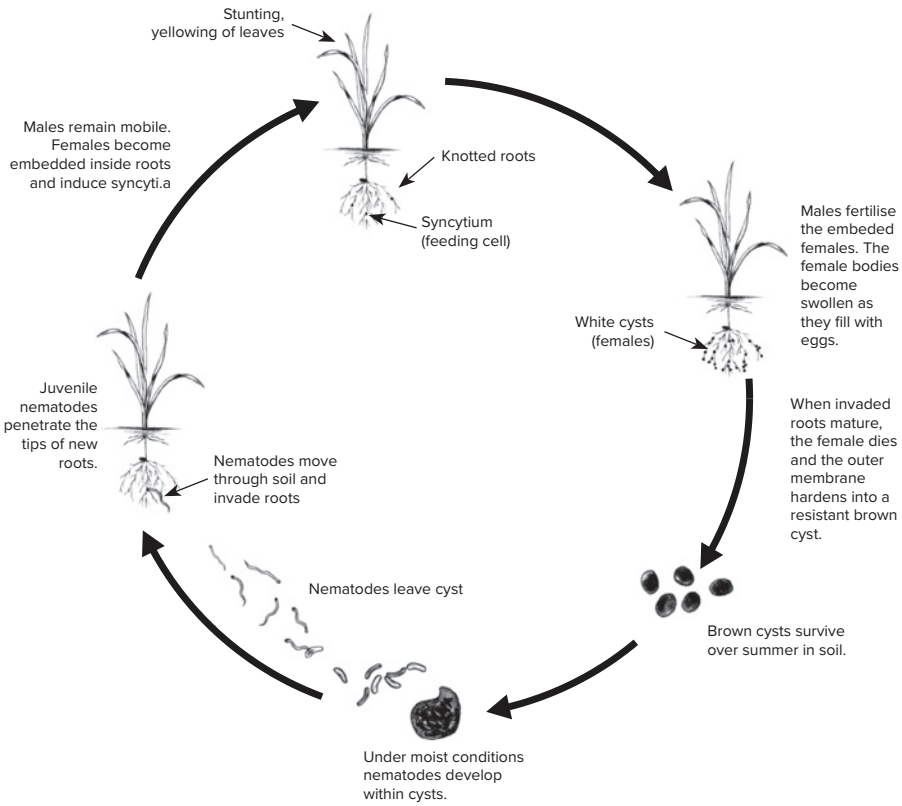

Figure 4. Cereal cyst nematode disease cycle. (Adapted from Kylie Fowler)

Management of CCN risks

Assess CCN risk using a PreDicta B™ test in autumn

All growers, but particularly those planting CCN-susceptible cereals, should monitor CCN numbers in their paddock using a PreDicta B™ soil test, which can be conducted by accredited agronomists. The test also detects a range of other important soil-borne diseases. The test allows growers to identify which paddocks have low/below detection CCN numbers and can therefore be safely planted to a CCN-susceptible cereal. See more information about this test in Box: 'More about PreDicta B™'.

Assess CCN risk using plant or soil samples during the season

In WA, growers can submit samples of affected plants in paddocks expressing suspected CCN symptoms for testing through the DAFWA Diagnostic Laboratory Services (DDLS): Plant pathology service (formerly AGWEST Plant Laboratories).

Control CCN through choosing resistant varieties and break crops

CCN control is achieved by avoiding or minimising susceptible cereal crops and grass weeds within the rotation. If CCN is detected in a paddock, a two-year break is required before growing a susceptible cereal.

Good disease breaks for CCN include:

- grass-free pulse crops, oilseed crops and legume pastures
- resistant cereals
- chemical fallow to remove susceptible hosts before nematodes have produced viable eggs.

Fortunately, there are many wheat, barley, oat and triticale varieties now available that are resistant to CCN. Cereal disease guides and state sowing guides (see Useful Resources section) provide CCN resistance ratings for most of the current cereal cultivars. Varieties that are resistant will reduce nematode densities and provide a suitable break to CCN, as long as the crop is free of grass weeds. In contrast, cereal cultivars rated as susceptible will increase CCN numbers within a paddock, which may cause yield loss to following cereal crops (Figure 8).

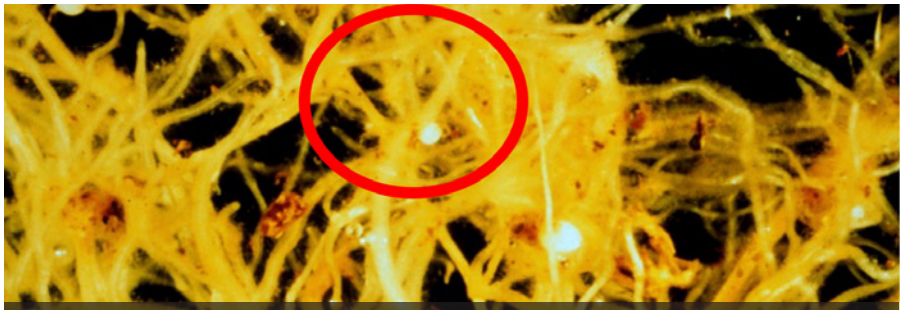

Figure 5. Characteristic 'white females' circled in red on washed wheat roots. (Photo: Agriculture Victoria)

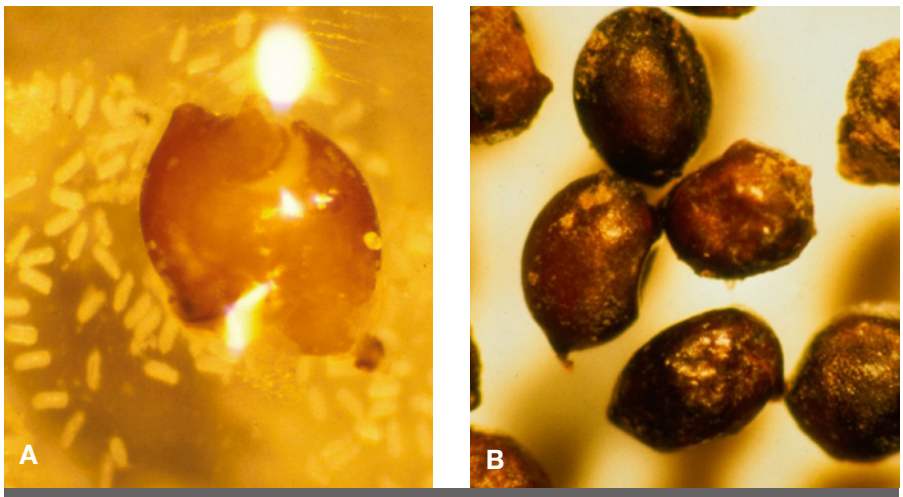

Figure 6. A: CCN eggs from artificially ruptured brown cyst, B: Brown CCN cysts carry the nematode over the summer. (Photos: A: SARDI, B: Agriculture Victoria)

MORE ABOUT PREDICTA B™

PreDicta B™ is a DNA-based soil test (Figure 7) that detects levels of a range of cereal pathogens, including CCN:

- It is available to growers from accredited agronomists only. Agronomists need to be trained through the South Australian Research and Development Institute (SARDI).
- The test identifies the level of risk for CCN and other soil-borne pathogens prior to sowing. However, the test requires a dedicated sampling strategy and is not a simple add-on to a soil nutrition test.
- Results are available within two weeks of testing.
- Accredited agronomists should consult SARDI for the latest recommended, region-specific sampling strategy. As a general rule, sampling should include:
  - » soil cores from the previous winter cereal rows, if possible
  - » short pieces of stubble (1 or 2 from each PreDicta B™ soil sampling location) from previous winter cereal crops and/or grass weed residues (while stubble is not required to detect CCN it can help to detect other diseases like crown rot).

More information on PreDicta B™

Figure 7. PreDicta B™ soil test kit.

Control grass weeds

Timely removal of grass weed hosts, which include wild oats and CCN-susceptible cereals in break crops and pastures, is important for CCN control. Host plants must be removed before the nematodes have developed eggs. This is approximately 10 weeks after the autumn break. The timing of host removal is critical when establishing a disease break.

In calculating the critical date to chemically fallow or remove host species from break crops, growers should consider how long it will take for host plants to die after being treated with herbicide. Nematodes will continue to feed and reproduce until the plant is dead.

Avoid cultivation

Cultivating the soil exacerbates CCN damage because it spreads cysts and hatched nematodes in the direction of cultivation. The widespread adoption of no-till farming systems, and sowing between the rows of the last cereal crop, has played a role in reducing losses from CCN.

CCN AND YIELD LOSS

CCN, also known as eel worm, was the most damaging disease of cereal crops in South Australia and Victoria during the 1970s and 1980s. Yield losses of more than 50% in crops were common. During the 1990s, CCN was controlled following the widespread adoption of CCN-resistant cereal varieties and rotations with grass-free, non-host crops.

Resistant crops prevent nematodes multiplying and therefore decrease nematode numbers, whereas susceptible crops allow nematodes to multiply. (Read more about resistance and tolerance on page 5.)

While CCN is generally well-controlled, risks of CCN infestation can increase where susceptible cereals are grown in close rotations, resulting in significant yield losses (Figure 8). In paddocks with a high CCN risk, yield losses of up to 70% may occur in wheat and even greater losses may occur in oats.

CCN damage plants when they penetrate into the roots and form 'feeding cells' that direct nutrients from the plants to the nematodes. The resulting root damage causes reduced crop yields.

The extent of yield loss from CCN is related to the number of nematodes in the soil and this is influenced by:

- The frequency of CCN-susceptible cereals in the rotation; susceptible crops allow nematodes to multiply.
- Prevalence of grass weeds, particularly susceptible cereals and/or wild oats, in break crops. One wild oat or susceptible cereal per square metre is enough to maintain high nematode numbers in the soil. Ryegrass, brome and barley grass are poor hosts, and therefore lower risk.
- Soil type and distribution; CCN prefers sand to sandy loam soil and well-structured clay soil and it is not present in hard-setting red soils. It is most widely distributed in sandy and clay soils in South Australia and Victoria. It is not regarded as a pest in Queensland or most of New South Wales but is a problem in restricted areas in Western Australia.

In addition to the number of nematodes present at planting, the extent of yield loss is also influenced by how tolerant the variety is to CCN and seasonal conditions.

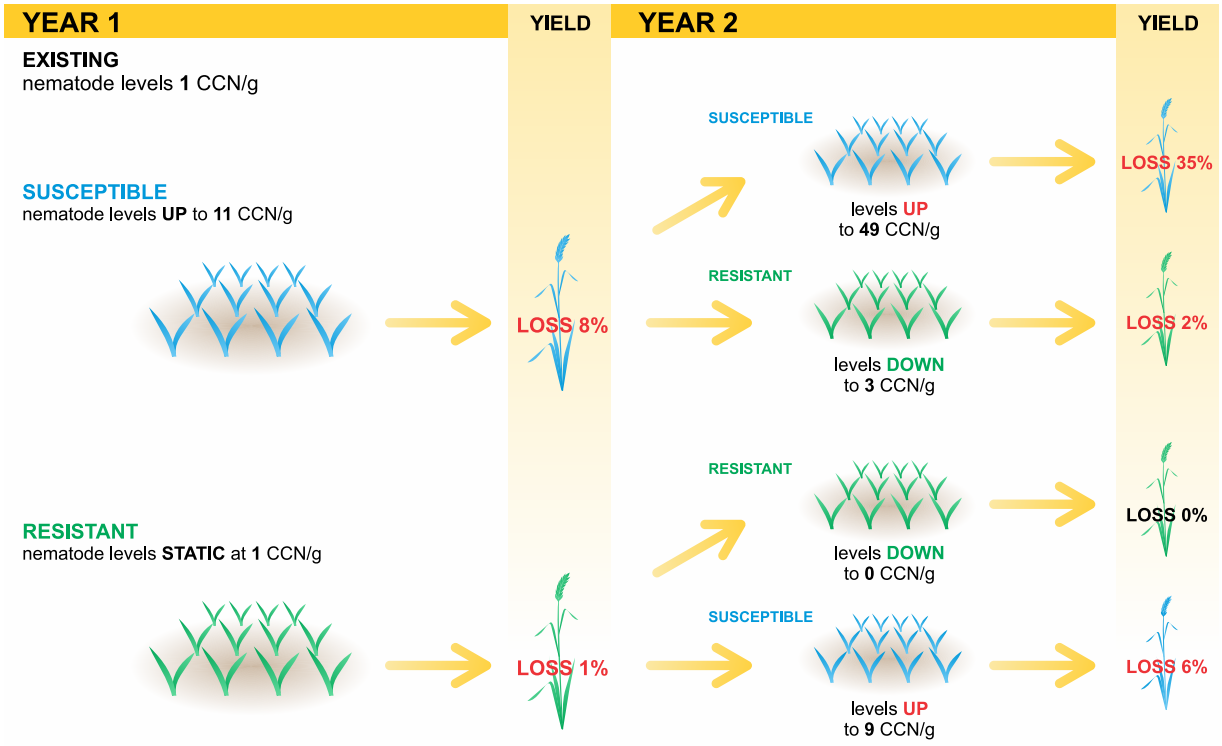

Figure 8. The effect of resistant and susceptible varieties on CCN number (CCN/g of soil), PreDicta B™ risk and associated yield loss. Different resistant and susceptible varieties were sown into multiple plots in year 1. In year 2, a susceptible was sown onto a year 1 resistant and year 1 susceptible plot and a resistant variety was also sown into a year 1 resistant and a year 2 susceptible plot. (Source: Agriculture Victoria)

Resistance and tolerance explained

Cereal varieties can differ in both their resistance/susceptibility and tolerance/intolerance to nematodes (Figure 9).

The mechanisms of resistance and tolerance are different and therefore they need to be considered differently when making cropping decisions.

Resistance/susceptibility refers to the effect the crop variety will have on reproduction of the nematodes. Planting resistant crops decreases nematode numbers, while planting susceptible crops increases nematode numbers.

Tolerance/intolerance refers to the effect nematodes have on the yield of the current crop. An intolerant crop yields poorly when attacked, whereas a tolerant crop yields well in the presence of nematodes.

Interactions between resistance/susceptibility and tolerance/intolerance

A tolerant but susceptible variety will increase nematode numbers in the crop and paddock without yielding poorly.

An intolerant but resistant variety will decrease nematode numbers but will yield poorly, if infected.

Figure 9. Four combinations of CCN resistance and tolerance ratings of crops. Tolerance/intolerance = the effect on the yield of the current crop, Resistance/susceptibility = the effect on nematode numbers and the carryover to next year's crop. (Source: Adapted from Kylie Fowler)

FAQs

Is CCN likely to be a major problem in Australian farming again?

Yes. The widespread adoption of resistant cereal varieties and non-host rotations has significantly reduced the problem. However, if susceptible varieties are grown in continuous rotation, CCN numbers could easily increase again in areas suitable for the nematode. It is important that growers remain vigilant.

What do I need to do to determine if I have a CCN problem in my paddock?

CCN can be visually identified on the roots of affected cereal crops from early spring (flowering). The most definitive ways to test for CCN presence are to: a) send a plant or soil sample to a regional diagnostic laboratory or b) have an accredited agronomist collect a soil sample for a PreDicta B™ test.

Are all future varieties likely to be bred with resistance or is this something I actively need to check for?

New varieties have a range of resistances to different diseases, and not all will be resistant to CCN. It is therefore important to check the resistance ratings of new varieties.

USEFUL RESOURCES

Agriculture Victoria (2016) Cereal Root Diseases

DAFWA (2016) Root diseases and nematodes

DAFWA (2015) Diagnosing cereal cyst nematode

Cereal disease guides

The National Variety Trials website (image below) provides crop summaries including disease ratings for varieties. Current disease ratings for all crops are also available in the Crop Disease Au app (available in the App Store and Google Play).

Victoria:

Western Australia

South Australia

New South Wales

Queensland

MORE INFORMATION

Joshua Fanning
Root Disease Pathologist
Agriculture Victoria
03 5362 2111
joshua.fanning@ecodev.vic.gov.au

Sarah Collins
Senior Nematologist
Department of Agriculture WA
08 9368 3612
sarah.collins@agric.wa.gov.au

Alan Mckay
Senior Research Scientist
and Program leader
South Australia RDI
08 8303 9375
alan.mckay@sa.gov.au

Luise Sigel
Extension Plant Pathologist
Agriculture Victoria
03 5362 2111
luise.sigel@ecodev.vic.gov.au

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