NORTHERN
SEPTEMBER 2018

GRDC GROWNOTES™

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

CANOLA

SECTION 1

PLANNING AND PADDOCK PREPARATION

PADDOCK SELECTION | PADDOCK ROTATIONS AND HISTORY | FALLOW WEED CONTROL | HERBICIDE PLANT-BACK PERIODS | SEEDBED REQUIREMENTS | SOIL MOISTURE | YIELD AND TARGETS | POTENTIAL DISEASE PROBLEMS | NEMATODE STATUS OF PADDOCK

Planning/Paddock preparation

1.1 Paddock selection

In addition to early preparation and good crop management, success with canola cropping depends on careful paddock selection. The major considerations when selecting a paddock to grow canola in rotation with other crops are:

- soil type
- potential disease problems
- previous herbicide use
- broadleaf weeds.

Choosing more reliable and weed-free paddocks is the best option (Figure 1). It is desirable to soil test prior to sowing the crop and to continue to manage broadleaf and grass weeds prior to sowing. In the northern region growers need to soil test later the previous winter as nitrogen readings will change due to summer microbial breakdown and leaching.

When considering the rotation using crops such as wheat or barley prior to sowing canola will allow for increased broadleaf control through more herbicide options and increased crop competition. If a pulse is the prior crop, consider the use of herbicide-resistant varieties to manage broadleaf weeds. Well thought out weed control can have significant benefits, especially where problem weeds are difficult to control in canola. [1]

Many growers are now growing canola to actually control weeds not able to be controlled in wheat. This is through use of Round Up ready or TT varieties.

Figure 1: *Choosing more reliable and weed-free paddocks is the best option for canola.*

1 P Parker (2009) Crop rotation and paddock selection. Ch. 4. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

MORE INFORMATION

Climate and Soils

1.1.1 Soil types

Canola is adapted to a wide range of soil types. Whilst sandy soils can grow canola successfully particularly in areas with winter dominant rainfall, canola is best adapted to red-brown earths and clay soils. These soils generally have higher organic matter and inherent fertility. Canola has a high requirement for Nitrogen that will need to be met by fertiliser application in soils of lower fertility. Canola will perform best on neutral to alkaline soils, with good tilth. Paddocks with a uniform soil type will permit more even sowing depth and seedling emergence and more even crop ripening.

Avoid growing canola where the following problems occur.

Hardpans

Although canola is a tap-rooted plant, it is not strong enough to penetrate some tight hardpans and can still suffer from 'J' rooting problems. Paddocks should be checked 12 months in advance by using a soil probe or by digging a small pit to visually assess a suspected problem and determine the depth of working or ripping that may be required to break up any hardpan.

Crusting soils

The surface of a soil can crust after rainfall and reduce plant establishment if it is poorly structured with low organic matter levels, or a sodic clay that disperses after wetting. The use of gypsum and/or stubble retention on hardsetting sodic clay soils may improve seedling emergence and early growth.

Acid soils

Canola is more susceptible to low pH and aluminium (Al) toxicity than most other crops. If you expect the $pHCaCl_2$ to be <5.0, have the prospective canola paddock soil-tested in the previous winter. If acidic subsoil is suspected, take split samples of soil depths 0–10 and 10–20 cm. Where a $pHCaCl_2$ <4.7 is combined with exchangeable Al level of ≥3%, do not grow canola before obtaining specific advice. Other indicators of acidity problems are poor growth in barley and lucerne, or if oats and triticale grow better than wheat. Consider using lime when the topsoil $pHCaCl_2$ drops to <5.0.

MORE INFORMATION

Canola best practice management guide for south-eastern Australia

Sodic subsoils

Soils with a sodic clay subsoil of low permeability become waterlogged when rainfall exceeds their infiltration capacity. A sodic subsoil problem can be identified by a simple soil testing procedure (dispersion test) backed up by laboratory chemical analysis. Avoid these soils unless they have a good depth of well-drained topsoil, which allows for adequate root growth even after heavy rainfall. Use of raised beds has been a successful strategy for reducing the impact of waterlogging in high-rainfall areas of south-western Victoria and Western Australia. [2]

1.2 Paddock rotations and history

Optimising crop sequence is critical to maximising system efficiency and sustainability however there is no 'one crop sequence' fits all when it comes to profitable farming. [3 4]

2 P Parker (2009) Crop rotation and paddock selection. Ch. 4. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

3 L Bell, J Whish, A Zull, P DeVoil, D Thornby (2016) High performance crop sequences for Southern Queensland. GRDC Update Papers 22 June 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/06/High-performance-crop-sequences-for-Southern-Queensland

4 T Somes (2016) Right crop sequence critical for farm sustainability. GRDC E-Newsletter 27 July 2016, https://grdc.com.au/Media-Centre/GRDC-E-Newsletters/Paddock-Practices/Right-crop-sequence-critical-for-farm-sustainability

MORE INFORMATION

GRDC Update Paper: Likely fit of summer and winter forage crop options in Central West farming systems

MORE INFORMATION

Choosing rotation crops—north

Canola—northern NSW planting guide

Over the bar with better canola agronomy

Canola best practice management guide for south-eastern Australia

Crown rot in winter cereals

MORE INFORMATION

Melina Miles QDAF discusses Rutherglen bug. GRDC Radio (Northern Update) 106: Safe seed storage strategy

Canola can reduce but not eliminate the incidence of some cereal root and crown diseases, such as crown rot and take-all. Research has shown canola to be the most effective winter crop for reducing levels of crown rot in subsequent wheat crops. [5]

Canola and lupins are two species that are not dependent on arbuscular mycorrhizal fungi (AMF) but also do not host the fungi. As a consequence, AMF levels after canola may be low and be of similar impact as a long fallow. [6] This may disadvantage subsequent crops that are highly dependent on AMF, particularly if environmental conditions and progressive fallows have also reduced AMF levels. Crops with a reliance on AMF include all commonly grown summer crops (sorghum, cotton, maize, sunflowers and the summer pulses) as well as faba beans and chickpeas.

Wheat, barley and oats have a lower dependence on AMF, and any reduction can be counteracted through additional phosphate fertiliser application. Because canola reduces AMF levels the same way as long fallows, it should be grown with short (about 6 months) fallows before and after.

Research has shown that wheat yield increases of ~0.6–1.0 t/ha can be expected when following canola compared with following wheat.

No-tillage, which retains more stubble, is increasing the carryover of many of the main cereal diseases, such as crown rot, in NSW. Canola fits well into this system by allowing an additional season for cereal stubble breakdown to occur, therefore reducing the carryover of disease.

Trials in the northern region have indicated that faba beans and canola are better break crops for crown rot than chickpeas. [7]

Canola should not be included in the rotation more frequently than one in every four years. This reduces the potential for canola disease build-up and also allows for rotation of herbicide and weed control tactics. The use of triazine-tolerant (TT), imadozoline-tolerant (IT) and roundup ready (RR) canola systems can also be used strategically for hard to control weeds.

When planning cropping systems on the farm consider placement of future crops in relation to potential insect pest host crops. Rutherglen bugs may be present in large numbers on canola stubble around harvest time. These can readily move into neighbouring summer crops or crops planted directly into the canola stubble, causing serious damage. [8]

Crop choice, more than crop sequence, remains a key element when evaluating how growers reduce their risk of root lesion nematode numbers in the paddock. Resistant winter crops, such as canola, are required to reduce risks in winter-dominated sequences. [9] [10]

1.2.1 Canola as a break crop

Results from experimentation undertaken in southern NSW between 2011 and 2013 have shown that canola and legume break crops can frequently be as profitable, and in a number of instances considerably more profitable, than wheat. Canola was consistently the most profitable break crop. However, legumes provide additional rotational benefits for subsequent crops by increasing soil N supply.

5 L Serafin, J Holland, R Bambach, D McCaffery (2005) Canola: northern NSW planting guide. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0016/148300/canola-northern-NSW-planting-guide.pdf

6 A Mitchell, B Burton, R Daniel (2016) Sorghum following canola – Is there an issue? GRDC Update Papers 21 July 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/07/Is-there-an-issue-with-sorghum-following-canola

7 S Simpfendorfer (2016) Crown rot an update on latest research. GRDC Update Papers 24 July 2015, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/07/Crown-rot-an-update-on-latest-research

8 L Serafin, J Holland, R Bambach, D McCaffery (2005) Canola: northern NSW planting guide. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0016/148300/canola-northern-NSW-planting-guide.pdf

9 L Bell, J Whish, A Zull, P DeVoil, D Thornby (2016) High performance crop sequences for Southern Queensland. GRDC Update Papers 22 June 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/06/High-performance-crop-sequences-for-Southern-Queensland

10 T Somes (2016) Right crop sequence critical for farm sustainability. GRDC E-Newsletter 27 July 2016, https://grdc.com.au/Media-Centre/GRDC-E-Newsletters/Paddock-Practices/Right-crop-sequence-critical-for-farm-sustainability

Wheat following break crops was consistently more profitable than wheat on wheat. Sequences with canola were largely profitable due to the high returns from canola itself. Crop sequences involving legumes can be profitable due to increased wheat yields and lower costs of production. [11]

1.3 Fallow weed control

Fallow management is important in all parts of NSW and Queensland. Whether winter- or summer-dominant rainfall the management of weeds throughout the summer has been found to directly add value to the next crop. This is achieved through the storage of moisture, particularly in soils with some clay content, but also by avoiding situations where weeds are tying up nutrients, hosting insect pests, or providing a green bridge for disease.

Weeds can affect crop yield either through direct competition or possibly as hosts for pathogens such as *Sclerotinia*. In particular, for canola, a number of *Brassica* weeds can cause significant problems.

Growers should be aware of the following important *Brassica* weeds when selecting a paddock for canola:

- charlock (*Sinapis arvensis*)
- wild radish (*Raphanus raphanistrum*)
- wild or Mediterranean turnip (*Brassica tournefortii*)
- wild cabbage or hare's ear (*Conringia orientalis*).

Each of these weeds has a seed size similar to canola and they cannot be easily removed from canola grain samples. Because they contain ~50 times more erucic acid in the oil and ~10 times more glucosinolates in the seed than found in canola, any contamination could result in the crop being rejected at delivery because of the impact on oil and meal quality.

Other problem *Brassica* weeds have smaller seed than canola and they are usually removed during harvesting. These include shepherd's purse (*Capsella bursa-pastoris*), turnip weed (*Rapistrum rugosum*), musk weed (*Myagrum perfoliatum*) and the mustards (*Sisymbrium* spp.). These weeds reduce yield through competition; for example, shepherd's purse may be a problem weed of canola grown after a pasture phase.

If sowing canola into paddocks where any of these *Brassica* weeds are present, select an appropriate, herbicide-resistant variety. Growing TT, Clearfield® or Roundup Ready® canola allows problem broadleaf weeds to be managed. However, eradicating problem weeds or reducing their seed populations prior to sowing is preferable. [12]

Paddocks usually have multiple weed species present at one time, making weed-control decisions more difficult and often involving a compromise after assessment of the prevalence of key weed species. Knowledge of your paddock and controlling weeds as early as possible are important for good control of fallow weeds. Information is included for the most common problem weeds; however, for advice on individual paddocks, contact your agronomist.

Benefits of fallow weed control are significant:

- Conservation of summer rain and fallow moisture, which can include moisture stored from last winter or the summer before in a long fallow, is integral to winter cropping in the northern region, particularly as the climate moves towards summer-dominant rainfall.

The GRDC funded Northern Grower Alliance (NGA) is trialing methods to control summer grasses. Key findings include:

MORE INFORMATION

GRDC Update Paper: Herbicide residues in soils – are they an issue? (Northern)

MORE INFORMATION

Canola volunteer control guide

MORE INFORMATION

GRDC Integrated Weed Management Manual

Summer fallow spraying

11 T Swan, L Goward, J Hunt & M Peoples, T Pratt (2015) Impact of crop rotations on profit, nitrogen and ryegrass seed bank in crop sequences in southern NSW. GRDC Update Papers 28 July 2015, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/07/Impact-of-crop-rotations-on-profit-nitrogen-and-ryegrass-seed-bank-in-crop-sequences-in-southern-NSW

12 P Parker (2009) Crop rotation and paddock selection. Ch. 4. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

1. Glyphosate-resistant and -tolerant weeds are a major threat to reduced tillage cropping systems.
2. Although residual herbicides will limit re-cropping options and will not provide complete control, they are a key part of successful fallow management.
3. Double-knock herbicide strategies (sequential application of two different weed-control tactics) are useful but the herbicide choices and optimal timings will vary with weed species.
4. Other weed-management tactics can be incorporated, for example crop competition, to assist herbicide control.
5. Cultivation may need to be considered as a salvage option to avoid seedbank salvage.

Double-knock strategies

Double-knock refers to the sequential application of two different weed-control tactics applied in such a way that the second tactic controls any survivors of the first. Most commonly used for pre-sowing weed control, this concept can also be applied in-crop. [13]

Consider the species present, interval timing and water rate. For information on double-knock tactics, download the GRDC Herbicide Application Fact Sheet: Effective double knock herbicide applications northern region.

Double-knock herbicide strategies are useful for managing difficult-to-control weeds but there is no 'one size fits all' treatment.

The interval between double-knock applications is a major management issue for growers and contractors. Shorter intervals can be consistently used for weeds where herbicides appear to be translocated rapidly (e.g. awnless barnyard grass, ABYG) or when growing conditions are very favourable. Longer intervals are needed for weeds where translocation appears slower (e.g. fleabane, feathertop Rhodes grass and windmill grass).

Critical factors for successful double-knock approaches are for the first application to be on small weeds and to ensure good coverage and adequate water volumes, particularly when using products containing paraquat. Double-knock strategies are not fail-proof and rarely effective for salvage weed-control situations unless environmental conditions are exceptionally favourable.

Important weeds in northern cropping systems

Weed management, particularly in reduced tillage fallows, has become an increasingly complex and expensive part of cropping in the northern grains region. Heavy reliance on glyphosate has selected for species that were naturally more glyphosate-tolerant or has selected for glyphosate-resistant populations.

13 C Borger, V Stewart, A Storrie. Double knockdown or 'double knock'. Department of Agriculture and Food Western Australia.

Awnless barnyard grass

Figure 2: *Awnless barnyard grass.*

Photo: Rachel Bowman

Awnless barnyard grass (Figure 2) has been a key summer grass problem for many years. It is a difficult weed to manage for at least three main reasons:

1. Multiple emergence flushes (cohorts) each season
2. Easily moisture-stressed, leading to inconsistent knockdown control
3. Glyphosate-resistant populations increasingly being found

Key points

- Glyphosate resistance is widespread. Tactics against this weed must change from glyphosate alone.
- Utilise residual chemistry wherever possible and aim to control 'escapes' with camera spray technology.
- Try to ensure that a double-knock of glyphosate followed by paraquat is used on one of the larger early-summer flushes of ABYG.
- Restrict Group A herbicides to management of ABYG in-crop and aim for strong crop competition.

Resistance levels

Prior to summer 2011–12, there were 21 cases of glyphosate-resistant ABYG. Collaborative surveys were conducted by NSW Department of Primary Industries (DPI), Department of Agriculture, Fisheries and Forestry Queensland (QDAF) and NGA in summer 2011–12, with a targeted follow-up in 2012–13. Agronomists from the Liverpool Plains to the Darling Downs and west to areas including Mungindi collected ABYG samples, which were tested at the Tamworth Agricultural Institute with Glyphosate CT at 1.6 L/ha (a.i. 450 g/L) at a mid-tillering growth stage. Total application volume was 100 L/ha.

The main finding from this survey work was that the number of 'confirmed' glyphosate-resistant ABYG populations had nearly trebled. Selected populations were also evaluated in a separate glyphosate rate-response trial. The experiment showed that some of these populations were suppressed only when sprayed with 12.8 L/ha.

Growers can no longer rely on glyphosate alone for ABYG control.

Residual herbicides (fallow and in-crop)

Several active ingredients are registered for use in summer crops, e.g. metolachlor (e.g. Dual Gold®) and atrazine, or fallow, e.g. imazapic (e.g. Flame®), and these provide useful management of ABYG. The new fallow registration of isoxaflutole (Balance®) can provide useful suppression of ABYG, but this herbicide has stronger activity against other problem weed species. Few (if any) residuals give consistent, complete control. However, they are important tools that need to be considered to reduce the weed population exposed to knockdown herbicides, as well as to alternate the herbicide chemistry being employed. Use of residuals together with camera spray technology (for escapes) can be a very effective strategy in fallow.

Double-knock control

This approach uses two different tactics applied sequentially. In reduced-tillage situations, it is frequently glyphosate applied first, followed by a paraquat-based spray as the second application or 'knock'. Trials to date have shown that glyphosate followed by paraquat gives effective control, even on glyphosate-resistant ABYG. Note that the most effective results will be achieved from paraquat-based sprays by using higher total application volumes (100 L/ha) and finer spray quality and by targeting seedling weeds.

Several Group A herbicides, e.g. Verdict® and Select®, are effective on ABYG but should be used in registered summer crops such as mungbeans. Even on glyphosate-resistant ABYG, a double-knock of glyphosate followed by paraquat is an effective tool. In the same situations, there has been little benefit from a Group A followed by paraquat application. Note that Group A herbicides appear more sensitive to ABYG moisture stress. Application on larger, mature weeds can result in very poor efficacy.

Timing of the paraquat application for ABYG control has generally proven flexible. The most consistent control is obtained from a delay of ~3–5 days, when lower rates of paraquat can also be used. Longer delays may be warranted when ABYG is still emerging at the first application timing; shorter intervals are generally required when weed size is larger or moisture-stress conditions are expected. High levels of control can still be obtained with larger weeds but paraquat rates will need to be increased to 2.0 or 2.4 L/ha.

Flaxleaf fleabane

Figure 3: *Flaxleaf fleabane.*

Photo: QDAF

There are three main species of fleabane in Australia: *Conyza bonariensis* (flaxleaf fleabane; Figure 3), *C. canadensis* (Canadian fleabane) and *C. albida* (tall fleabane). There are two varieties of *C. canadensis*: var. *canadensis* and var. *pusilla*. Of the three species, flaxleaf fleabane is the most common across Australia. [14]

For more than a decade, flaxleaf fleabane has been the major weed-management issue in the northern cropping region, particularly in reduced-tillage systems. Fleabane is a wind-borne, surface-germinating weed that thrives in situations of low competition. Germination flushes typically occur in autumn and spring when surface-soil moisture levels stay high for a few days. However, emergence can occur at nearly all times of the year.

An important issue with fleabane is that knockdown control of large plants in the summer fallow is variable and can be expensive due to reduced control rates.

Key points

- Utilise residual chemistry wherever possible and aim to control 'escapes' with camera spray technology.
- This weed thrives in situations of low competition; avoid wide row cropping unless effective residual herbicides are included.
- 2,4-D is a crucial tool for consistent double-knock control.
- Successful growers have increased their focus on fleabane management in winter (crop or fallow) to avoid expensive and variable salvage control in the summer.

Resistance levels

Glyphosate resistance has been confirmed in fleabane. There is great variability in the response of fleabane to glyphosate with many samples from non-cropping areas still well controlled by glyphosate, whereas fleabane from reduced-tillage cropping situations shows increased levels of resistance. The most recent survey has focused on non-cropping situations, with a large number of resistant populations found on

14 M Widderick, H Wu. Fleabane. Department of Agriculture and Food Western Australia.

MORE INFORMATION

Australian glyphosate resistance register: summary

roadsides and railway lines where glyphosate alone has been the principal weed-management tool employed.

Residual herbicides (fallow and in-crop)

One of the most effective strategies to manage fleabane is the use of residual herbicides during fallow or in-crop. Trials have consistently shown good efficacy from a range of residual herbicides commonly used in sorghum, cotton, chickpeas and winter cereals. There are now at least two registrations for residual fleabane management in fallow.

Additional product registrations for in-crop knockdown and residual herbicide use, particularly in winter cereals, are being sought. A range of commonly used winter cereal herbicides exists with useful knockdown and residual fleabane activity. Trials to date have indicated that increasing water volumes from 50 to 100 L/ha may improve the consistency of residual control, with application timing to ensure good herbicide–soil contact also important.

Knockdown herbicides (fallow and in-crop)

Group I herbicides have been the major products for fallow management of fleabane, with 2,4-D amine the most consistent herbicide evaluated. Despite glyphosate alone generally giving poor control of fleabane, trials have consistently shown a benefit from tank mixing 2,4-D amine and glyphosate in the first application. Amicide® Advance at 0.65–1.1 L/ha mixed with Roundup® Attack at a minimum of 1.15 L/ha and then followed by Nuquat® at 1.6–2.0 L/ha is a registered option for fleabane knockdown in fallow. Sharpen® is a product with Group G mode of action. It is registered for fallow control when mixed with Roundup® Attack at a minimum of 1.15 L/ha but only on fleabane up to a maximum stage of six leaves.

For more information on label rates, visit: Australian Pesticides and Veterinary Medicines Authority.

Double-knock control

MORE INFORMATION

Flaxleaf fleabane—a weed best management guide

Integrated Weed Management of Feathertop Rhodes Grass 2014

The most consistent and effective double-knock control of fleabane has included 2,4-D in the first application followed by paraquat as the second. Glyphosate alone followed by paraquat will result in high levels of leaf desiccation but plants will nearly always recover.

Timing of the second application in fleabane is generally aimed at ~7–14 days after the first application. However, the interval to the second knock appears quite flexible. Increased efficacy is obtained when fleabane is actively growing or if rosette stages can be targeted. Although complete control can be obtained in some situations (e.g. summer 2012–13), control levels will frequently reach only ~70–80%, particularly when targeting large, flowering fleabane under moisture-stressed conditions. The high cost of fallow double-knock approaches and inconsistency in control level of large, mature plants are good reasons to focus on proactive fleabane management at other growth stages.

Feathertop Rhodes grass

Figure 4: *Feathertop Rhodes grass.*

Photo: Rachel Bowman

Feathertop Rhodes grass (Figure 4) has emerged as an important weed-management issue in southern Queensland and northern NSW since ~2008. This is another small-seeded weed species that germinates on, or close to, the soil surface. It has rapid early growth rates and can become moisture-stressed quickly. Although FTR is well established in central Queensland, it remains largely an 'emerging' threat further south. Patches should be aggressively treated to avoid whole-of-paddock blowouts.

Key points

- Glyphosate alone or glyphosate followed by paraquat has generally poor efficacy.
- Utilise residual chemistry wherever possible and aim to control 'escapes' with camera spray technology.
- A double-knock of Verdict® followed by paraquat can be used in Queensland prior to planting mungbeans where large spring flushes of FTR occur.
- Treat patches aggressively, even with cultivation, to avoid paddock blowouts.

Residual herbicides (fallow and in-crop)

This weed is generally poorly controlled by glyphosate alone, even when sprayed under favourable conditions at the seedling stage. Trials have shown that residual herbicides generally provide the most effective control, a similar pattern to that seen with fleabane. Currently registered residual herbicides are being screened and offer promise for both fallow and in-crop situations. The only product currently registered for FTR control is Balance® (isoxaflutole) at 100 g/ha for fallow use.

Double-knock control

Although a double-knock of glyphosate followed by paraquat is an effective strategy on ABYG, the same approach is variable and generally disappointing for FTR management. By contrast, a small number of Group A herbicides (all members of the 'fop' class) can be effective against FTR but need to be managed within a number of constraints:

- Although they can provide high levels of efficacy on fresh and seedling FTR, they need to be followed by a paraquat double-knock to get consistent, high levels of final control.
- Group A herbicides have a high risk of resistance selection, again requiring follow-up with paraquat.
- Many Group A herbicides have plant-back restrictions to cereal crops.

- Group A herbicides are generally successful at a narrower range of weed growth stages than herbicides such as glyphosate; that is, Group A herbicides will generally give unsatisfactory results on flowering and/or moisture-stressed FTR.
- Not all Group A herbicides are effective on FTR.

For information on a permit (PER12941) issued for Queensland only for the control of FTR in summer fallow situations prior to planting mungbeans, see: Australian Pesticides and Veterinary Medicines Authority.

Timing of the second application for FTR is still being refined, but application at ~7–14 days generally provides the most consistent control. Application of paraquat at shorter intervals can be successful, when the Group A herbicide is translocated rapidly through the plant, but has resulted in more variable control in field trials. Good control can often be obtained up to 21 days after the initial application.

Windmill grass

Figure 5: *Windmill grass.*

Photo: Maurie Street

Whereas FTR has been a grass-weed threat coming from Queensland and moving south, windmill grass is more of a problem in central NSW but is spreading north. Windmill grass (Figure 5) is a perennial, native species found throughout northern NSW and southern Queensland. The main cropping threat appears to be from the selection of glyphosate-resistant populations, with control of the tussock stage providing greatest management challenges.

Key points

- Glyphosate alone or glyphosate followed by paraquat has generally poor efficacy.
- Preliminary data suggest that residual chemistry may provide some benefit.
- A double-knock of quizalofop-p-ethyl (e.g. Targa®) followed by paraquat can be used in NSW.

Resistance levels

Glyphosate resistance has been confirmed in windmill grass with three documented cases in NSW, all located west of Dubbo. Glyphosate-resistant populations of windmill grass in other states have all been collected from roadsides, but in Central West NSW, two were from fallow paddock situations.

Residual herbicides (fallow and in-crop)

Preliminary trials have shown a range of residual herbicides with useful levels of efficacy against windmill grass. These herbicides have potential for both fallow and in-crop situations. Currently, there are no products registered for residual control of windmill grass.

Double-knock control

Similar to FTR, a double-knock of a Group A herbicide followed by paraquat has provided clear benefits compared with the disappointing results usually achieved by glyphosate followed by paraquat. Constraints apply to double-knock for windmill grass control similar to those for FTR.

For information on a permit for NSW only for the control of windmill grass in summer fallow situations, visit: Australian Pesticides and Veterinary Medicines Authority.

Timing of the second application for windmill grass is still being refined, but application at ~7–14 days generally provides the most consistent control. Application of paraquat at shorter intervals can be successful, when the Group A herbicide is translocated rapidly through the plant, but has resulted in more variable control in field trials and has been clearly antagonistic when the interval is ≤1 day. Good control can often be obtained up to 21 days after the initial application. [15]

MORE INFORMATION

Herbicide resistance in summer grasses

1.4 Herbicide plant-back periods

Canola is particularly susceptible to a range of residual herbicides. Under dry seasonal conditions or in alkaline soils, residues from a herbicide applied to a previous pulse or cereal crop can persist into the next cropping season. For example, the sulfonylurea group (e.g. chlorsulfuron, sulfosulfuron) used in cereal crops have a canola plant-back period of 24–30 months. Similarly, some herbicides registered in pulse crops can have plant-back periods ranging from 9 months (simazine) to 24 months (flumetsulam) to 34 months (imazethapyr). The use of these herbicides can therefore restrict crop options and prevent the sowing of canola for up to 3 years. The use of various herbicide-tolerant (TT or Clearfield®) canola varieties coupled with their companion herbicides (triazines or Group B herbicides) can restrict crop-selection options in the following year. Plant-back periods are provided on herbicide labels for sensitive crops under these conditions. [16]

Plant-back periods do not begin until there has been a significant rainfall event.

Plant-back periods are the obligatory times between the herbicide spraying date and safe planting date of a subsequent crop.

Soil behaviour of pre-emergent herbicides in Australian farming systems: a reference manual for agronomic advisers

Some herbicides have a long residual. The residual is not the same as the half-life. Although the amount of chemical in the soil may break down rapidly to half the original amount, what remains can persist for long periods, as is the case for sulfonylureas (chlorsulfuron) (see Table 1). Herbicides with long residuals can affect subsequent crops, especially if they are effective at low levels of active ingredient, such as the sulfonylureas. On labels, this will be shown by plant-back periods, which are usually listed under a separate heading or under 'Protection of crops etc.' in the 'General Instructions' section of the label. [17]

MORE INFORMATION

Ground Cover Radio 122: Northern region extension

15 R Daniel (2013) Weeds and resistance—considerations for awnless barnyard grass, *Chloris* spp. and fleabane management. Northern Grower Alliance, http://www.nga.org.au/module/documents/download/225

16 P Parker (2009) Crop rotation and paddock selection. Ch. 4. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

17 B Haskins (2012) Using pre-emergent herbicides in conservation farming systems. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/431247/Using-pre-emergent-herbicides-in-conservation-farming-systems.pdf

Table 1: *Residual persistence of common pre-emergent herbicides, and noted residual persistence in broadacre trials and from paddock experience.* [18]

Herbicide	Half-life (days)	Residual persistence and prolonged weed control
Logran® (triasulfuron)	19	High. Persists longer in high pH soils. Weed control commonly drops off within 6 weeks
Glean® (chlorsulfuron)	28–42	High. Persists longer in high pH soils. Weed control longer than triasulfuron
Diuron	90 (range 1 month–1 year, depending on rate)	High. Weed control will drop off within 6 weeks, depending on rate. Has had observed, long-lasting activity on grass weeds such as black/stink grass (*Eragrostis* spp.) and to a lesser extent broadleaf weeds such as fleabane
Atrazine	60–100, up to 1 year if dry	High. Has had observed, long-lasting (>3 months) activity on broadleaf weeds such as fleabane
Simazine	60 (range 28–149)	Medium–high. 1 year residual in high pH soils. Has had observed, long-lasting (>3 months) activity on broadleaf weeds such as fleabane
Terbyne® (terbuthylazine)	6.5–139	High. Has had observed, long-lasting (>6 months) activity on broadleaf weeds such as fleabane and sow thistle
Triflur® × (trifluralin)	57–126	High. 6–8 months residual. Higher rates longer. Has had observed, long-lasting activity on grass weeds such as black/ stink grass (*Eragrostis* spp.)
Stomp® (pendimethalin)	40	Medium. 3–4 months residual
Avadex® Xtra (triallate)	56–77	Medium. 3–4 months residual
Balance® (isoxaflutole)	1.3 (metabolite 11.5)	High. Reactivates after each rainfall event. Has had observed, long-lasting (> 6 months) activity on broadleaf weeds such as fleabane and sow thistle
Boxer Gold® (prosulfocarb)	12–49	Medium. Typically quicker to break down than trifluralin, but tends to reactivate after each rainfall event
Sakura® (pyroxasulfone)	10–35	High. Typically quicker breakdown than trifluralin and prosulfocarb; however, weed control persists longer than with prosulfocarb

Sources: CDS Tomlinson (Ed.) (2009) The pesticide manual (15th edn), British Crop Protection Council; Extoxnet, http://extoxnet.orst.edu/; California Department of Pesticide Regulation Environmental Fate Reviews, www.cdpr.ca.gov/

1.5 Seedbed requirements

Seed–soil contact, especially under dry conditions, is crucial for helping moisture to diffuse into the canola seed (Figure 6). Emergence of canola seedlings can be reduced by the formation of soil crusts in hardsetting, sodic or dispersing soils. Sodic or dispersing soils that surface-seal will reduce the emergence of canola seedlings.

A firm, moist seedbed provides uniform seed germination and rapid seedling growth. Adequate soil moisture at the seedling and elongation stages promotes the

MORE INFORMATION

Australian Pesticides and Veterinary Medicines Authority

Using pre-emergent herbicides in conservation farming systems

Weed control in winter crops 2016

Sulfonylurea spray contamination damage to canola crops

18 B Haskins (2012) Using pre-emergent herbicides in conservation farming systems. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/431247/Using-pre-emergent-herbicides-in-conservation-farming-systems.pdf

development of a strong, healthy plant less prone to lodging and with maximum leaf growth by the end of July. [19]

Figure 6: *The hard canola seed needs good seed–soil contact to germinate.*

1.6 Soil moisture

Soil moisture is vital for both germination and emergence. Canola must absorb a high percentage of its weight in water before germination begins. It will germinate when the seed moisture content has risen to approximately 24%.

Water absorption is a passive process. The ability of seeds to absorb water depends on the difference in water potential between the seed and the surrounding soil. Seeds can absorb water even at very low soil-water potentials, but low water potentials may induce secondary dormancy.

Seed size influences the rate of water absorption. Small seeds have a high surface-to-volume ratio, which means that less time is required to absorb adequate moisture for germination.

In soils with a low moisture content, the germination rate will be lower and emergence slower (Table 2).

Table 2: *Effect of soil moisture content on final emergence percentage and days to 50% emergence.*

Total soil water content (% weight)	Final emergence percentage	Days to 50% emergence
18	82	9
15	59	12
13	45	13
11	4	–

Source: Modified from Canola Council of Canada (2003)

The trial was established in a growth chamber at constant day–night temperatures of 8.5°C–10°C. In summary:

- The higher the total soil water content, the higher the final germination percentage.
- The higher the soil water content, the quicker the time to 50% seedling emergence. [20]

MORE INFORMATION

Canola best practice management guide for south-eastern Australia

Lifting productivity in retained stubble systems

MORE INFORMATION

SoilWaterApp – a new tool to measure and monitor soil water

GRDC Update Paper: Commonly asked questions about soil water and soil management

19 J Edwards, K Hertel (2011) Canola growth and development. PROCROP Series. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/516181/Procrop-canola-growth-and-development.pdf

20 J Edwards, K Hertel (2011) Canola growth and development. PROCROP Series. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/516181/Procrop-canola-growth-and-development.pdf

Water is essential for plant growth. Adequate soil moisture:

- promotes root growth
- promotes a large, abundant leaf area
- helps plants to retain their leaves longer
- lengthens the flowering period
- increases the numbers of branches per plant, flowers forming pods and seeds per pod
- increases seed weight and seed yield.

Moisture stress is more important during podfill than at the vegetative stage. However, too much or too little water at any growth stage reduces yield potential. Factors that may limit yield include:

- the amount of moisture stored in the soil over summer
- the rate and duration and timing of rainfall during the growing season
- the ability of the soil to absorb water, store it, and make it available for plants.

Modifying some of these factors can improve moisture availability and efficiency of water use.

When soil water and nutrients are abundant, the balance of root to stem and leaf growth typically shifts in favour of stem growth at the expense of roots. When water is limited, the opposite usually occurs. Roots account for ~25% of plant dry matter at stem elongation in moisture-stressed canola, compared with ~20% in unstressed plants.

1.6.1 Moisture stress during rosette formation and elongation

Canola has limited ability to withstand severe drought. To avoid dehydration, the plant closes its stomata and rapidly sheds leaves.

Moisture stress during the early vegetative stages reduces the ability of stomata to conduct carbon dioxide and therefore slows photosynthesis. This in turn reduces leaf area expansion and dry matter production. It also limits root growth, which reduces nutrient uptake. More severe water deficits inhibit photosynthesis because of cell and chloroplast shrinkage.

This is important in seasons with dry winters. It is also important in low-rainfall areas where the period of crop growth is restricted at the start of the season by lack of rainfall and at the end of the season by water deficits and high temperatures.

Plants under early-season moisture stress will usually recover normal growth with subsequent rainfall or irrigation. Stressed plants are able to recover leaf area, form flowers, set pods and fill seeds when water becomes available, but with hastened development rates, crops have early maturity and lower yields. The worst time for drought stress in canola is during stem elongation or flowering.

Long periods of drought will reduce yields more than frequent, short periods of drought. The impact will be greatest on coarse-textured soils and shallow soils with low water-storage capacity.

Adequate soil moisture tends to lengthen the number of days to maturity by up to 10 days. Additional soil moisture will result in no further increase in yield and may cause yield reductions through poor soil aeration and/or increased lodging and diseases. [21]

MORE INFORMATION

[How spring planted canola can work in a graze and grain system]

[Yield of wheat and canola in the high rainfall zone of south-western Australia in years with and without a transient perched water table]

21 J Edwards, K Hertel (2011) Canola growth and development. PROCROP Series. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/516181/Procrop-canola-growth-and-development.pdf

1.7 Yield and targets

Average canola yields in NSW vary over a range of around 1 t/ha in the drier regions but up to 3–4 t/ha in the more favourable growing areas or on irrigation. Canola has traditionally yielded approximately half of what wheat would yield in the same situation. Said another way it achieves only half the Water Use Efficiency of that of wheat (kg of grain per mm of water available).

With improved varieties, agronomy and management of the crop many farmers are now targeting 60–70% of typical wheat yields.

As discussed in Section 2, varieties vary in yield performances. However, several generalisations can be made:

- TT varieties will often perform less well than conventional, Clearfield or Roundup Ready varieties as there is a fitness penalty integral to breeding herbicide tolerance. This is often referred to as yield drag and quoted as up to 15% compared to conventional varieties. However some agronomists believe this is over-estimated in some regions and it must be remembered that the TT tolerance allows control of weeds that could otherwise not be controlled. TT varieties often have less seedling vigour which can hinder establishment and this can have ramifications through to harvest.
- Hybrid varieties generally have higher yield potential than open pollinated varieties. This is achieved through the hybridization process, enabling coupling of strong and desirable traits from the parent varieties. Many breeding or seed companies are also investing greater effort into hybrid varieties as gains are easier and quicker to achieve as well in ensures seed sales each year.
- GMO varieties, specifically Round Up Ready or glyphosate-tolerant varieties, promise improved yield potential and performance but at present these varieties are achieving only average performance, not withstanding weed management benefits.

In setting yield targets or expectations, growers also need to take into account sowing date, seasonal conditions (particularly rainfall and fallow moisture) and disease and pests. In southern regions Blackleg, and more sporadically Sclerotina, can impact heavily on crop performance but the northern region does not seem to experience the same level of disease particularly Blackleg so this should not in many cases be too much of a yield barrier.

1.7.1 Seasonal outlook

The NSW DPI provides a seasonal outlook to assist grain growers. The Seasonal Conditions and Climate Change Summary e-newsletter will let you know as soon as the monthly report is published. Subscribe now.

1.7.2 Fallow moisture efficiency

Like wheat, canola will benefit from stored subsoil moisture, particularly in marginal cropping areas where winter and spring rainfall is unreliable. Manage fallows efficiently to maximise the amount of moisture at sowing. [22]

Key points

- While ~20% of rain is stored during fallows, small changes in soil management can improve this apparent low efficiency and have large impacts on profit.
- Water stored can be improved through longer fallow, weed control, soil cover and reduced compaction. This can be achieved through reduced tillage, controlled traffic and planting crops before the soil fills.
- Stubble retention combined with reduced or zero tillage almost universally results in better water storage.

22 L Jenkins (2009) Crop establishment. Ch. 5. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

MORE INFORMATION

NSW climate summary

Seasonal crop outlook—wheat

Grain marketing—wheat, canola and barley outlook

Agribusiness Outlook 2015

Canola agronomy research in central NSW

Irrigated canola - Management for high yields

Growing hybrid canola

MORE INFORMATION

Ground Cover Radio 117: Ground Cover Supplement - incrop canola management

Ground Cover Radio 121: Future of OP canola hinges on grower support

GRDC Update Paper: Irrigation cropping - can we afford the water?

GRDC Update Paper: Irrigated cropping project results

GRDC Update Paper: The irrigated cereal and canola project update

GRDC Update Paper: Achieving 10 t ha of irrigated wheat and 4 t ha of irrigated canola in the Murrumbidgee Valley region

MORE INFORMATION

GRDC Update paper: Pushing the production barriers

GRDC Update paper: Finely irrigated wheat, canola and faba beans systems results 2014

GRDC Update Paper: Understanding & managing N loss pathways

- Better water storage results in better yields, especially in dry years.
- Soil water and N mineralisation can be tracked using a number of decision support tools (e.g. Australian CliMate, Soil Water App, Yield Prophet). [23]

1.7.3 Nitrogen- and Water Use Efficiency

Nitrogen fertiliser can increase the Water Use Efficiency (WUE) of early-sown canola. The additional N enables the crop to cover the ground quicker and develop a dense leaf canopy, resulting in reduced soil evaporation and better WUE. [24]

Nitrogen fertiliser is one of the most significant input costs for northern grain growers, so understandably growers want to minimise applied nitrogen losses through better management to maximise return on investment.

Key points

- Nitrogen is a mobile nutrient and can be lost downwards (leaching), sidewards (erosion) and upwards (gas emissions).
- To reduce losses avoid unnecessarily high nitrogen rates.
- Delay or split nitrogen fertiliser application so that peak nitrogen availability coincides with peak crop demand.
- Using legumes in crop rotations will also reduce nitrogen losses. [25]

1.7.4 Estimating maximum yield per unit water use by location and nitrogen

Researchers propose a three-step procedure to derive the 'slope' parameter representing maximum yield per unit water use accounting for N and location.

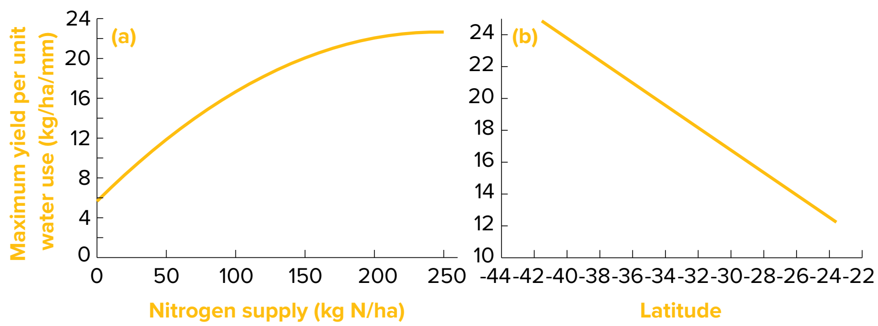

Figure 7: *Maximum yield per unit water use (kg/ha.mm) as a function of (a) nitrogen and (b) location.*

Step 1

Use the data in Figure 7*a* to account for the effect of N on maximum yield per unit water use. For severely limited crops (N supply <50 kg N/ha), maximum yield per unit water use would be about 5–6 kg grain/ha.mm. For crops with abundant N supply (>200 kg N/ha), the parameter approaches 24 kg grain/ha.mm. For intermediate N supply, maximum yield per unit water use can be estimated graphically using this curve.

23 D Freebairn (2016) Improving fallow efficiency. GRDC Update Papers 23 February 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/Improving-fallow-efficiency

24 P Hocking, R Norton, A Good (1999) Crop nutrition. Australian Oilseeds Federation, http://www.australianoilseeds.com/__data/assets/pdf_file/0013/2704/Chapter_4_-_Canola_Nutrition.pdf

25 T Somes (2016) Lost nitrogen and what you can do. Ground Cover Issue 123, July–August 2016, https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-123-JulyAugust-2016/Lost-nitrogen-and-what-you-can-do

Step 2

Use the line in Figure 7*b* to correct for location. For a latitude of –41.5° (Launceston, the southernmost location in this study), maximum yield per unit water use would be ~24–25 kg grain/ha.mm. For a latitude of –23.5° (Emerald, the northernmost location), maximum yield per unit water use would be ~12 kg grain/ha.mm. For intermediate locations, maximum yield per unit water supply can be estimated graphically using the line in Figure 6*b*.

Step 3

Select the lowest value from steps 1 and 2. For example, if we want to estimate the maximum yield per unit water use for Dalby (latitude –27.1°) with intermediate N supply (100 kg N/ha), the location correction would return 14.7 kg/ha.mm and the N correction would return 16.6 kg/ha.mm. We therefore select the lowest value, 14.7 kg/ha.mm, as a benchmark for this combination of location and N supply. [26]

Table 3: *Water Use Efficiency based on total biomass (WUEdm) or grain yield (WUEgy) of different crops.*

Crop	Region	WUEdm	WUEgy	Source
		(kg/ha.mm)		
Canola	Victoria	24.0 (17.1–28.4)	6.8 (4.7–8.9)	Norton and Wachsmann 2006
Canola*	NSW		13.4	Robertson and Kierkegaard 2005
Chickpeas	Western Australia	16.0 (11.1–18.3)	6.2 (2.6–7.7)	Siddique et al. 2001
Lentils		12.7 8.5–16.7)	6.7 (2.4–8.5)	
Lupins		17.3 (9.3–22.3)	5.1 (2.3–8.3)	
Faba beans		24.2 (18.7–29.6)	10.4 (7.7–12.5)	
Peas		26.2 (17.6–38.7)	10.5 (6.0–15.9)	
Vetch		18.2 (13.4–22.4)	7.5 (5.6–9.6)	
Chickpeas	Tel Hadya, Syria	13.7 (9.4–18.1)	3.2 (2.1–5.2)	Zhang et al. 2000
Lentils		8.7 (5.0–14.2)	3.8 (1.9–5.5)	
Wheat	South Australia	36.1 (21.2–53.1)	15.9 (9.2–23.2)	Sadras et al. (unpublished)
	South-east Australia		9.9 (max =22.5)	Sadras and Angus 2006

Water Use Efficiency is based on the biomass or yield per mm of crop water use. Values are mean and range.

There are intrinsic differences in the WUE of crops (Table 3), with wheat more water-use efficient than grain legumes or canola, in terms of both total biomass production and grain yield. Differences in the composition of the grain—it is more energy efficient to produce starch than oil or protein—partially explain the higher grain yield per unit water use of wheat compared with oilseed crops and pulses.

Further, canola and the grain legumes are grown at lower plant densities and/or have less vigorous seedlings than wheat, contributing to greater early losses of moisture

26 V Sadras, G McDonald (2012) Water Use Efficiency of grain crops in Australia: principles, benchmarks and management. GRDC Integrated Weed Management Hub, http://www.grdc.com.au/GRDC-Booklet-WUE

MORE INFORMATION

Water Use Efficiency of grain crops in Australia

Nitrogen and Water Use Efficiency of canola and mustard in South Australia

Nitrogen use efficiency in canola

Water Use Efficiency of canola in Victoria

through soil evaporation, and hence to lower WUE. The amount of winter growth made by the crop is therefore an important factor in determining crop WUE. [27]

1.8 Potential disease problems

Blackleg is the major disease of canola in Australia and can significantly reduce yields, especially in higher rainfall districts. Research has shown that 95–99% of blackleg spores originate from the previous year's canola stubble. Blackleg is found in crops in northern NSW but at a lower incidence due to the lower frequency of canola in the rotation and overall area grown.

Spores can travel >1 km on the wind but most travel shorter distances, so selecting a paddock as far away as possible from the previous season's canola stubble will help to reduce disease pressure. Where possible, a buffer distance of 500 m is recommended.

On larger farms, it may be possible to implement a system of block farming whereby blocks of several paddocks of a particular crop type are rotated around the farm to maintain an adequate buffer distance. Reducing canola stubble by raking and burning provides only limited benefits in reducing the disease level because not all of the infected stubble and old roots are destroyed.

Figure 8: *Sclerotinia is a major cause of canola stem rot.*

Photo: Cox Inall Communications

Use of blackleg-resistant varieties in combination with an appropriate fungicide treatment, if necessary, is the best way to minimise yield losses. Careful paddock selection can also assist in reducing the impact of another potentially serious canola disease, Sclerotinia stem rot (caused by *S. sclerotiorum*) (Figure 8).

Sclerotinia stem rot - Managing the disease in 2013

Sclerotinia stem rot is an intermittent problem in many canola-growing districts, particularly central and southern NSW. It has a wide host range of broadleaf plants and weeds, including lupins, chickpeas, field peas, faba beans, sunflowers, cape weed and Paterson's curse. Growing canola after any of these crops or in paddocks that have had large populations of these weeds can increase the risk of Sclerotinia stem rot, especially when canola is grown under irrigation or in higher rainfall areas. [28]

27 V Sadras, G McDonald (2012) Water Use Efficiency of grain crops in Australia: principles, benchmarks and management. GRDC Integrated Weed Management Hub, http://www.grdc.com.au/GRDC-Booklet-WUE

28 P Parker (2009) Crop rotation and paddock selection. Ch. 4. In Canola best practice management guide for south-eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf

Sclerotinia infection occurs when there is rainfall around petal drop but only when those petals have sclerotinia spores on them. Predicting infection is difficult but fungicides can be applied to combat the infection. The economic benefits of this approach in the northern region are questionable.

1.9 Nematode status of paddock

Canola has hosting ability of root-lesion nematodes of low–medium for *Pratylenchus thornei* and medium–high for *P. neglectus*.

Testing soil is the only reliable way to determine whether root-lesion nematodes are present in a paddock. Before planting, soil tests can be carried out by PreDicta B (SARDI Diagnostic Services) through accredited agronomists, to establish whether crops are at risk and whether alternative crop types or varieties should be grown. Growing-season tests can be carried out on affected plants and associated soil; contact local state departments of agriculture and PreDicta B. [29]

To organise testing and sending of soil samples, visit the PreDicta B website.

For testing and interpretation of results contact:

Rob Long, Crown Analytical Services
0437 996 678
crownanalytical@bigpond.com

For more information, see GrowNotes Section 8. Nematodes.

MORE INFORMATION

Variety choice and crop rotation key to managing root lesion nematodes

29 GRDC (2015) Root-lesion nematodes. GRDC Tips and Tactics, February 2015, http://www.grdc.com.au/TT-RootLesionNematodes