Managing blackleg of canola starts with knowing your enemy

By H Schreuder and D Mostert, Department of Plant Pathology, Faculty of AgriSciences, Stellenbosch University, and G van Coller, Directorate: Plant Sciences, Western Cape Department of Agriculture, Elsenburg

The South African canola industry has grown steadily over the past 25 years. After a record yield of over 2t/ha was achieved in 2020, the year 2021 stood out for both the highest area planted under canola (100 000ha) and the highest canola production (195 000 tons). With this came the need to address some of the challenges facing canola production.

Blackleg is the most damaging disease of canola, but little research has been done in this regard. Planting cultivars that provide resistance to blackleg is one of the most efficient ways to manage the disease. However, to make the best use of cultivar resistance, it is important to have information on the local pathogen population and to understand the life cycle of the blackleg pathogen.

This article will explain how knowledge on the pathogen population and life cycle link to cultivar resistance, and will also provide feedback on progress made in research, funded by the Oil and Protein Seeds Development Trust (OPDT), which commenced in 2021.

Crown canker caused by blackleg.

The basics of blackleg resistance

Resistance against blackleg is governed at a genetic level. Two types of resistance exist, namely single-gene (qualitative) and polygenic (quantitative) resistance. Little is known about polygenic resistance against blackleg. It cannot prevent infection but can reduce the severity of the crown and stem cankers that develop later in the season.

In contrast to this, single-gene resistance can prevent infections. Single-gene resistance is controlled by what is called the gene-for-gene concept. This means that for each gene that enables the pathogen to cause infection (known as an avirulence or avr gene), there is a corresponding gene (called a resistance or R-gene) in the host, which provides resistance against the avr gene.

For successful infection, the specific avr gene should be present in the pathogen while the corresponding R-gene should be absent in the host. If the corresponding R-gene is present, the host will be able to recognise the avr gene in the pathogen and stop infection.

In short, the blackleg pathogens (*Leptosphaeria maculans* and *Leptosphaeria biglobosa*) produce spores which encounter a canola plant, germinate and grow into the plant tissue, thereby causing infection. The first infections occur early in the season during the cotyledon to five-leaf stage. The pathogen grows from the initial infection sites on the cotyledons or young leaves into the developing stem, where it remains to cause the characteristic stem and crown cankers (*Photograph 1*) later in the season.

Because single-gene resistance can prevent these initial infections, it can prevent the development of damaging stem and crown cankers later in the season and limit yield loss. However, to utilise single-gene resistance against blackleg, it is necessary to know which avr genes are present in the local pathogen population. Cultivars with the corresponding R-genes can then be selected, which will limit early infections and reduce the number of cankers later on.

Genes and races

To date, 15 R-genes against blackleg have been detected in the *Brassica* family. These genes can occur in different combinations within a host and are based on the number of known gene-for-gene interactions. As an example, a study conducted in Canada determined that 170 races of *Leptosphaeria maculans* (*L. maculans)* occur in Manitoba alone.

A race is a group within the pathogen population that can only infect certain canola cultivars. Because of the large number of potential races, single-gene resistance in a cultivar can easily be overcome if cultivars with the same R-genes are successively planted on the same fields. Because R-genes only suppress pathogens with the correspondent avr genes, races without these specific avr genes can still infect the plant and will increase in numbers. This is known as selection pressure.

A cultivar trial was held at Uitkyk Farm, Riversdale, to assess the resistance of canola cultivars to blackleg under field conditions.

Over time, these races will become dominant, and since the host does not have the corresponding R-genes, these races will cause disease.

To prevent the pathogen from overcoming host resistance, cultivars from different resistance groups are planted in successive years which decreases selection pressure. However, for this practice to be successful, the pathogen populations must constantly be monitored to detect shifts in the race structure.

Information on the avr genes present in the pathogen population is then used to make recommendations to producers on which cultivars would be safe to plant the following season. To establish a similar practice in South Africa, information is needed on the avr genes present in the local pathogen populations. Unfortunately, the race structure of the blackleg pathogen populations in the Western Cape is currently unknown. To address this problem, one part of the blackleg research project which started in 2021 focusses on determining the race structure of the local pathogen population.

The first step to acquire this information was to obtain a pathogen isolate collection representative of all the canola production regions in the Western Cape. Isolate collection commenced in the 2020 season, and to date, 1 850 isolates have been obtained from infected leaf, crown and stem tissue. Isolates were collected in representative regions across the Western Cape, including fields in Eendekuil, Langgewens and Hopefield in the Swartland, and Napier, Swellendam and Riversdale in the Overberg and Southern Cape.

These isolates have all been identified as *L. maculans*, which is the most damaging of the two blackleg pathogens. No *L. biglobosa* has been found so far. Isolate collection will continue throughout 2022. Once a complete collection has been obtained, further testing will be done to aid decisions on cultivar choice.

Table 1: Resistance rating of cultivars evaluated in field trials in the Western Cape in 2021, with R-genes present and blackleg resistance grouping.

Cultivar	Blackleg resistance rating (without seed treatment)	R-genes present	Blackleg resistance group
Quartz	R	*Rlm1, Rlm4, LepR1*	ABD
43Y92	R-MR	*Rlm4*	B
Hyola 350TT	R	*Rlm1, Rlm4, Rlm6, LepR1*	ABDF
45Y93	R	*Rlm3, Rlm4*	BC
44Y90	R-MR	*Rlm4*	B
Hyola 559TT	R-MR	*Rlm1, Rlm4, LepR1*	ABD
45Y95	R-MR	Unknown	Unknown
Diamond	MR	*Rlm1, Rlm4, Rlm6*	ABF
Alpha TT	MS-MR	Unknown	Unknown
Blazer	R	*LepR1 (maybe also Rlm1)*	ADF
44Y94	R-MR	*Rlm3, Rlm4*	BC
Hyola 650TT	R	*Rlm1, Rlm4, LepR1*	ABD

R = resistant, MR = moderately resistant, MS = moderately susceptible.

Western Cape cultivar trials

The canola cultivars planted in South Africa are primarily imported from Australia. These cultivars have a resistance rating based on how they performed in blackleg resistance trials in Australia. The performance of a cultivar in such trials is dependent on the races of the pathogen present, as well as environmental conditions, and although South Africa has a similar climate to Australia, a cultivar which achieved a high resistance rating in the Australian trials will not necessarily perform the same in South Africa.

To assess the resistance of the commonly planted cultivars under local conditions, cultivar trials were conducted at Langgewens Research Farm (Moorreesburg), Tygerhoek Research Farm (Riviersonderend) and Uitkyk Farm (Riversdale) during 2021 (*Photograph 2*). Twelve cultivars were evaluated (*Table 1*).

Blackleg severity (percentage visible damage on a stem cross section) was the greatest at Langgewens (39%), followed by Riversdale (33%) and lastly Tygerhoek (19%). Due to heavy rains during the autumn of 2021, the trial at Tygerhoek had to be replanted in early June and, as a result, the plants did not develop optimally and could not be compared to the two other trials.

For the two other sites, some patterns were visible. Excluding 44Y90, all the other Clearfield® cultivars were in the top five. On the other end of the spectrum, Hyola 559TT had the highest blackleg severity in both trials. For the remainder of the cultivars, no clear relationship could be seen between the trials at Riversdale and those at Langgewens.

Cultivar resistance against blackleg cannot be utilised efficiently without knowing the race structure of the pathogen population. Studies like the one in progress can therefore contribute to better blackleg management. Apart from the work on cultivar resistance, fungicide trials are also in the pipeline, which will further provide information for an integrated approach to managing blackleg.

This project was funded by the Oil and Protein Seeds Development Trust. For more information, contact 011 234 3400 or visit *www.opot.co.za*.