



Anthracnose in Lentils: Managing Fungicide Insensitivity

April, 2023

Anthracnose is a fungal disease of lentils caused by the pathogen *Colletotrichum lentis*. The disease has the potential to infect all plant parts and can result in pre-mature leaf drop, yield loss, and even plant death when conditions favour disease development. Anthracnose is the most prevalent disease of lentils in Saskatchewan and was found in 74% and 92% of surveyed lentil fields in 2018 and 2019 respectively. At the end of the 2019 field season insensitivity to Group 11 strobilurin fungicides was confirmed in Saskatchewan. As we move to understand the levels of resistance across the province in baseline populations, it is important to understand the disease and integrated approaches for management.

Symptoms

Symptom development typically occurs at the 10-12 node stage or at early flower, with symptoms first occurring on lower leaflets and stems close to the soil surface. Symptoms will first appear as white to grey or cream coloured spots on leaflets and stems. Infected leaflets will wither and fall to the ground (premature leaf drop). Stem lesions will appear sunken, and tan to dark brown in colour with defined lesions. Pin-shaped black microsclerotia will often be present within the stem lesions (a characteristic symptom of Anthracnose). When environmental conditions favour disease development, lesions may progress up the canopy, coalesce and girdle the stem. When Anthracnose infection is severe, defoliation and stem girdling will restrict the plant's ability to access nutrients and water and may result in plant death.

Disease Cycle

The Anthracnose pathogen overwinters in fields as microsclerotia on infected crops residue. Initial infection occurs when the lower stems and leaves come into contact with infected crop residue and when environmental conditions favour disease development (frequent rain, high humidity, dense canopy, warm temperatures of 20-24°C, and a lot of leaf wetness). As a polycyclic disease (a plant disease that can increase in multiple cycles in one growing season), new spores (conidia) will be produced within each stem and leaf lesion. These spores will be spread upwards within the canopy and to neighboring plants via rain splash or wind-dispersed rain. As a result, the disease can spread quickly when pathogen levels are high and environmental conditions favour disease development.

Fungicide Insensitivity

Fungicide insensitivity refers to the reduced effectiveness of a specific fungicide on a pathogen (fungus). Pathologists prefer to use the term insensitivity to refer to the resistance of the pathogen to a fungicide since the term resistance is typically used to describe the resistance of a host plant to a particular pathogen.

Recently, high levels of insensitivity to Group 11 (strobilurin, QoI) fungicides in the Anthracnose pathogen were confirmed from Saskatchewan lentil fields. Testing to confirm this insensitivity detected a mutation (G143A) that enables the pathogen to have cross resistance to all Group 11 fungicides.

This means that no fungicide active ingredient within Group 11 will provide effective disease control in fields with high levels of insensitivity.

Preliminary results from a 2020 survey of commercial lentil fields across the province indicated that strobilurin insensitive strain(s) of anthracnose are more common in Saskatchewan than strobilurin sensitive strain(s). Producers are encouraged to make informed fungicide application decisions to reduce selection pressure, and manage Anthracnose through an integrated approach in order to improve disease management and reduce reliance on fungicides.

Minimizing the Risk of Developing Fungicide Insensitivity in Anthracnose of Lentils

The risk of developing fungicide insensitivity depends on many factors including the pathogen biology, the fungicide mode of action, and agronomic practices used for disease management. More information on fungicide insensitivity can be found in the article **Fungicide Insensitivity in Pulse Crops**. This information can be used to make informed disease management decisions to reduce the likelihood of fungicide insensitivity developing.

Using an integrated approach to disease management will help break disease cycles, improve disease management, and reduce the risk of fungicide insensitivity arising. Strategies for integrated Anthracnose disease management include:

- **Crop Rotation:** A four-year crop rotation with a three year break between lentil crops is recommended. This will allow the infected residue to decompose and reduce the amount of the pathogen present to cause infection the next time a lentil crop is grown.
- **Residue Management:** As a residue borne disease, harvest can be a time for spreading the disease. Practices that minimize spread, harvesting during high wind, waiting too long to harvest, and encourage quick breakdown of residue can help reduce spore loads for future years.
- **Resistant Varieties:** Some varieties of lentils are resistant to Anthracnose race Ct1 but all commercially available varieties are susceptible to race Ct0. Since race Ct0 is the predominant race in lentil growing regions of Western Canada, these Anthracnose resistant varieties will not provide effective disease resistance in Saskatchewan.

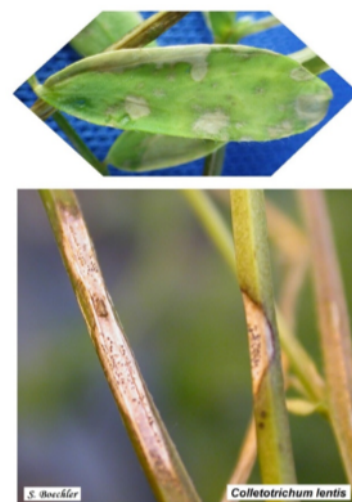


Figure 1. Anthracnose lesions on leaves (top) and sunken lesions showing microsclerotia on stems (bottom) of lentils.
Source: S. Boechler

- **Seed Quality:** Anthracnose is weakly transmitted from infected seed. However, a good seed source is still important for preventing introduction into new lentil fields. Lesions on the seed coat can also make the seed more susceptible to mechanical damage.
- **Scouting:** Monitoring fields and disease development throughout the growing season will help determine when fungicides are needed in order to suppress disease. Late season disease assessment is also the best way to determine if the management strategies used were effective in managing the disease, and can provide the first clues that fungicide insensitivity may exist within the pathogen population present.
- **Risk Assessment:** Fungicides should only be used when the risk of disease exists. The following fungicide risk assessment chart can be used to assess disease risk and guide informed fungicide application decisions. Disease in lentils is a major concern as Anthracnose can reduce both yield and seed quality. To help producers determine the need for fungicide control, a disease decision support checklist was developed (Table 1). It requires the crop to be inspected between the 10 node stage and early flowering. A risk value is then calculated based on the risk factors listed. If the risk value is less than 50, a fungicide application is not recommended, but a new assessment should be made at three-to-five day intervals until the crop is no longer flowering. When the risk value is 50 or above, a fungicide application is recommended.

Table 1. Risk Estimation for Predicting the Need for Fungicide Application in Lentils for Anthracnose

Factor	Risk Estimation					Scores					
						1	2	3	4	5	Average
Plant Stand	Thin (0)	Moderate (5)	Normal (10)	Dense (15)	-						
Rain in Last 14 Days	None (0)	1-2 days (5)	3-4 days (10)	5-6 days (15)	7+ days (20)						
5-Day Weather Forecast	Dry (0)	Unpredictable (10)	Showers (15)	Rain (20)	-						
Symptoms on Plant	None (0)	Few lesions on lower 1/2 up to 10% infected (5)	Lesions on lower 1/2 up to 25% infected (15)	Lesions + premature leaf drop (Anthracnose) (25)	Lesions at stem base (30)						
Score	<i>If 50 or more, then fungicide application recommended</i>										

Source: Developed by Lone Buchwaldt, Godfrey Chongo, and Bruce Gossen, with Agriculture and Agri-Food Canada.

Fungicides

Fungicides provide protection against disease development and need to be applied preventatively before major crop damage has occurred. Fungicides cannot cure disease damage but can protect healthy tissue from infection and reduce disease spread in the plant and crop canopy. To ensure the most effective disease control, it is important to select fungicides that are registered for the disease you are trying to manage, ensure optimum coverage, and follow all label instructions. Timing is extremely important as preventing infection is key. Once symptoms are visible the plant has already been infected and yield loss could occur. It is important to never cut fungicide rates. Reducing the rates of the fungicide may result in sub-lethal rates and will increase the selection for fungicide insensitivity.

For fungicides registered for lentils there are three main classes: Group 11 (quinone outside inhibitors (QoIs), also known as strobilurins); Group 7 (- succinate dehydrogenase inhibitors (SDHI); also known as carboxamides); and Group 3 (demethylation inhibitors (DMI); also known as triazoles). These three Groups work on preventing infection by direct effects on fungal spore germination and growth. Group 3 and 7 have single site modes of action and are at medium (Group 3) and medium to high (Group 7) risk of developing resistance. With Group 11 insensitivity in Anthracnose the application of Groups 3 + 11 or Groups 7 + 11 in single products puts high selective pressure on the Group 3 or 7 and therefore mixing these products with other modes of action is advised for good insensitivity management.

Some fungicides also have multi-site activity and are known more as having contact activity: Group M3 (dithiocarbamates) and Group M5 (chloronitriles). These multi-site fungicides are considered low risk for resistance developing in fungal pathogens and are good options for tank mixing with other actives or using in spray programs where multiple applications may be warranted.

Ensure Optimal Disease Control With Fungicides

- Ensure good coverage and canopy penetration
- Select a fungicide that is effective against the disease that you are trying to manage
- Follow suggested timing and all label instructions
- Do not cut rates or exceed the maximum number of applications per growing season

Estimating the Risk of Insensitivity in Existing Fields

It is difficult to determine whether a field may have Anthracnose that has developed insensitivity to Group 11 fungicides prior to the onset of disease when control measures should be initiated. Here are some factors to consider when evaluating the risk in individual fields:

- **Group 11 Strobilurin Fungicide Use:** Repeated use of Group 11 fungicides as the sole actives in lentils that are applied in individual years and across years increases the risk of insensitivity development. Utilizing good fungicide management strategies including rotating active ingredients that have activity on Anthracnose would reduce the risk
- **Anthracnose Severity:** If anthracnose has been an issue in the previous lentil fields nearby or within the field, and control measures involving Group 11 fungicides were implemented with minimal impact, then there could be insensitivity in the population

Managing Anthracnose in Fields with Confirmed or Suspected Group 11 Fungicide Insensitivity

With confirmed fungicide insensitivity in the pathogen population in a field, or if it is suspected, the Group 11 fungicides will not provide effective control of the disease and alternative modes of action should be considered. Managing the development of fungicide insensitivity also enforces the need to consider alternative modes of action in fungicide plans. The challenge is that activity of individual components of products on individual pathogens are not always known, and when actives are combined they can be more effective than the individual components. For recommendations to manage strobilurin insensitivity, Anthracnose labels were consulted and the products registered for use in lentil with labelled activity on Anthracnose are listed in Table 2 and broken out by fungicide group and divided into Sections according to the classifications listed.

Section A – Fungicides that contain only Group 11 fungicides. These will have no activity on insensitive Anthracnose. These products can still be used for management of other diseases but must be combined with fungicides with different modes of action with activity on Anthracnose.

Section B – These products do not contain Group 11 fungicides but are registered for activity on anthracnose and other diseases. These products are options for managing insensitive Anthracnose, especially when the single active products are combined with other fungicides for multiple modes of action.

Section C – Multiple mode of action fungicides that contain a Group 11 in combination with a Group 3 and/or Group 7. These products are great options for reducing the risk of developing fungicide resistance as the multiple modes of action can work together to increase disease control. With Anthracnose that is insensitive to Group 11 fungicides, the products are then relying on the non-Group 11 components for control. In most cases the non-Group 11 component is not registered for control of Anthracnose on its own and therefore use for managing insensitive populations may be limited. The exception is Elatus™ where the Group 7 active is labelled for control of Anthracnose. With Group 11 insensitive Anthracnose care should be taken to use these products in combination with other modes of action to reduce the selective pressure on the Group 3 or 7 to prevent multiple insensitivity from developing. Check with individual companies when considering the combination products from this group for managing insensitive Anthracnose.

Products with multiple modes of action on the same pathogen are recommended as a good strategy for insensitivity management. However, activity of individual actives on Anthracnose is not always known. In general, there is a need for a better understanding of product activity, even if only suppression, on insensitive Anthracnose to help manage these populations in the future.

The best recommendations on fungicide management under high risk situations, or where insensitive Anthracnose has been identified, are:

- Avoid applying Group 11 products by themselves; always mix with at least one other mode of action with activity on the pathogen
- Consider including fungicides that do not include a Group 11 component (mancozeb (M3) or chlorothalonil (M5) products), alone or in combination with other fungicides
- Use fungicides with multiple modes of action where more than one active contributes to Anthracnose control
- When moving from first to second application, use fungicides from alternative groups as much as possible
- Use fungicides according to their activity as preventative, curative, or strictly contact products

Table 2. Fungicides Registered for Activity on Anthracnose in Lentils. Activity on Group 11 insensitive Anthracnose indicated by colours (Red = no activity; Green = activity; Yellow = suppression)

Fungicide	Company	Non Group 11 Component Registered for Control of Anthracnose*	Active Ingredients	Groups	Group 3	Group 7	Group 11	Group M3	Group M5	PHI
A. GROUP 11 ONLY FUNGICIDES										
Acapela™	Corteva	NA	Picoxystrobin	11			x			14 days
Azoshy 250 SC	Sharda CropChem	NA	Azoxystrobin	11			x			15 days
Headline® EC	BASF	NA	Pyraclostrobin	11			x			30 days
Mpower Spade	New Agco	NA	Pyraclostrobin	11			x			30 days
Quadris®	Syngenta	NA	Azoxystrobin	11			x			15 days
B. NON GROUP 11 FUNGICIDES										
Cotegra™	BASF	CONTROL	Prothioconazole + Boscalid	3 + 7	x	x				21 days
Proline Gold™	Bayer CropScience	CONTROL	Prothioconazole + Fluopyram	3 + 7	x	x				21 days
Proline® 480 SC	Bayer CropScience	SUPPRESSION	Prothioconazole	3	x					7 days
Bravo 500 ZN®	Syngenta	CONTROL	Chlorothalonil	M5					x	48 days
Echo 720	UAP	CONTROL	Chlorothalonil	M5					x	48 days
Dithane™ Rainshield	Corteva	CONTROL	Mancozeb	M3				x		35 days
Manzate® Pro-stick	UPL	CONTROL	Mancozeb	M3				x		35 days
Manzate® Max	UPL	CONTROL	Mancozeb	M3				x		35 days

**Non Group 11 Component
Registered for Control of
Anthracnose***

Fungicide	Company	Non Group 11 Component Registered for Control of Anthracnose*	Active Ingredients	Groups	Group 3	Group 7	Group 11	Group M3	Group M5	PHI
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Pencozeb 75 DF®	UPL	CONTROL	Mancozeb	M3				x		35 days
C. COMBINATION GROUP 11 + OTHER ACTIVE FUNGICIDES										
Delaro 325 SC™	Bayer CropScience	SUPPRESSION	Prothioconazole + Trifloxystrobin	3 + 11	x		x			30 days
Dyax™	BASF	NOT ON LABEL	Fluxapyroxad + Pyraclostrobin	7 + 11		x	x			30 days
Elatus™	Syngenta	CONTROL	Benzovindiflupyr + Azoxystrobin	7 + 11		x	x			15 days
Fungtion	Sharda CropChem	NOT ON LABEL	Propiconazole + Azoxystrobin	3 + 11	x		x			30 days
Lance® AG	BASF	NOT ON LABEL	Boscalid + Pyraclostrobin	7 + 11		x	x			30 days
Miravis® Neo 300SE	Syngenta	NOT ON LABEL	Propiconazole + Pydiflumetofen + Azoxystrobin	3 + 7 + 11	x	x	x			30 days
Priaxor®	BASF	NOT ON LABEL	Fluxapyroxad + Pyraclostrobin	7 + 11		x	x			30 days
Quilt®	Syngenta	NOT ON LABEL	Propiconazole + Azoxystrobin	3 + 11	x		x			30 days

*Colours indicate whether anthracnose is on the label of individual actives (other than Group 11). Please consult label for recommended rates. Higher rates may be needed to achieve control for specific fungicide products.

Who to Contact if You Suspect Fungicide Insensitivity

The only way to confirm fungicide insensitivity in the field is through lab and/or greenhouse testing or DNA-based testing to detect the mutation that allows the pathogen to survive Group 11 fungicides. Currently this test is not commercially available, but may become available in the future.

If you suspect fungicide insensitivity, contact:

- Agriculture Knowledge Centre: 1-800-667-4442
- Dale Risula, Saskatchewan Ministry of Agriculture: dale.risula@gov.sk.ca or 306-787-4665
- Sarah Anderson, Saskatchewan Pulse Growers: sanderson@saskpulse.com or 306-381-6038
- Michelle Hubbard, Agriculture and Agri-Food Canada: michelle.hubbard@canada.ca or 306-772-0470