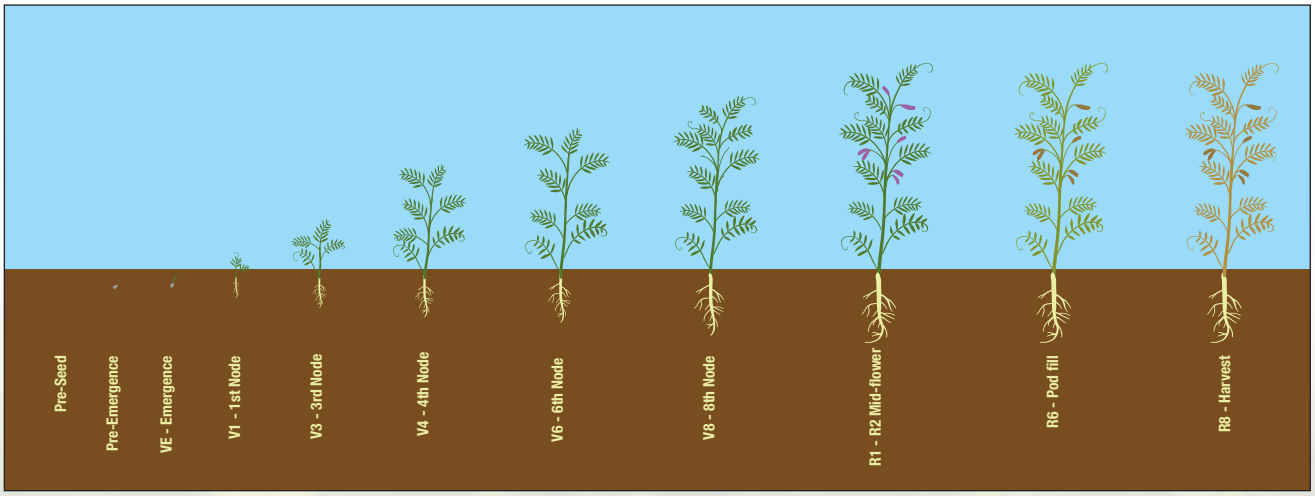
FMC An Agricultural Sciences Company

Lentil Production Manual

Your guide to growing lentils in Western Canada

Canada is the world's leading producer and exporter of lentils. Saskatchewan produces 95% of Canada's lentils with the balance grown mainly in Alberta. Up to 5 million acres of lentil has been grown in Saskatchewan as recently as 2016, but acreage has levelled off to around 4 million acres, according to Saskatchewan Ministry of Agriculture's 2021 Specialty Crop Report.[i]

Lentil staging guide



Lentil growth staging is an important part of production. Understanding growth stages guides the application timing of herbicides, fungicides and desiccants.

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Chapter 1: Seeding

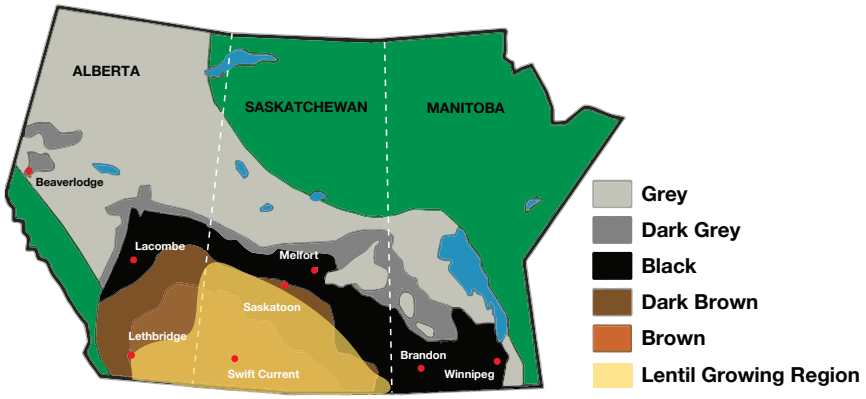
Lentils are a management-intensive crop. Maintaining a predictable crop rotation and carefully choosing which field gets seeded to lentils are necessary steps to set your crop up for success.

If you consider rotation, seeding lentils after canola, mustard, field pea or faba bean puts the crop at risk of developing sclerotinia stem rot. Seeding lentils after lentils puts your crop at risk of severe ascochyta blight.

Here are other management tips from the Saskatchewan Ministry of Agriculture and the Saskatchewan Pulse Growers to help set your lentil crop up for higher yields, right from the get-go.

Adaptation

- Lentils are a cool season crop and are best adapted to the Brown and Dark Brown soil zones. They root to a depth of approximately 2 feet and grow to a height of 8 to 30 inches.
- Lentils are moderately resistant to high temperatures and drought, although they need 6 to 10 inches of moisture during the growing season for optimum yield.

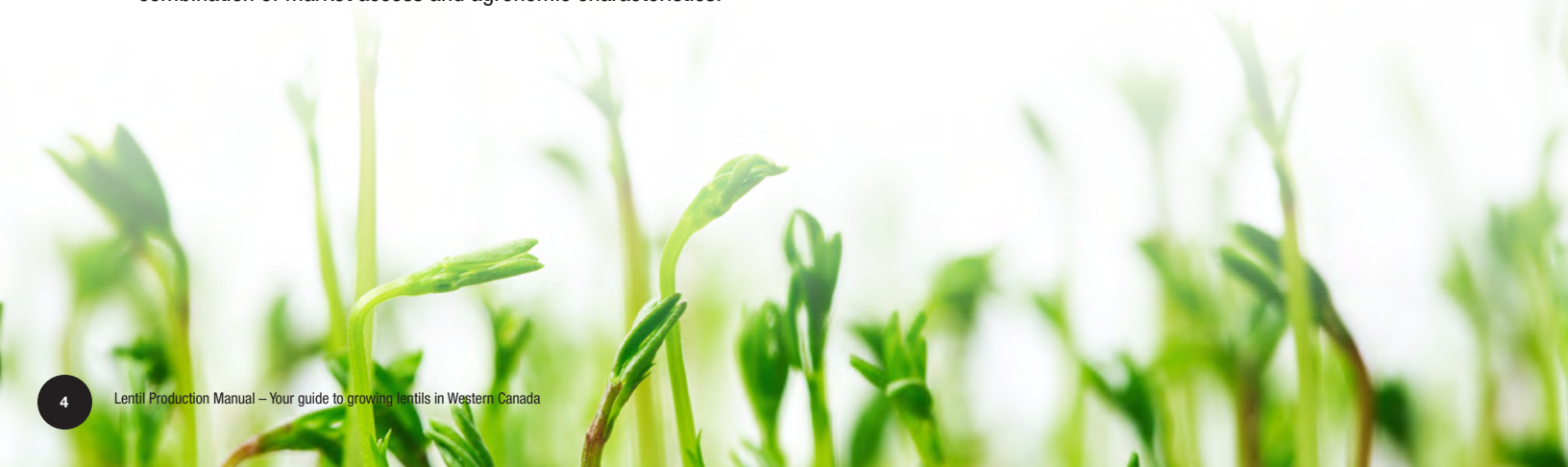


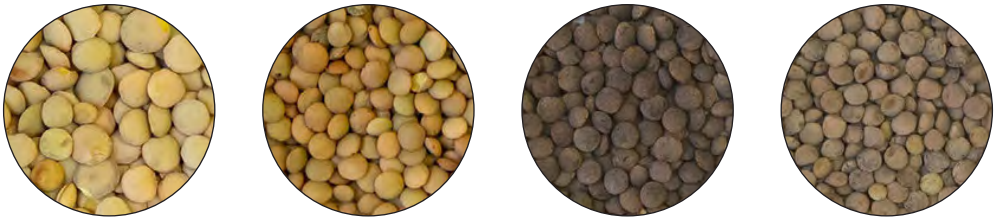
Field selection

- Select fields with well-drained soils and pH levels of 6 to 8.
- Avoid fields with high salinity or fields that flood.
- Avoid fields with high levels of soil nitrogen (N). Soil nitrate levels of 25 to 35 pounds per acre (lbs./ac) can delay the development of nitrogen-fixing nodules, and combined soil and fertilizer N levels over 50 lbs./ac can prevent nodulation and nitrogen fixation, according to research done at the University of Saskatchewan. (Dona et al. 2019.)[ii]
- Choose fields that are relatively free of rocks and with level terrain to make harvesting easier.
- Understand herbicide recropping restrictions. Generally, some herbicides in Groups 2, 4, 14 and 27 can have recropping intervals greater than one year. Always refer to the product manufacturer and/or labels for complete guidance on recropping restrictions for lentils.
- Avoid fields with perennial weed problems, as in-crop herbicides provide little control of these weeds.

Variety selection

Lentil varieties have a range of seed sizes and seed coat colours. Small varieties are as small as 25 g/1,000 seeds and large varieties are over 60 g/1,000 seeds. Seed coat and cotyledon colours combine to determine specific market classes. About two-thirds of lentils grown in Saskatchewan are red lentils, followed by large green lentils and small green lentils. Variety selection should be based on a combination of market access and agronomic characteristics.





- Red lentils: Large, small and extra small market classes. Small reds are earlier maturing and shorter than greens.
- Green lentils: Large, medium, small and extra small market classes. About 75% are large greens. Green lentils are relatively late maturing with an indeterminant growth habit.
- Specialty market classes: Black, French green, green cotyledon, Spanish brown and large red classes.
- Consult the Saskatchewan Varieties of Grain Crops publication for performance tables of registered lentil varieties.

Seeding tips

The foundation of successful lentil production is establishing a healthy, uniform plant stand.

- Lentil seed with less than 14% moisture content is subject to mechanical damage. Handle seeds gently to avoid seed coat damage. Slowly run augers full and reduce air seeder fan speeds as much as possible without plugging.
- Studies at Agriculture and Agri-Food Canada at Swift Current found that direct seeding into tall, standing wheat stubble significantly increased yield compared to cultivated or short stubble.
- Seed early when soil temperature at seeding depth reaches a minimum of 5°C.
- Lentils have good frost tolerance. If the main shoot is damaged by frost, the plant can regrow from one of the scale nodes below the soil surface, but maturity may be delayed.
- Seed into moisture at a depth of 1 to 3 inches.
- Historically, the advice was to target a plant stand of 12 plants per square foot. However, recent research at the University of Saskatchewan found optimal stands across lentil classes was 18 plants per square foot, and up to 24 plants per square foot for red lentils.
- Use a thousand kernel weight calculator to determine the actual seeding rate, which accounts for seed size, germination rate and seedling mortality.
- Row spacing generally does not have an impact because of its indeterminant growth. Narrower row spacing will have faster canopy closure, resulting in better competition with weeds.
- Plant high-quality, certified seed with low levels of seedling disease. A fungicidal seed treatment is recommended, especially if ascochyta seed-borne disease levels are 5% or above.
- Do not plant anthracnose-infected seed where lentils have never been grown.
- If cutworm is a concern, treat seed with an insecticidal seed treatment.
- Roll lentils to improve harvestability by pushing down rocks and lumps any time after seeding up to the 7-node stage. Rolling past this stage can increase the risk of foliar disease and reduce yield.

Chapter 2: Fertility

As with all crops, soil fertility must be managed for optimum yield. Lentils are a pulse crop that can fix nitrogen from the air, providing the benefit of reduced N fertilizer input costs.

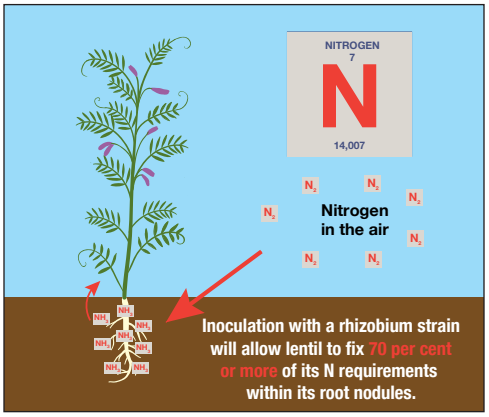
Adequate fertility will help get your lentils off to a good start. A healthy crop is better able to handle stress as the season develops and also contributes to yield at harvest.

But it's a delicate balance. Lentils have a high potential for injury to starter fertilizer placed in the seedrow.

Here is what the most recent research says about managing fertility for healthy, high-yielding lentils:

Inoculation

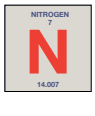
According to Saskatchewan Pulse Growers, inoculation with a rhizobium strain (Rhizobium leguminosarum) will allow lentil to fix 70 per cent or more of its N requirements.



- Inoculants are sensitive to seed-placed fertilizer and some seed-applied fungicides. Check manufacturer recommendations for compatibility between inoculants and fungicides.
- Liquid inoculants are convenient to use and are easily metered into the seedrow but are more sensitive to environmental extremes and fungicide seed treatments. They can be applied directly to the seed or to the seedrow.
- Peat-based inoculants are less prone to environmental and fungicide seed treatment damage than liquid inoculants. They may be applied with a sticker for adhesion and are applied directly to the seed prior to seeding either as a dry powder or in a slurry.
- Granular inoculants are applied directly to the seedrow but require a separate air tank for application. They are the least affected by environmental and fungicide seed treatment stress. Under drier soil conditions, granular inoculants usually outperform peat or liquid inoculants.

You can assess nodulation at early flowering. Gently dig up several plants at 5 different areas of the field and wash the dirt off the roots. Slice open the nodules and assess the colour. A strong pink colour indicates active fixation. Nodules that are brown, white or green are not effectively functioning. Five or more clusters of pink pigmented nodules indicated good nitrogen fixation.

Poor nitrogen fixation can show up as nitrogen deficiency symptoms and crop yellowing and poor plant development. In the case of nodulation failure, there are no current recommendations on top-dress N rescue treatments.



Nitrogen

On soils with less than 35 lbs. N/ac, nitrogen fixation provides the majority of lentil's N requirements with the remaining coming from soil reserves.

- On soils with very low soil nitrate levels of less than 10 lbs./ac, starter N applied in the seedrow or side-banded may be necessary to overcome early season deficiencies. The starter N, though, may not necessarily result in higher yield.
- Lentils are sensitive to seed placed N fertilizer.[iii]
- Nitrogen found in monoammonium phosphate (MAP; 12-51-0) may be all the starter N required to promote early season growth.
- On a field where lentil has never been grown, starter N may be beneficial.

Phosphorus

A 30 bu/ac lentil crop takes up 22 to 27 lbs. P_2O_5/ac, while 17 to 20 lbs./ac is removed from the field in the seed. The average removal rate is 0.62 lbs. P_2O_5 per bushel of grain. Good phosphorus fertility plays an important role in nitrogen fixation and promotes early-season plant vigour and a better root system.

- Soils testing low in available P may show early-season response to P fertilization, but may not show a yield response.
- The maximum safe rate of seed-placed MAP is 20 lbs. P_2O_5/ac. This is based on knife openers with a 1-inch spread, 9-inch row spacing, and good to excellent soil conditions – 10 to 15% seedbed utilization.
- If potassium (K) is seed-placed along with P fertilizer, the total pounds of phosphorus plus pounds of potassium should not exceed the maximum safe rates of seed-placed phosphorus.
- If higher levels of P fertilizer are applied, they should be side-banded to the side and below the seed.
- Since average crop uptake of P is greater than safe seedrow rates, some growers apply extra P in the year prior to lentils.

Potassium

Lentils are heavy users of K, taking up 69 to 84 lbs. K_2O lbs. for a 30 bu/ac crop, while removing 29 to 36 lbs. K_2O.

- Information from Saskatchewan Pulse Growers suggests that most Saskatchewan soils have sufficient soil reserves but deficiencies may be found in sandy black and grey soils in northern Saskatchewan.
- Potassium fertilizer has a high salt index that can hurt germination and stand establishment.
- If applying K, seed-placed K and P must not exceed the recommended rate for seed-place P applied alone. You can also sideband the blend away from the seed.

Sulphur

Lentils require moderate amounts of sulphur (S), taking up 8 to 10 lbs. in a 30 bu/ac crop, with removal in the seed at 4 to 5 pounds. Sulphur deficiencies most often occur on sandy soils.

- Limited yield responses have been observed in research, except in fields testing very low in S.
- Soils testing deficient in S may require fertilizing with plant-available sulphate forms of S by side-banding, mid-row banding or broadcasting.
- The most common sulphate-sulphur fertilizer sold in Saskatchewan is granular ammonium sulphate (20-0-0-24, 21-0-0-24, 19-2-0-22). Ammonium sulphate contains S in a plant-available form.
- Elemental sulphur fertilizers are not immediately plant-available and are used in a longer-term S fertility management program.

Micronutrients

Micronutrient deficiencies have not been identified as a problem in the lentil growing areas of Western Canada according to Saskatchewan Agriculture.

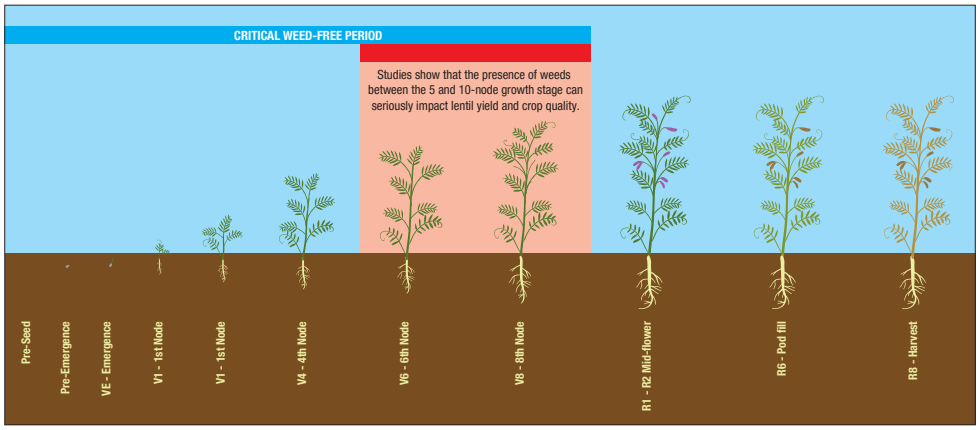
- If a micronutrient deficiency is suspected, work with an agronomist to diagnose the issue.
- Stressed growth symptoms can be similar to some micronutrient symptoms.

Chapter 3: Weed control

Lentils are very poor competitors with weeds and an integrated approach is required for optimum weed control.

Controlling perennial weeds and winter annuals prior to seeding is key. Kochia, Russian thistle, wild mustard, stinkweed, Canada thistle and quackgrass are the main weeds impacting lentil production.

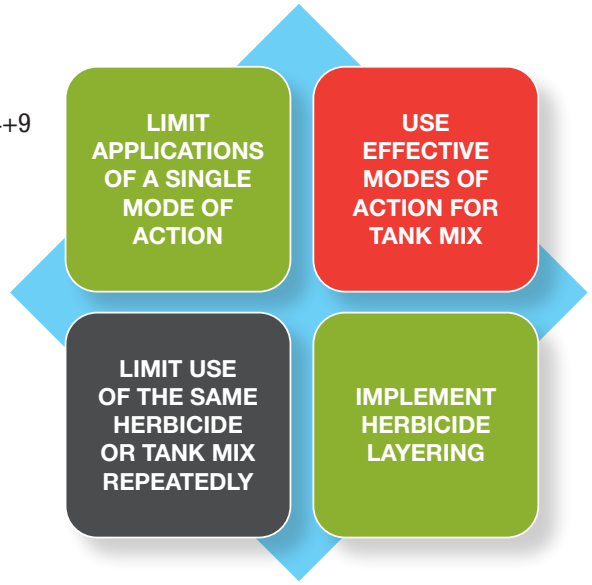
Lentils require a long weed-free period to achieve full yield potential. Research from the University of Saskatchewan[iv] indicates the presence of weeds between the 5- and 10-node growth stage can seriously impact lentil yield and crop quality, necessitating protection in the early stages of development. Starting with a clean field and keeping it clean until that 10-node growth stage requires an integrated approach that should include a pre-seed/pre-emergent product with extended control to maximize the success of in-crop herbicide applications.



Herbicide resistance

Herbicide resistance has become a serious issue on the Prairies. Many annual grassy and broadleaf weeds have developed resistance to various herbicide groups, making weed control in lentils even more challenging. The Saskatchewan Guide to Crop Protection and Heap (2023) (Herbicide Resistance Action Committee - www.weedscience.org) indicate that the main resistant weeds of concern in lentils are:

- Wild oats: In recent surveys, wild oat populations were found to be 62% resistant to Group 1, 27% resistant to Group 1+2 and 34% resistant to Group 2 herbicides (Beckie et al. 2020, Resistant Wild Oat Action Committee).
- Chickweed and cow cockle: Group 2
- Cleavers: Group 2, 4 and Groups 2+4
- Kochia: All populations are considered resistant to Group 2. In addition, resistance to Group 4, 9 and multiple resistance to Groups 2+9, 2+4, 2+4+9 have been identified.
- Wild mustard: Group 2, 4 and 5.
- Narrow-leaved hawk's-beard and stinkweed: Group 2
- Redroot pigweed: Group 2
- Russian thistle: Group 2 and Group 9 (in Montana).



Strategies to combat herbicide resistance

The key is to plan ahead and know your options. Consider the following:

- What are the target weeds in the field?
- What is the optimal timing to control the target weeds?
- What are the herbicide choices based on crop rotation?
- Are the herbicides being considered effective on the targeted weeds?

A herbicide use strategy will help optimize weed control performance. The key elements of a herbicide use strategy are:

- Limit the application of a single mode of action.
- Limit the use of the same herbicide or tank-mix repeatedly.
- Use effective modes of action in the tank-mix.
- Implement herbicide layering strategies.

Herbicide layering using a product with extended control

Herbicide layering is the practice of using herbicides from multiple groups in sequential applications to target the same weeds and will include soil-applied herbicides combined with pre-seed burnoff, followed by an in-crop herbicide application.

Layering three to four herbicide groups is most effective. In doing so, the soil-applied herbicide will control many of the germinating weeds and the in-crop herbicide of a different herbicide group will control weed escapes and weeds germinating after seeding. It also means that any weeds germinating later will be smaller and therefore more easily controlled by the in-crop herbicide.

In research trials in Saskatchewan on kochia control in lentils, herbicide layering with Edge® herbicide, Focus® herbicide, Fierce® herbicide and Valtera® herbicide in the fall were followed up with glyphosate or glyphosate plus Heat® herbicide pre-seed and Solo® herbicide in-crop on a Clearfield lentil variety. The fall layering herbicides all reduced kochia populations compared to the glyphosate only treatments, and the highest yielding treatments included Focus® herbicide and Fierce® herbicide with spring-applied glyphosate. (Enns et al. 2020).

Herbicide layering scenario

An example outlining herbicide layering with lentils as part of the crop rotation.

Year	Crop	Pre-Seed	In-Crop		Pre-Harvest	Post-Harvest
			Grass	Broadleaf		
1	Lentils	14 + 15 + 9	-	5	22	3 + 15
2	Barley	2 + 4 + 9	1	4	-	-
3	Canola	14 + 6 + 9	1 + 10	10	-	4 + 9 + 14
4	Durum	-	2	2 + 4	-	-

This example features a field in the brown soil zone that has Group 2 and 9 resistant kochia.

Year 1: *In Year 1 the rotation is started with lentils and as pointed out in this manual, there are limitations to the in-crop herbicides due to resistance issues. The following approach considered begins with a multi-mode of action pre-seed application:*

Pre-seed: Group 14 (carfentrazone) and Group 9 (glyphosate), along with a herbicide layering Group 15 (pyroxasulfone) to achieve extended activity on herbicide resistant kochia, wild mustard and stinkweed.

In-crop: A Group 5 (metribuzin) can be used in-crop to target any additional broadleaf weeds. The Group 15 (pyroxasulfone) has extended activity on the grassy weeds and is keeping them at bay.

Pre-harvest: Group 22 (diquat)

Post-harvest: To set up the next season's crop for success, a fall-applied application of a Group 3 (triallate) and Group 15 (trifluralin) can be used.

Year 2: *Barley is planted and the following herbicide plan is implemented:*

Pre-seed: Group 2 (tribenuron) + Group 4 (dicamba) + Group 9 (glyphosate) to clean up any winter annuals or annuals.

In-crop: The extended control of the soil-applied herbicide the previous fall means grassy and broadleafs have been suppressed. To maintain yield, a timely application of a Group 1 (pinoxaden) and Group 4 (fluroxpyr) to ensure the wild oats and kochia do not set seed.

Pre-harvest: Nothing, it's malt barley.

Post-harvest: Nothing; a rigorous herbicide strategy early in the season combined with a competitive crop meant little weed growth in the fall.

Year 3: *InVigor canola is planted, opening up the opportunity to use:*
Pre-seed: Group 14 (carfentrazone), Group 6 (bromoxynil) and Group 9 (glyphosate)

In-crop: Group 10 (glufosinate) and Group 1 (clethodim)

Pre-harvest: Research at the University of Saskatchewan has shown that pre-harvest herbicide applications at canola swath timing are too late to result in any appreciable weed control benefits as most weed seeds have already matured. https://www.canolacouncil.org

Post-harvest: Fall applications of a soil-applied herbicide, like Authority® 480 herbicide (Group 14 - sulfentrazone), to control early germinating weeds like kochia the following year. Combining it with Group 9 (glyphosate) and Group 4 (2,4-D) will control any winter annuals that have emerged after canola harvest.

Year 4: *The crop is durum. Since durum is seeded early and fall-applied products set up the field for minimal to no weed pressure in the spring, no pre-seed herbicide is applied.*

Pre-seed: Nothing; durum is seeding early and fall applied products have set up the field.

In-crop: Rotating wild oat graminicides is important to delay herbicide resistance. Take advantage of the durum year to use a Group 2 graminicde (pyroxsulam), combined with multi-mode of action broadleaf products (Group 2 - tribenuron, thifensulfuron, Group 4 - fluroxypyr, MCPA Ester)

Pre-harvest: Nothing

Post-harvest: Nothing

Pre-seed burnoff

A pre-seed or pre-emergent burnoff of weeds is important to control weeds early, prior to seeding. Left uncontrolled, these weeds will outcompete lentils for moisture and nutrients.

- University of Saskatchewan research on wheat found that early pre-seed weed control, up to 2 weeks prior to seeding, yielded more than a burnoff conducted 1 day before late seeding of wheat.
- Glyphosate has been the standard pre-seed burnoff herbicide but with the increase in herbicide-resistant weeds, tank-mixes with other herbicide groups are recommended.
- Some restrictions apply to herbicide applications prior to lentils. Always consult label for complete application instructions.

In-crop weed control

Controlling weeds prior to seeding lentils is critical, and lots is riding on your in-crop weed control as well.

- According to the Saskatchewan Pulse Growers, the critical period of weed control begins at the 5-node stage and continues to the 10-node stage.
- Group 1 herbicides Poast Ultra and quizalofop (i.e. Assure® II herbicide) are registered for control of grassy weeds in lentil.
- Metribuzin (Group 5) is registered for broadleaf weed control. Application should be made at the 3- to 5-node stage and when weeds are small (< 2-leaf stage).
- Under certain field or weather conditions, a split application of metribuzin may provide better weed suppression than a single application. Allow 7 to 10 days between applications. Heavy rainfall after metribuzin application can move the herbicide into the lentil rooting zone and cause crop injury. Plant lentils at least 2 inches deep.
- Do not use metribuzin on soils with less than 4% organic matter.
- During periods of crop stress, lentils have less ability to tolerate herbicide. Delay applications if possible.
- A University of Saskatchewan research study (Redlick et al. 2017) found that increasing lentil seeding rate to at least 26 seeds/ft^2 resulted in more consistent weed control under challenging environmental conditions.
- The widespread development of Group 2 broadleaf herbicides is challenging the Clearfield production system. Clearfield lentils are tolerant to Group 2 herbicides (i.e. imazapyr, imazamox and imazethapyr), but these herbicides cannot control Group 2-resistant weed biotypes.

Post-harvest weed control

Weeds that germinate in the fall after harvest can take up moisture and nutrients that would otherwise be available to the lentil crop in the spring. In addition, some of these weeds can overwinter and start growing early in the spring, stealing moisture and nutrients from the upcoming lentil crop. Winter annuals include stinkweed, flixweed, shepherd's purse and narrow-leaved hawk's-beard.

- A low rate (113 grams or less per acre) of 2,4-D (Group 4) controls fall and winter annuals in the mustard family. Higher rates may have soil residual rates that can impact lentil germination in the spring.
- Glyphosate can be tank-mixed with Express® SG herbicide (Group 2) for a wider range of weeds including annual, perennial and biennial weeds like dandelion, flixweed, narrow-leaved hawk's-beard, stinkweed, volunteer canola and wild buckwheat.
- Focus® herbicide (Group 14 + 15) can be tank-mixed with glyphosate for fall application to control emerged winter annuals such as stinkweed and mustard. A fall application of Focus® herbicide will also provide early season suppression of weeds like kochia, wild oats, foxtail barley, wild mustard and stinkweed the following spring.

Specific weed challenges

Canada thistle, perennial sow thistle, dandelions and quackgrass are perennial weeds with few in-crop herbicide choices.

- Control perennial weeds in the year(s) prior to lentils with pre- or post-harvest applications of glyphosate (Group 9).
- Poast® Ultra herbicide (Group 1) and quizalofop (Group 1) are registered for in-crop control of quackgrass.
- Focus® herbicide (Groups 14 + 15) is registered for suppression of germinating foxtail barley.
- Pre-emergent Valtera™ (Group 14) and Fierce® herbicide (Group 14 + 15) are registered for control of dandelion emerging from seed, but not if emerged at application.
- Solo® Ultra herbicide and Odyssey® Ultra NXT herbicide (both Group 2) suppress quackgrass in Clearfield® lentil varieties when applied post-emergent.


Kochia


Russian thistle


Wild mustard


Canada thistle


Quackgrass


Stinkweed

Chapter 4: Disease and insect management

Diseases

Root and foliar diseases are major challenges for lentil growers.

Management practices to prevent or reduce the impact of diseases include crop rotation, fungicide seed treatment and foliar fungicide applications. A Fungicide Decision Support Checklist for lentils has been developed by Agriculture and Agri-Food Canada and can be found at Saskatchewan Pulse Growers website.

Root rot

Root rot in lentils is caused by a complex of pathogens that can be seed or soil borne. They can infect the plant at any stage and can cause almost total crop failure.

- Pathogens that cause root rot, seed rot, seedling blight, damping off and wire stem include species of *Rhizoctonia, Pythium, Fusarium*, and *Botrytis*. These pathogens are widespread across the Prairies.
- Symptoms may include poor emergence, root decay, stunting, yellowing and death of shoots. Lesions may develop on the stem base leading to constriction of the stem and seedling collapse.
- Fungicide seed treatments are available to help manage these pathogens, but only last 2 to 3 weeks against early season disease pressure.
- Root rots can also be caused by *Aphanomyces euteiches*, which has been identified across most of Saskatchewan. *Aphanomyces* can survive in the soil for 10 to 15 years. Research is currently being conducted on survival periods, and suitable crop rotations away from *A. euteiches* susceptible crops. Learn more at the www.saskpulse.com.
- Warm soil temperatures and high soil moisture are favourable for *A. euteiches* development.
- Lentils and peas are the most susceptible to *aphanomyces*; faba beans and sainfoin have partial resistance; chickpeas are considered moderately resistant; and soybeans and fenugreek are non-hosts in the legume family.
- *Aphanomyces* can infect the plant at any growth stage, and crops can go from healthy looking to complete collapse during vegetative or reproductive stages.
- Intego Solo seed treatment is registered for early season suppression of *A. euteiches*, but needs to be tank-mixed with other seed treatments for control of other root rot pathogens.
- Lentils and peas should not be planted on fields with confirmed *A. euteiches* for a minimum of 6 and preferably 8 years.

Foliar symptoms of root rot

Photo credit: Mary Burrows, Montana State University, Bugwood.org

Ascochyta blight

Ascochyta blight is a seed- or soil-borne disease that infects leaves, stems, pods and seeds. Tan or grey lesions develop as spots with dark margins. Tiny black fruiting bodies called pycnidia may be present in the centre of the lesions. The disease develops most quickly in cool, rainy weather. Ascochyta blight prevalence has been increasing in Saskatchewan over recent years (Canadian Plant Disease Survey - Canadian Phytopathological Society)[vii].

- Most lentil varieties have some level of resistance to ascochyta blight. However, monitoring ascochyta levels will be important to detect resistance breakdown (Akhavan et al. 2021)
- Use a 4-year rotation in fields where an infection is found.
- Seed treatments can help prevent seed-borne infections.
- A foliar fungicide application at flowering can help prevent the spread of the pathogen to healthy plants, and can help decrease flower and pod abortion.

Photo credit: Mary Burrows, Montana State University, Bugwood.org

Anthracnose blight

Anthracnose blight is caused by *Colletotrichum truncatum* in lentils, and can cause economic losses. It develops under warm, moist conditions, and is more common in short rotations. It is the most prevalent disease in Saskatchewan, observed in 83.8% of fields surveyed in 2020 (Canadian Plant Disease Survey - Canadian Phytopathological Society). Symptoms develop at the 8th to 12th node with white to grey lesions on lower leaves around flowering. The lesions spread to stems and pods. Defoliation can occur.

- Low levels of infection can cause yield loss.
- Infected crop residue is the main source of disease spread.
- Use a minimum 3-year crop rotation away from lentils.
- Plant clean seed. Most lentil varieties are moderately resistant to anthracnose Race 1.
- Scout for anthracnose at the beginning of the 10th node stage through flowering. A foliar application near canopy closure may be necessary. A second application can be applied if disease pressure is high.

Group 11 strobilurin fungicide insensitivity has been confirmed in Saskatchewan, and a 2020 survey found this insensitivity to be more common in susceptible populations. Manage fungicide insensitivity by using fungicides with multiple modes of action, rotate fungicide groups between sequential applications. Do not apply more than the maximum number of applications listed on the label.

Photo credit: Daren Mueller, Iowa State University, Bugwood.org

Sclerotinia white mould

Sclerotinia stem and pod rot, also called white mould, is caused by *Sclerotinia sclerotiorum* and can develop under high moisture conditions. Research by Dr. Kazi Kader et al[viii]. found that most varieties tested were susceptible to sclerotinia white mould, and had significant yield losses under heavy infestations.

Lesions develop on stems, branches and leaves. Bleaching of the leaves and wilting of the plant may occur. Dark resting bodies called sclerotia develop and can be found inside the stem.

- Canola, peas and sunflowers are other susceptible crops, so crop rotations with these crops should be avoided. Crop rotations also have limited value because the sclerotia can survive in the soil for several years.
- Foliar fungicides are registered for control and are applied when lentils are at 20% to 30% flowering, or when 15 to 20 flowers are open on the main stem.

Stemphylium blight

Stemphylium blight on lentils is caused by *Stemphylium botryosum* and can infect lentil at any growth stage. When the disease first develops, leaves appear chlorotic and yellow but stems appear healthy. Lesions develop on the leaves, first cream-coloured and then dark brown or black.

- Yield losses have not been confirmed but may not be significant if the disease develops later in the growing season.
- Disease development progresses fastest under warm conditions of 25°C to 30°C and wet conditions.
- Losses can occur from seed staining, reduced seed size, and decreasing germination rates.
- Fungicides targeting other foliar disease may also provide some control of Stemphylium blight.

Insects

Several above- and below-ground insect pests can impact lentil production. Grasshoppers and cutworms can be significant problems. Crop scouting and economic thresholds guide the need for insecticide treatments.

Grasshoppers

Lentil plants are not generally favoured by grasshoppers, but they still may cause economic losses during outbreaks. Feeding on flower buds, flowers and developing pods cause the most damage and yield loss.

- The economic threshold is 0.2 grasshoppers/ft^2 (2/m^2) at flowering and pod set.
- Grasshoppers generally move in from field edges. Insecticide application at these locations may help control the populations from moving further into the field. Scout across the whole field, as adult grasshoppers may have laid eggs throughout the field the previous year.
- Agriculture departments in the three Prairie provinces develop grasshopper forecast maps annually to help growers plan scouting activities.
- Control options for grasshoppers include Coragen® MaX insecticide and insecticides with the active ingredient lambda-cyhalothrin*.

Cutworms

Several species of cutworm, including army, dingy, redbacked and pale western, feed on developing lentil roots and shoots. Damage and yield loss can be highly variable.

- Dingy and army cutworms feed above ground on lentil shoots and foliage.
- Pale western and red-backed cutworms feed and cut off plants below or near the soil surface.
- Scout for cutworms in the spring and early summer for signs of feeding. Look for thinning of plants in rows, and bare patches. Frequent scouting is required.
- Dig around the base of severed plants to a depth of 3 inches and around healthy plants near bare patches.
- Agriculture and Agri-Food Canada has produced an identification and management field guide for cutworms, "Cutworm Pests of Crops and the Canadian Prairies".
- The economic threshold for cutworms in lentil is 0.2 to 0.3/ft^2 (2 to 3/m^2) in the top 3 inches of soil (7.5 cm).
- There is one insecticidal seed treatment (Lumivia®) available if cutworms are an ongoing problem in a specific field.
- Several foliar insecticides are registered for cutworm control in seedling lentil. These include Coragen® MaX insecticide and Pounce® 384EC insecticide, and insecticides with the active ingredients deltamethrin or lambda-cyhalothrin*.


Grasshoppers


Cutworms

*Always read and follow label instructions.

Lygus bug

Lygus bug has not been a significant problem in Western Canada. Immature and adult lygus bugs feed on seeds and pods of lentil. In lentils, the feeding damage causes chalk spot. The seed has a chalky, white spot caused by the feeding injury.

- Lygus bug feeding and seed downgrading have been a sporadic issue in lentil.
- Scout for lygus bug by conducting 180 degree sweeps with a 15-inch sweep net in at least 5 different places in the field during blooming and podding.
- The economic threshold for lygus bugs in lentils is 7 to 10 adults per 25 sweeps during blooming and podding.
- Several foliar insecticides, such as insecticides containing the active ingredients deltamethrin or lambda-cyhalothrin*, are registered for control of lygus bug in lentils. Carbine™ insecticide can be used to reduce lygus bug numbers.

Pea aphid

Pea aphid causes damage to lentils by sucking plant sap and have become more problematic in recent years. Yield can be reduced by decreased seed formation and damaged seed. Pea aphids prefer lentil and pea over other pulses. They can produce 7 to 15 generations per year and a single female can produce 4 to 12 young aphids per day.

- Start to scout when 50% to 75% of the plants are flowering.
- Agriculture and Agri-Food Canada is working on establishing Saskatchewan-based economic thresholds. They have found 180-degree sweeps works best for estimating pea aphid levels in lentil but are still working on establishing economic thresholds.
- In North Dakota, a nominal economic threshold is used. An insecticidal application is recommended when 30 to 40 aphids per 180-degree sweep are captured, few natural enemies are present, and aphid numbers do not decline over a two-day period.
- Several insecticides such as Carbine™ insecticide, Cygon® 480-AG systemic insecticide, and insecticides with the active ingredient lambda-cyhalothrin* are registered for pea aphid control in lentil.


Lygus bug


Pea aphid

Chapter 5: Harvesting

Achieving high-quality lentil grades is important for maximizing returns.

Because lentils have indeterminant growth, the plants need a stressor to speed maturity. Most growers use swathing, desiccation or harvest aids to speed up harvest and to maintain seed quality. The objective is to dry down the crop as quickly as possible so that combining can occur in a timely manner to avoid quality downgrading due to weathering.

Harvest management timing

Desiccation, pre-harvest glyphosate and swathing all occur at the same stage – when seed moisture content reaches 30% or less. This applies to the entire field, so delay harvest management until the field is uniformly mature.

Keep it Clean, provides the following guidelines for assessing when a lentil crop is at less than 30% seed moisture content:

- 80% of the plant is yellow to brown in colour.
- Top of plant may still have slight green colour, but seeds fully formed and not juicy.
- Seeds in pods from the bottom third of the plant are tan-brown, hard and pods rattle when shaken.
- Seeds from the middle third are full size and firm with 100% colour change (light green to tan-brown).
- Seeds from the upper third have 50%-75% colour change with no immature seeds (shiny green seeds).

Swathing

There are advantages and disadvantages to swathing. Swathing can speed drydown and reduce shattering losses compared to the crop being left to stand for straight-combining. On the other hand, heavy rain can result in quality losses due to sprouting, wrinkling and disease. Swaths are also susceptible to wind damage.

- The quality of seed is usually better for swathing than desiccated lentils, especially for green lentils – if good drying weather is present.
- Cut close to the ground to capture the bottom pods with a cutterbar angle of 20 to 30 degrees.
- Pickup reels and crop lifters are usually required.
- A flexible cutterbar will allow faster speeds.
- Slower speeds will reduce shattering.
- Rolling is not recommended.

Desiccation

Chemical desiccation will dry down the crop and weeds quickly. This can reduce shatter loss, speed harvest and result in improved quality. Applying a desiccant before 30% moisture content can result in shrivelled seed and may result in pesticide residues in the seed that are above maximum residue limits (MRLs).

- Consult www.keepitclean.ca to make sure that the desiccant applied is compatible with market access requirements.
- Follow pre-harvest intervals for desiccant applications. This is the time between the application of the desiccant and the cutting (swath or combine) of the crop.
- After desiccation and under hot, dry and sunny conditions, the crop may be ready to combine in 4 to 7 days, but more usually 7 to 10 days.
- Use high water volumes for good coverage and high recommended rates to speed crop drydown.

Harvest aids

Glyphosate can be used as a harvest aid to control perennial weeds in lentil. However, glyphosate is not considered a desiccant because it is slower to act in drying down the crop. Application must also be when the crop reaches physiological maturity at less than 30% seed moisture content.

- Do not apply glyphosate to crops grown for seed as it may affect germination and seedling development.
- Cool, wet weather delays glyphosate activity and drydown.
- Follow pre-harvest intervals and guidelines at www.keepitclean.ca.

Combining timing

Combine timing is an important factor in achieving high quality lentil seed.

- Canadian Grain Commission moisture specifications consider green lentils to be 'dry' at less than 14% seed moisture content, 'tough' at 14.1% to 16%, and 'damp' above 16%.
- Red lentils are considered 'dry' at less than 13% seed moisture content, 'tough' at 13.1% to 16%, and 'damp' above 16%.
- Combining green lentils at 16% to 18% moisture is considered ideal, assuming drying to 14% can be accomplished.
- Similarly, harvesting red lentils at a higher moisture content and then drying to 13% is recommended.
- Harvesting lentils 'tough' helps to minimize splits and cracks that can downgrade seed quality.

Combine settings

Combine adjustments should be monitored throughout the day to ensure high seed quality. Saskatchewan Agriculture and Saskatchewan Pulse Growers have developed recommended starting points for combine settings:

- Low cylinder or rotor speed is required to prevent seed chipping and breaking. However, they must be fast enough to prevent cylinder plugging. This is usually around 250 to 500 revolutions per minute.
- Under good threshing conditions, the concave settings can be wide to allow good threshing and separation with minimal seed damage.
- Start with chaffers set at 3/4 inch and cleaning sieves at 3/8 inch and adjust from there. Keep tailings to a minimum. Ensure grain and return elevators are not splitting the seed.
- Keep fan speed only high enough to produce a clean sample, as lentil seed can be blown out the back of the combine.

Storage

Safe storage of lentils, like other crops, depends on seed moisture content and temperature. As moisture and temperature rise, the safe storage period declines. For example, at a temperature of 15°C or less, and a seed moisture content of 14%, seed can be stored for up to 40 weeks.

- Monitor grain bins regularly for hot spots especially during seasonal changes when moisture migration directions change.
- Also monitor for stored grain insects.
- If seed moisture content is too low the seed begins to shrink from the seedcoat and becomes more susceptible to damage during handling.
- Green lentils can oxidize and darken in colour over time. To prevent discoloration that could cause downgrading, don't store green lentils through a second summer.

Number of weeks for safe storage of lentils at the specified grain moisture content and storage temperature

Temperature (°C)	Moisture Content of Seed (%)					
	12	13	14	16	18	21
	Maximum Safe Storage (Weeks)					
25	31	16	13	7	4	2
20	55	28	23	13	7	4
15	100	50	40	20	12	6
10	200	95	80	38	20	21
5	370	175	150	70	39	20

Source: Protection of Farm-Stored Grains, Oilseeds, and Pulses from Insects, Mites, and Moulds. Agriculture and Agri-Food Canada, 1851/E (revised)

Drying

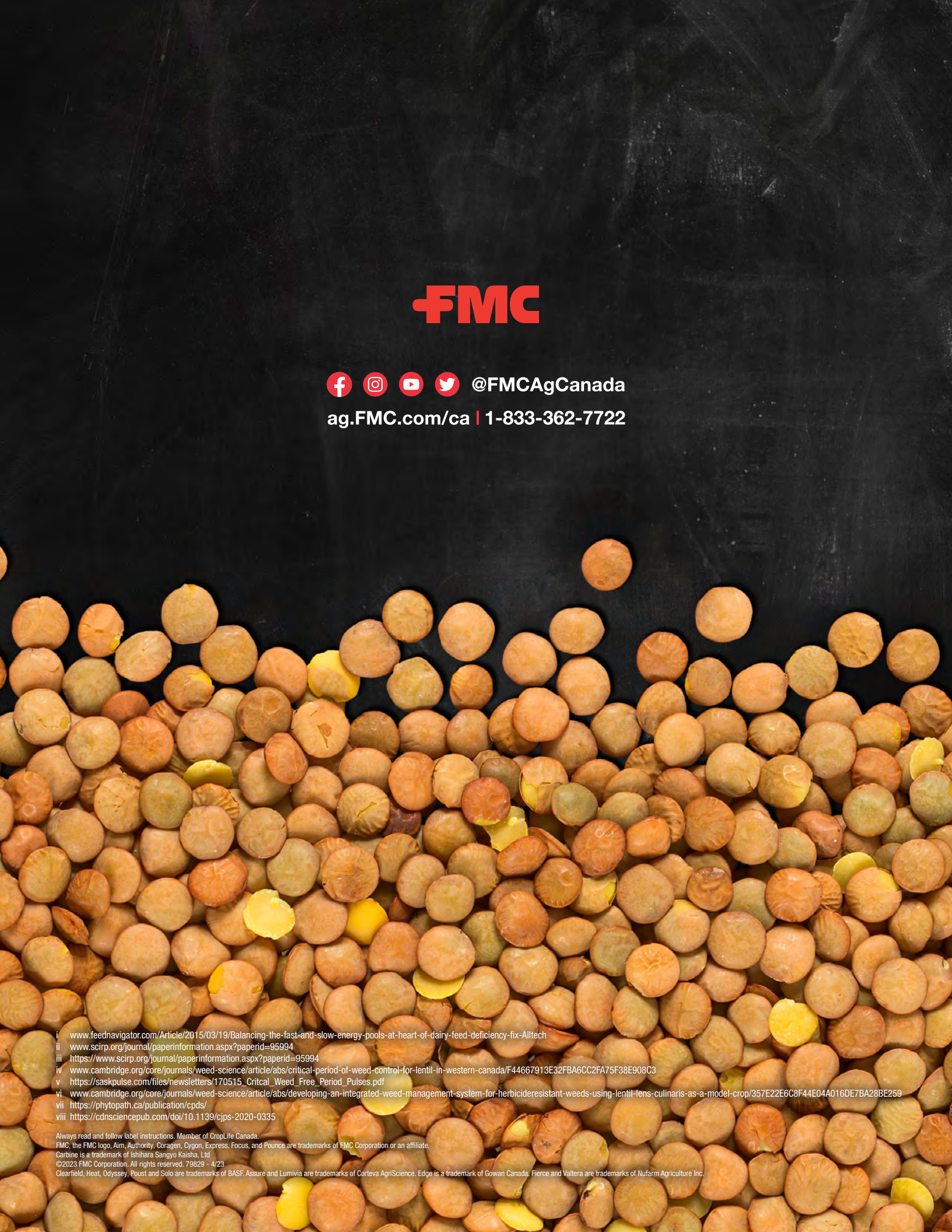
Aeration or drying with supplemental heat will be necessary if the crop was harvested above safe storage temperatures.

- Natural air aeration can effectively dry down lentils to safe storage moisture content and temperature because lentils are typically harvested early when ambient temperatures are high and relative humidity is low.
- Aeration can also be used to cool down lentils to safe storage temperatures. For example, if the seed moisture content was 14% and the grain temperature was 25°C, the crop could be stored for 13 weeks. However, if the same grain was cooled to 15°C, it could be stored for 40 weeks.
- If artificial heat is used for grain drying, the air temperature should not exceed 45°C. Do not dry down by more than 4 to 5 seed moisture percentage per pass through the dryer.

Handling

Dry lentil seed is subject to chipping and splitting. Handle gently.

- Use belt conveyors instead of augers.
- Reduce speed and run full if using an auger.
- Bean ladders can help to minimize damage
- Don't handle below -20°C to avoid chipping and splitting.



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