Lentils in Saskatchewan

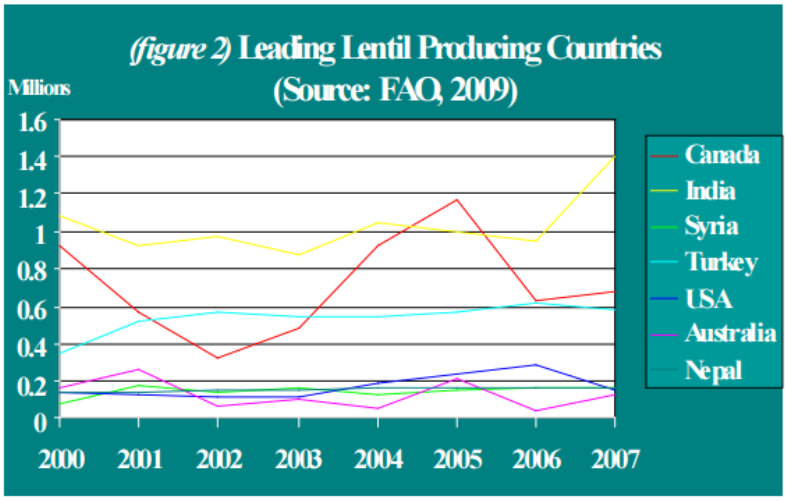
Introduction

Lentil (Lens culinaris L.) was first grown in southwest Asia about 7,000 B.C. It is best adapted to the cooler temperate zones of the world, or the winter season in Mediterranean climates. Split lentil (dhal) is an important source of dietary protein in the Mediterranean and south Asian regions.

Figure 1. Lentil pods
Source: SA

Lentil is a very important pulse crop in Western Canada. It is grown to improve economic returns to producers, diversify and lengthen crop rotations and reduce the requirement for nitrogen fertilizer. Lentil, a member of the legume family, Leguminosae, can supply a significant part of its nitrogen requirement by fixing nitrogen from the air when inoculated with the appropriate rhizobial inoculant.

Total world lentil production ranged from 2.8 – 4.03 million tonnes from 2000-2007. Major lentil producing countries include India, Canada, Turkey, Syria, Australia, Nepal and the United States (Figure 2). Canada is the leading lentil exporting nation, while India is the leading lentil consuming and producing nation.



Commercial production of lentil in Western Canada began in 1970, when approximately 600 hectares (ha) were grown. Production has increased in Saskatchewan to as much as 2.1M ha (5.2 million ac.) in 2016. The 5-year average yield in Saskatchewan is 1,657 kg/ha (1,479 lb./ac.), and the bushel weight of lentil is 60 pounds. The Saskatchewan Ministry of Agriculture's publication *Specialty Crop Report* contains more statistical information on lentil.

Lentil seed size is classified in two types: Chilean/large-seeded (greater than 50 grams per 1,000 seeds) and Persian/small-seeded (45 grams or less per 1,000 seeds). The two main market classes are green and red. Green lentil is usually marketed as whole seed, while red lentil is marketed as whole seed or in de-hulled and split form. The majority of world lentil production and trade is in red lentil. Seed coat colour can vary from clear to light green to deep purple, mottled, grey, brown or black. Cotyledon (seed leaf) colour is yellow, red or green. The predominant lentil grown in Western Canada is the red lentil.

Plant Description

Lentil plants are typically short, compared to cereal crops, ranging from 20-75 cm (8-30 in.) in height. The first two nodes on the stem develop below, or at the soil surface, and are known as scale nodes (Figure 3). Injury to young lentil seedlings by late spring frost, heat canker or wind damage may cause the plant to initiate regrowth from a scale node below the soil surface. The third node on the stem is the usual site of the first leaf development. Lentil seedlings can produce a new node every four to five days under good growing conditions. Just prior to flowering, new leaves will develop a short tendril at the leaf tip.

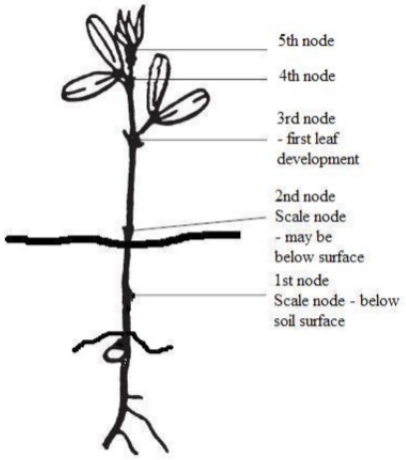


Figure 3: Lentil seedling

Leaves are about five centimetres (2 in.) long with nine to 15 leaflets. Lentil plants have an indeterminate growth habit, so they will continue to flower until there is some form of stress, such as lack of moisture, nutrient deficiency, or high temperature. Flowers are self-pollinated. Flower stalks produce one to three flowers, which develop pods. Pods (Figure 1) are less than 2.5 cm (1 in.) in length and contain one or two seeds. Most of the seed is produced by the aerial branches that form from the uppermost nodes on the main stem just below the first flowering node.

Market Opportunities

Lentil is used mainly for human consumption as a source of protein and carbohydrate in soups, stews and vegetarian dishes. Most lentil is consumed in the region of production, except for Turkey, Australia and North America. Canada is the largest exporter of lentil, in the world. See the Saskatchewan Agriculture Specialty Crop Report for statistical information on lentil production and export.

Nutritional Characteristics

Chronic diseases are more prevalent world-wide and research shows how diet plays a role in the development of these diseases. Cardiovascular disease, obesity, and diabetes are most prevalent in developed countries. Research shows that lentil consumption may help alleviate this problem because of the nutritional benefits it provides. See Table 1 for a profile on the nutritional quality of lentil.

Table 1. Nutrition facts for lentils

Nutrition Facts **Per 125 ml (87 g)**			
Amount		**% of Daily Value**	
Calories	240		
Fat	1.0 g		2 %
Saturated + Trans	.0 mg 0 g		
Cholesterol	0 mg		
Sodium	0 mg		0 %
Carbohydrates	42.0 g		14%
Fibre	9.0 g		36%
Sugars	2.0 g		
Protein	19.0 g		
Vitamin A	0%	Vitamin C	6%
Calcium	4%	Iron	40%
Thiamin	25%	Riboflavin	10%
Niacin	25%	Folate	95%

Adapted from, "*Lentil Superfood brochure*", Saskatchewan Pulse Growers

Additional nutritional information is available from the Saskatchewan Pulse Growers website: http://www.saskpulse.com/

Adaptation

Lentil is a cool season crop with a relatively shallow root system (0.6 m or 2 ft.) and is moderately resistant to high temperature and drought. Lentil has an indeterminate growth habit, often continuing to flower as long as growing conditions remain favourable for vegetative growth. Therefore, a moisture or nitrogen stress is required to encourage seed set and hasten maturity. Lentil does best in soil with pH levels of six to eight and will not tolerate water-logging, flooding, or soils with high salinity.

In Saskatchewan, lentil is best adapted to the Brown and Dark Brown soil zones, but can be grown successfully in the Thin Black soil zone in years without excessive moisture.
In the Brown soil zone, lentil performance is best on fallow in medium to fine textured soils, or on stubble using direct seeding techniques. In the Dark Brown, moist Dark Brown and Thin Black soil zones, lentil grown on stubble tends to receive a stress needed to reduce the time to maturity, prevent excessive vegetative growth and reduce the risk of damage from early fall frost. To date, most lentil production in Saskatchewan has been of the large green market class, but red lentil production has recently grown to equal or greater proportion. There is opportunity to expand lentil production into the moist Dark Brown and Thin Black soil zones by increasing red and small green production. These more determinate red and small green varieties are better suited to the cooler moist lentil growing areas of the province. Research is ongoing to determine the best varieties and agronomic practices for lentil production in these areas.

Rotational Considerations

Lentil production is most successful when grown in rotation with cereals, such as spring or durum wheat. Crop rotation research conducted by Agriculture and Agri-Food Canada (AAFC), Swift Current, shows yields of cereal crops grown on stubble were best following lentil or pea crops. Lentil rooting depth was found to be about 0.6 m (2 ft.). This allows the following wheat crop, with a rooting depth to 1.8 m (6 ft.), to extract water from a greater depth and produce higher yield and protein.

Lentil is susceptible to ascochyta blight and anthracnose (see Disease Control), and careful consideration must be given to crop rotation to reduce the risk of these diseases. In areas where ascochyta blight is a problem, avoid lentil production more often than one in three years in the same field. In areas where anthracnose is a problem, avoid seeding lentil more often than one in four years in the same field, and avoid seeding lentil in fields adjacent to lentil stubble, as anthracnose is easily transferred on wind-blown dust and residue. Lentil seedling diseases, such as root rots and seedling blights, are more common in fields where pulse crops have been grown more frequently. Sclerotinia stem rot may be a problem if lentil follows other susceptible broadleaf crops, such as canola, sunflower, mustard or pea.

Volunteer flax, canola or mustard may be difficult to control in lentil. Volunteer cereals, such as barley or durum wheat, are difficult to clean from lentil seed and should be controlled in the field.

In order to avoid class contamination, experienced lentil growers refrain from growing red and green cotyledon lentil in rotation in the same field for at least four years. As is the case with mustard and canola production, it may be advantageous to never grow red and green lentil in the same field, but designate fields for one colour only.

Fallow fields with high levels of available nitrogen and moisture may produce excessive vegetative growth at the expense of seed production, especially in late-maturing varieties.

Research conducted at AAFC, Swift Current, indicates that lentil seedlings benefit from the protection of standing cereal stubble, as the seedlings are less prone to damage by wind or heat. However, lentil seedlings emerging through inadequately spread crop residue can be more susceptible to late spring frost. Lentil does not provide much crop residue.

Lentil is a very poor competitor to weeds, so selection of a mostly weed-free field is essential as few herbicides are registered for use. Perennial weeds, such as Canada thistle and sow thistle, should be controlled in the years prior to lentil production. Lentil is susceptible to the soil residues of some herbicides used in previous years. It is important to maintain herbicide records each year and to avoid seeding lentil in fields with potentially damaging herbicides. The Saskatchewan Agriculture publication *Guide to Crop Protection* contains more information about herbicides and their soil residual properties.

Varieties

Green varieties

The majority of lentil varieties grown in Canada have green seed coats and yellow cotyledons (seed leaves). Green lentil is divided into three market classes in Canada - large green, medium green and small green. The release of the large green variety Laird) by the Crop Development Centre in Saskatoon in 1980 was the single most important factor contributing to the rapid expansion of the lentil industry in Canada. Most of the large green varieties require early seeding because they are relatively late maturing and indeterminate. They produce tall plants which can be prone to lodging, and are susceptible to botrytis (grey mould) infestations in high rainfall areas There are some large green lentil varieties with tolerance to Clearfield herbicides.

CDC Richlea is a medium green lentil similar in size and colour to the Chilean lentil grown in United States. It is high yielding and susceptible to ascochyta blight. CDC Meteor is a high yielding, ascochyta resistant, medium green variety with similar seed and plant characteristics as CDC Richlea. CDC Impress CL is a Clearfield variety with herbicide tolerance. It is very similar to CDC Meteor; however, it has marginally better resistance to Race 1 anthracnose, but yields are lower.

See the Saskatchewan Agriculture publication, *Varieties of Grain Crops* for more information on lentil varieties.

Red varieties

Canada is an important producer and exporter of red lentil. Red lentil varieties typically have brown to pale green seed coats with red cotyledons. Red lentil accounts for more than half the world trade of the crop and is sold in either whole seed or split form. Processing facilities capable of de-hulling and splitting red lentil suitable for the world market have been built in Saskatchewan.

CDC Redberry and CDC Rouleau have grey seed coats and are resistant to both ascochyta blight and Race 1 anthracnose. CDC Redberry and CDC Red Rider have a larger seed size compared to other red lentil varieties. CDC Impact CL, CDC Maxim CL, CDC Imperial CL, and CDC Impala CL are Clearfield red lentil varieties released in Canada. CDC Maxim CL is similar to CDC Redberry, but is tolerant to the Clearfield herbicides. The Saskatchewan Agriculture publication, *Varieties of Grain Crops* includes annually updated lentil variety information.

Other varieties

Small quantities of French green or dark speckled market class lentil varieties are produced in Saskatchewan. Varieties such as Indianhead (called Beluga in the United States) are produced in small volumes in western Canada and are sold into niche (specialty) markets.

Inoculation

Lentil inoculated with the proper rhizobium strain of bacteria is able to fix a significant portion of its nitrogen requirement from air in the soil. For this to occur, the seed or the soil surrounding the seed must be inoculated or treated with an inoculant formulated for

lentil that contains compatible rhizobium bacteria. The rhizobia enter the root hairs of the plant and induce nodule formation. The plant provides energy and nutrients for the bacteria living inside the nodules and the rhizobia, in return, convert atmospheric nitrogen to a form that can be used by the plant. The maximum benefit from nitrogen fixation is derived if the supply of available soil nitrogen is low and the soil moisture and temperature levels are good at the time of seeding. Rhizobium bacteria may die if they are exposed to stresses such as high temperature, drying winds, direct sunlight, or chlorinated water.
Therefore, both inoculant products and inoculated seed should be handled with care and every effort must be made to plant the inoculated seed into moist soil as soon as possible after inoculation. Rhizobium bacteria on inoculated seed will soon die if the seed is placed into a dry seedbed.

Rhizobium bacteria may be sensitive to direct contact with granular fertilizer, so consequently, do not tank mix fertilizer with inoculated seed. Inoculants are also sensitive to some seed-applied fungicides (see Disease Control). When using a combination of fungicide and inoculant, apply the fungicide to the seed first, allow it to dry and then apply the inoculant immediately prior to seeding. Granular inoculants are less sensitive to seed-applied fungicides than other inoculant formulations because the granular product does not have direct contact with the seed treatment. The Saskatchewan Ministry of Agriculture publication titled *Inoculation of Pulse Crops* provides more detailed information on the use of nitrogen-fixing inoculants.

Seeding
The use of high quality seed is extremely important for successful lentil production. It is important to have lentil seed tested by a seed-testing laboratory for germination, purity and seed-borne disease. Seed-borne diseases, such as ascochyta blight and botrytis can reduce seedling vigour and lead to yield and quality losses (See Disease Control).

Lentil seed is susceptible to mechanical damage during harvest, handling or seeding operations. Dry seed (less than 14 per cent moisture) is brittle and can easily crack or chip, leading to reduced germination. Moisturizing the seed with water before seeding can reduce mechanical injury. The Prairie Agricultural Machinery Institute (PAMI) has produced a factsheet, *Moisturizing Pulses to Reduce Damage* (See Additional Information).

Firm, weed-free seedbeds on well-drained soils are best for lentil production. Stony fields should be avoided or rolled after seeding to bury loose stones and smooth soil ridges that may present problems at harvest. The recommended seeding depth for lentil is 3-8 cm (1-3 in.). See the Weed Control section for seeding depth considerations when using metribuzin herbicide.

The desired plant population for lentil is 130/m^2 (12/$ft.^2$). Crop stands of this density provide better competition against weeds and will result in higher yields. Crop stands of greater density may increase the risk of foliar diseases, especially in wetter areas. Wider row spacing can be used in high moisture regions to reduce the risk of a thick crop canopy leading to poor pod set, foliar disease development and lodging.

The optimum seeding rate for each seed lot depends on its seed size. For example, the large green lentil variety CDC Sovereign has an average seed size of 66g/1,000 seeds.

The following formula should be used to determine the intended target seeding rate for individual seed lots.

$$\text{Seeding rate (lb./ac.)} = \frac{(\text{target \# plants/ft.}^2 \times \text{1000 seed wt. g}) \times 10}{\text{\% field emergence or survival}}$$

Example: CDC Sovereign $\quad \frac{(12 \text{ plants/ft.}^2 \times 66 \text{ g}) \times 10}{95 \text{ (anticipated \% of survival)}} = 83$ lb. /ac. seeding rate

The seeding date should be as early as possible, provided the average soil temperature at depth of seeding is greater than 5 C and the soil is not excessively wet. Lentil seedlings can withstand some late spring frost. Even if the frost is severe enough to kill the main shoot, the lentil plant can regrow from one of the scale nodes at or below the soil surface.

Early seeding can help avoid flower blast caused by high temperatures during flowering. Early seeding may also increase the height and size of the plant at time of first bloom, allowing the lower most pods to develop further above ground to ease harvest.

Fertilization

A properly conducted soil test can produce excellent guidelines for lentil fertility needs. Generally, nitrogen fertilizer application is not required if nitrogen fixation is optimized. However, soils with low available N under 35lb./ac., may see benefits with plant health by using small amounts of starter N.

When properly inoculated with the appropriate rhizobia inoculant, lentil can derive 70 per cent or more of its nitrogen requirement through fixation in good growing conditions. The remaining nitrogen comes from what is available in the soil at seeding, plus nitrogen released from the soil during the growing season.

Nitrogen

Nodule formation and subsequent nitrogen fixation are very sensitive to external nitrogen sources, including fertilizers and available soil nitrogen. In general, as the supply of nitrogen from soil and fertilizer increases, the amount of nitrogen fixed by the plant decreases. Low levels of available nitrogen may have little impact on nodulation and nitrogen fixation. However, when the combined levels of soil and fertilizer nitrogen exceed 28-40 kg/ha (25-35 lb. /ac.), any additional nitrogen will reduce nodulation and nitrogen fixation. Combined levels of soil and fertilizer nitrogen greater than 55 kg/ha (50 lb. /ac.) can dramatically delay nodulation and reduce or eliminate nitrogen fixation.

It can take up to three to four weeks after planting before nodules are fully functioning. In soils with nitrogen levels less than 11 kg/ha (10 lb./ac.), early plant growth may be poor and plants may appear yellow due to a nitrogen deficiency.
This early nitrogen deficiency can be corrected by adding low levels of starter- nitrogen at seeding. Similarly, if nitrogen fixation is not optimized due to unfavourable growing

conditions (e.g., relatively dry seedbed), lentil may benefit from low rates of starter nitrogen in some years. If the available soil nitrogen level is very low (less than 17 kg/ha or less than 15 lb./ac.) at planting, a small amount (20 kg/ha or 18 lb./ac.) of starter-nitrogen fertilizer may benefit the crop in some years. Although high levels of starter nitrogen may appear to help the crop overcome a nitrogen deficiency during early crop growth stages, final seed yield may not increase.

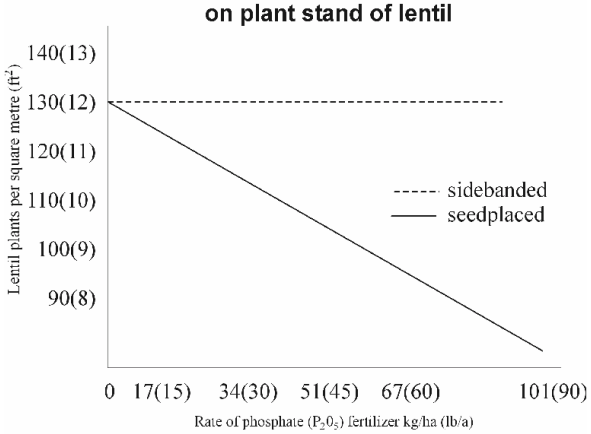
When used in a fertilizer program, side banded or seed placed monoammonium phosphate (example 12-51-0) provides small amounts of starter-nitrogen needed for early plant growth and, depending on the soil test, may provide all the starter- nitrogen required. The Saskatchewan Ministry of Agriculture publication titled *Inoculation of Pulse Crops* includes information on actions to take if the crop fails to fix nitrogen through inoculation.

Phosphorous

Lentil has a relatively high requirement for phosphorus to promote the development of extensive root systems and vigorous seedlings. Encouraging vigorous root growth is an important step in promoting good nodule development. Phosphorus also plays an important role in the nitrogen-fixing process. Lentil grown on soils testing low in available phosphorus may respond to phosphate (P_2O_5) fertilizer. As with cereals however, dramatic yield responses are not always achieved with P_2O_5 fertilizers. Even if seed yield increases are not achieved every year, a lentil crop may benefit from improved frost, disease, and drought tolerance because of phosphorus application.

The maximum safe rate of actual phosphate applied with the seed is 22 kg P_2O_5/ha (20 lb./ac.) in a 2.5 cm (1 in.) spread and 15-18 cm (6 to7 in.) row spacing under good to excellent moisture conditions. Rates of seed-placed fertilizer must be reduced if the seedbed has less than ideal moisture conditions. Higher rates of P_2O_5 fertilizer placed with the seed can damage the emerging seedlings and reduce the stand. If higher P_2O_5 rates are required, banding the fertilizer away from the seed (sideband or mid-row band) is recommended. Research conducted over a three- year period indicated that increasing rates of seed-placed monoammonium phosphate (11-55-0) resulted in reduced stands of lentil, compared to side-banded P_2O_5 application (Figure 6). In this study, even low rates of P_2O_5 fertilizer reduced the stand, but the benefit due to increased seed yield outweighed the loss due to stand reduction. It is important to recognize that lentil is a poor weed competitor, so stand reduction can lead to serious yield reduction.

Figure 6. Effect of phosphate fertilizer rate on plant stand of lentil



Adapted from: J.L. Henry, A.E. Slinkard, and T.J. Hogg 1995.

Sulphur
Some soils in Western Canada are testing deficient in sulphur. A 30 bu./ac. lentil crop requires about the same amount of sulphur as a 40 bu/ac wheat crop; approximately 9-11 kg/ha (8-10 lb./ac.). Soils testing low in available sulphur should have this deficiency corrected by side banding, mid-row banding or broadcasting ammonium sulphate, which contains sulphur in a plant available form. The Saskatchewan Agriculture publication *Sulphur Fertilization in Crop Production* contains additional details and options for correcting sulphur deficiencies.

Micronutrients
Micronutrient deficiencies in lentil production have not been identified. If a micronutrient deficiency is suspected, consult an agronomist to help identify the problem. It is advisable to analyze soil and plant samples within the suspect area and compare the analysis to soil and plant samples collected from a non-affected area of the same field. If the analysis confirms a micronutrient deficiency at a relatively early growth stage, a foliar application of the appropriate micronutrient fertilizer can correct the problem.

The Saskatchewan Ministry of Agriculture's publication titled *Guidelines for Safe Rates of Fertilizer Applied with the Seed* provides more information about fertilization of lentil.

Land Rolling
Lentil fields should be rolled to provide a smooth and level surface for harvest. Land rolling can be done before the crop emerges, but this practice can lead to increased soil erosion if the soil surface is dry. Research indicates that land rolling after crop emergence can be successfully completed up to the five to seven node stage, without significant yield loss. Land rolling past this stage can damage plants, increase the spread of foliar diseases and reduce yield. Best results are obtained if rolling is done when plants are slightly wilted and the soil surface is dry. Rolling should not be done on wet soils or when the crop is damp or stressed by extreme heat, frost or herbicide application.

For more information on land rolling pulse crops, consult the Alberta Agriculture and Forestry publication *Land Rolling Guidelines for Pulse Crops in Western Canada*.

Weed Control
Lentil is a poor competitor against weeds. Good weed control in lentil requires a long- term strategy involving the entire crop rotation. It is very important to control perennial weeds, such as Canada thistle, sow thistle or quack grass in the years prior to seeding lentil. Volunteer canola, mustard and flax are difficult to control in lentil. Volunteer wheat and barley are difficult to clean from small-seeded lentil and should be controlled in the field. Weeds that germinate late in the season, such as Russian thistle, kochia and wild tomato, cause severe competition to the crop. They interfere with harvesting, increase dockage and increase staining and moisture levels in the harvested seed.

Early seeding is important to allow the crop to better compete with weeds. Research completed at AAFC, Scott, showed that post-emergent harrowing with a tine harrow can be used to control weed seedlings when the crop is very short (less than 10 cm or 4 in.), provided that the foliage is dry and the operation is done on a warm, sunny day. An

increased lentil seeding rate should be used to offset the plant losses during harrowing.

Lentil is susceptible to the soil residues of some herbicides used in previous years (see Saskatchewan Agriculture's, *Guide to Crop Protection*). Lentil is also sensitive to herbicide drift. Inadvertent drift from broadleaf weed herbicides can be detrimental and cause slow crop growth, reduce yield, or both. Sprayer tanks should be thoroughly cleaned before applying any crop protection product on lentil, and producers should inform their neighbours about the location of their lentil crop.

During periods of crop stress (heat, drought, frost, or after land rolling) the ability of the lentil crop to tolerate herbicide application may be reduced. Crop injury can be reduced by waiting approximately four days after the crop stress before applying the

herbicide, by maintaining water volumes at label recommendations and by applying the product during the evening.

A late fall application of a phenoxy herbicide such as 2, 4-D or MCPA can be used at rates of 280 g ai/ha or less to control winter annual broadleaf weeds in fields planned for lentil production. Spring applications or applications that include dicamba should be avoided to prevent possible crop injury. A pre-emergence burn- off treatment of glyphosate can be used in lentil to control weeds before the crop emerges.

See Saskatchewan Agriculture's *Guide to Crop Protection t*o check herbicides that are registered for grassy and broadleaf weed control in lentil. Make sure to follow label directions and apply the herbicide at the correct time of plant development.
Some herbicides can move in the soil after heavy rainfall, so if the use of these products is anticipated, lentil must be planted at least 5 cm (2 in.) deep to prevent injury to seedlings. For example, do not use SENCOR in soils with less than four per cent organic matter.

EDGE and trifluralin (RIVAL, TREFLAN) are registered only for fall application. A spring application, especially in lighter soils, can cause seedling injury and may lead to increased incidence of seedling diseases such as rhizoctonia wire stem (see Disease Control).

Glyphosate is registered for pre-harvest weed control in lentil. This application is used to control perennial weeds, such as Canada thistle, sow thistle and quack grass in-crop before harvest begins. Do not use seed from crops treated with a pre- harvest application of glyphosate, as abnormal germination and seedling development will likely occur. Always read and follow label recommendations when using crop protection products. The Saskatchewan Ministry of Agriculture's publication *Guide to Crop Protection* provides more information on the use of herbicides and on lentil seedling growth stages.

Disease Control
Seedling blight and root rot are soil-borne diseases that can infect lentil seedlings. These include **rhizoctonia** wire stem, **pythium** damping off, **fusarium** root rot, Aphanomyces and **botrytis** grey mold. These disease pathogens are present in all Saskatchewan agricultural soils, and can infect and kill individual seedlings from germination to the early flowering stage. Lesions develop at the base of the stem, causing discolouration and constriction of the

stem. Diseased plants turn yellow and die. Usually, only scattered plants are infected, so these diseases rarely cause economic loss. Seedling stress or damage due to environmental or herbicide injury can lead to an increase in the incidence of seedling blight, especially wire stem. Crop rotations that include cereal and oilseed crops can reduce the build up of soil-borne pathogens specific to lentil. However, rotation with cereals will not decrease fusarium root rot, as cereals are also hosts of this pathogen. In soils where Aphanomyces is isolated, rotations between lentil crops may need to be extended to six years.

A seed test can determine if lentil seed is infected with a seed-borne disease, such as **ascochyta blight**, **botrytis** and **anthracnose** (see Saskatchewan Agriculture's publication *Guidelines for Seed-Borne Diseases of Pulse Crops* for more information on seed testing and tolerances for seed-borne diseases). See Saskatchewan Ministry of Agriculture's *Guide to Crop Protection* for seed treatment fungicides that are registered for the control of some seedling blights and seed rots of lentil. If a seed treatment fungicide is used, it should be applied to the seed first and allowed to dry before applying a nitrogen-fixing inoculant.

Heat canker, which occurs when young lentil seedlings are exposed to hot soil surface temperatures, can easily be confused with seedling blight. With seedling blight, the base of the stem becomes pinched and the seedling turns yellow and dies. With heat canker, the pinched stem usually remains white, and often new shoots will start from the scale nodes.

Ascochyta blight is a serious foliar disease of lentil in Western Canada. It can be seed-borne or residue-borne. Lesions form on leaves, stems, pods and seed.
Lesions appear as tan or grey spots with dark margins, and often have tiny black- fruiting bodies in the centre. This disease is most damaging to maturing pods and seeds if prolonged wet weather occurs during July and August. Severely infected seed lots may not be marketable or will be downgraded severely due to discolouration. Several lentil varieties have resistance to ascochyta blight (See Saskatchewan Ministry of Agriculture's *Varieties of Grain Crops*). Producers are advised to have their seed tested for seed-borne ascochyta blight at an accredited seed test laboratory.

Ascochyta blight inoculum also over-winters on lentil residue, so producers should not plant lentil on lentil stubble. The Saskatchewan Ministry of Agriculture's publication *Ascochyta Blight of Pulse Crops* contains more information on this disease.

Anthracnose is a foliar and stem disease found in most lentil producing areas in Western Canada. Research has identified two races of anthracnose. A few lentil varieties have been introduced with resistance to Race 1 (Ct1), but no varieties are resistant to Race Ct0. The anthracnose fungus causes grey to cream lesions on leaves and stems. Lower leaflets turn yellow and brown and drop to the soil surface. The lower stems become cankered by the disease and the plants die prematurely.

Diseased patches in the crop can expand rapidly and appear as yellow or grey patches within an otherwise green field. The disease is favoured by warm, moist weather and commonly kills the infected lentil plant before seed is produced.
Anthracnose can be spread on wind-borne residue and dust during harvest, and can be residue-borne in fields for a number of years. Although anthracnose is not considered a seed-borne disease, producers should attempt to use seed with low infection

levels, as there are no seed treatment fungicides effective at controlling seed-borne anthracnose for lentil. **Extend crop rotations to avoid planting lentil in the same field for at least four years.**

There are a few foliar fungicides registered for ascochyta bight and anthracnose in lentil. Generally, a fungicide should be applied before the plant canopy closes completely. However, follow label directions for correct time of application. The goal is to protect healthy plant material if disease inoculum is present in the field and weather conditions favour the disease. Up to three applications may be required if conditions favouring the disease persist.

Some of the foliar fungicides ~~is~~ registered for the control of ascochyta blight and anthracnose in lentil are designed to function as protectants. In most instances, the first application should be made when bud formation is evident. Multiple applications may be required if conditions favouring the disease persist. Be sure to follow application instructions found on the label of each product.

Currently, a few systemic foliar fungicides are registered for Ascochyta blight and anthracnose in lentils. Some are members of the strobilurin group of fungicides such as Headline EC and Quadris, and development of resistance of fungal pathogens to this group of fungicides is of great concern. No more than two applications per year of any strobilurin fungicide should be made to the same field, as disease resistance could develop. Lance and Proline 480EC are also systemic fungicides registered for the control of ascochyta blight and belong to a different fungicide group than the strobilurins and can be used in rotation to prevent fungal resistance.

Botrytis grey mould causes stem and pod rot during the flowering and seed filling stages and can cause economic losses. Soil-borne inoculum is present in all fields, but this disease is typically only a problem in heavy vegetative stands that have lodged in wet, cool summer weather. Leaves wilt and drop off, pods fail to fill, and infected areas turn grey to brown. Clouds of grey spores are dispersed into the air as infected areas are harvested. Producers are cautioned to use dust masks to prevent breathing difficulties. There are foliar fungicides registered for the control of the foliar blight caused by botrytis grey mould.

Sclerotinia white mould may occasionally occur in maturing lentil crops under high moisture conditions that promote vegetative growth and lodging, and can cause economic losses. Lentil crops are at increased risk to sclerotinia infection if grown in rotation with other susceptible crops, such as canola, pea or sunflower. There are foliar fungicides registered for the control of sclerotinia stem rot on lentil. All lentil tissues, including leaves, stems, pods and flowers, can be infected by spores of sclerotinia.

Stemphylium blight has been identified in a number of lentil fields in Saskatchewan. This foliar disease has similar leaflet drop symptoms as anthracnose and similar lesions on leaves as ascochyta blight. It has not yet been confirmed as causing significant yield losses, because the disease tends to show up later in the summer. The fungus thrives under warm (28 C) and wet conditions.
There have been differences noted between lentil varieties regarding their susceptibility to stemphylium blight.

For more information on fungicides, consult the product labels or the current edition of the Saskatchewan Ministry of Agriculture's publication *Guide to Crop Protection*. For assistance in identifying plant diseases of lentil, consider utilizing the services of the Ministry's Crop Protection Laboratory at 306-787-8130.

For more information on identifying lentil diseases, refer to the Ministry's publication titled *Lentil Diseases: Identification and Management – FAQ.*

Insect Control

Grasshoppers generally do not favour lentil foliage. However, they do eat flower buds, flowers and developing pods. Damage from grasshopper feeding is variable. Slight damage to the integrity of the pods may result in premature shattering and seed loss. These same damages to the pods may also allow access for moisture and fungal organisms making the seeds more susceptible to disease and staining. Research indicates that two grasshoppers per square metre will reduce yields enough to warrant an insecticide application. Insecticides are registered for control of grasshoppers in lentil. Optimum control is usually achieved when grasshoppers are young. Mature grasshoppers are more difficult to control and usually require higher levels of insecticide application. It is critical to respect the pre-harvest interval (PHI) of the insecticide selected to maintain crop marketability.

For more information on grasshopper damage of lentil, see the Saskatchewan Ministry of Agriculture's factsheet *Grasshoppers in Your Lentil Crops.*

Cutworms may cause economic damage to newly-emerged lentil crops and therefore require insecticide application. The most common species of cutworm in Saskatchewan are the pale western cutworm and red-backed cutworm. See the Saskatchewan Ministry of Agriculture publication *Guide to Crop Protection* for information of registered insecticides.

The lygus bug can be a pest of lentil in the United States, but has not been a problem in lentil in Saskatchewan to date. There are registered insecticides to control lygus bug, pea aphid and potato leafhopper on lentil. The Saskatchewan

Ministry of Agriculture's publication *Guide to Crop Protection* provides more information about insecticides and insect monitoring.

Desiccation

A desiccant used to burn off crop foliage and weeds can reduce the time from maturity to harvest and reduce some harvesting problems. Desiccants do not speed maturity of the crop, so treatment is made at the same time that swathing would occur. It should be applied when approximately 30 per cent of the lower-most pods are tan coloured, and their seeds rattle when shaken.

Glyphosate is not a desiccant, but a pre-harvest application of glyphosate is registered in lentil for control of perennial weeds. It may provide some dry-down effect if weather conditions are warm and dry, and will kill the weeds over time. Do not apply glyphosate to crops to be used for planting seed, as it may cause uneven germination and abnormal seedling development. For more information on desiccants and pre-harvest weed control,

consult the product label or the Saskatchewan Ministry of Agriculture's publication *Guide to Crop Protection*.

Harvesting

The average yield of lentil in Saskatchewan is approximately 1,657 kg/ha (1,479 lb./ac.). Pick-up reels, lifter guards, floating or flexible headers and air reels can be added to harvest equipment to ease the handling of short-stature, tangled or lodged lentil. Fields that were land rolled are easier to harvest, as the swather or combine cutterbar must be operated very close to the ground. A slower ground speed may also be required when harvesting lentil, compared to cereal crops.

Many lentil varieties have an indeterminate growth habit and continue producing new flowers and pods until stopped by stress due to heat, drought, or low available nitrogen. Swathing should occur when about 30 per cent of the lowermost pods turn tan and their seeds rattle in the pods. Shattering may be reduced by swathing under conditions of higher humidity. Lentil swaths are prone to wind damage.

Lentil can also be straight cut using a combine equipped with a flex header, or with a pick-up reel and vine lifters when seeds and pods are fully mature, or after desiccation. Excessively dry seed will chip and peel during threshing. It is preferable to thresh at about 18 per cent moisture and use aeration to dry the sample to 14 per cent for green varieties and 13 per cent for red varieties for safe storage. The red lentil splitting industry prefers product with moisture content below 13 per cent to improve the efficiency in their splitting plant. Check with your red lentil buyer for any seed moisture content requirements.
Low cylinder or rotor speeds are required to reduce seed chipping and breaking during combining. Cylinder speeds of 250 to 500 RPM are normally used, depending on cylinder diameter and moisture content of the lentil seeds. Combine augers and grain augers should be operated at low speeds to reduce seed damage.

Storage and Handling

Lentil seed containing green weed seeds and other high moisture materials should be cleaned as soon as possible to prevent heating. Moisture levels up to 13-14 per cent and temperatures below 15 C are considered safe for lentil. The use of aeration fans to reduce moisture and temperature will improve storage. If supplemental heat drying is necessary, air temperatures should not exceed 45 C to preserve germination, and the sample should not be dried more than four to five percentage points per pass through the dryer.

Lentil varieties with green seed coats will discolour with age, thus reducing the grade. Producers should store lentil in dry, dark conditions. Seed from successive years should not be mixed, as the oldest seed will cause downgrading of the entire sample. Lentil should not be stored through a second summer season in order to avoid excessive discolouration and downgrading. Lentil seed is susceptible to increased chipping and peeling if handled in temperatures colder than -20 C. For more information on storing, handling and grading of lentil, consult the Saskatchewan Pulse Growers' publication *Growing Lentils*

Marketing
A list of lentil buyers and marketers is available in the Saskatchewan Ministry of Agriculture's publication *Saskatchewan Special Crop Marketing Company Listing*. Several marketing companies offer production contracts for lentil.

Economics of Production
The Saskatchewan Ministry of Agriculture's publication *Crop Planning Guide* includes information on projected costs of production and expected returns of green and red lentil in Saskatchewan.

For more information

- Contact the Saskatchewan Ministry of Agriculture's Agriculture Knowledge Centre, at 1 866-457-2377

- Visit the Saskatchewan Ministry of Agriculture's website at www.saskatchewan.ca/agriculture and look up the following publications:
  - Specialty Crop Report
  - Guide to Crop Protection
  - Ascochyta Blight in Pulse Crops
  - Varieties of Grain Crops
  - Inoculation of Pulse Crops
  - Saskatchewan Special Crop Marketing Company Listing
  - Crop Planning Guide
  - Securing Low Erosion Risks after Growing Pulses and Oilseeds
  - Soil Improvement with Legumes
  - Sulphur Fertilization in Crop Production
  - Guidelines for Safe Rates of Fertilizer Applied with the Seed

- Visit the Saskatchewan Pulse Growers website at www.saskpulse.com and look up Growing Lentils.

- Visit the Prairie Agricultural Machinery Institute's website at www.pami.ca and look up the publication *Moisturizing Pulses to Reduce Damage* or call PAMI at 1-800 567-7264.

- Visit Alberta Agriculture and Forestry's website at www.agric.gov.ab.ca and look up Land Rolling Guidelines for Pulse Crops in Western Canada.

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