Growing Flax Profitably

(Quick Tips Guide)

MANFLAX

Manitoba Flax Growers Association

Flax Council of Canada

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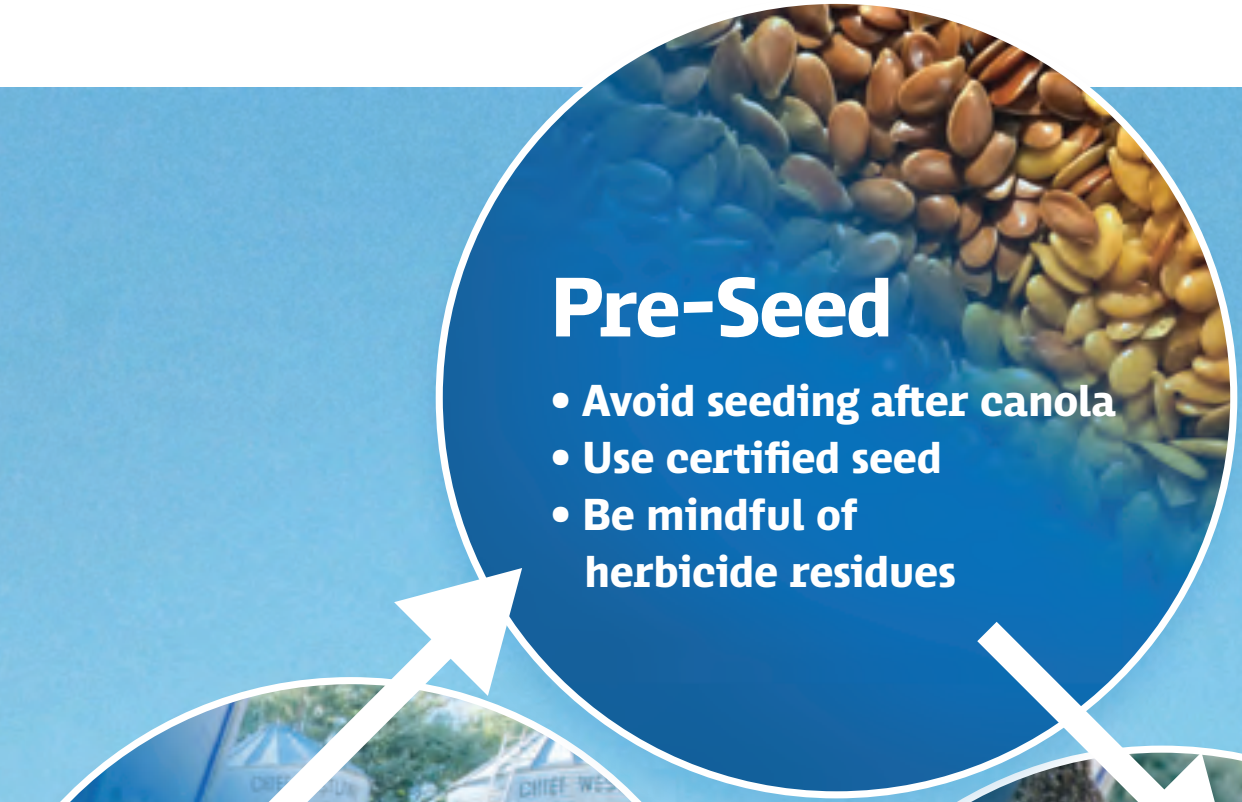
Summary of Key Management Activities in Flax



Pre-Seed

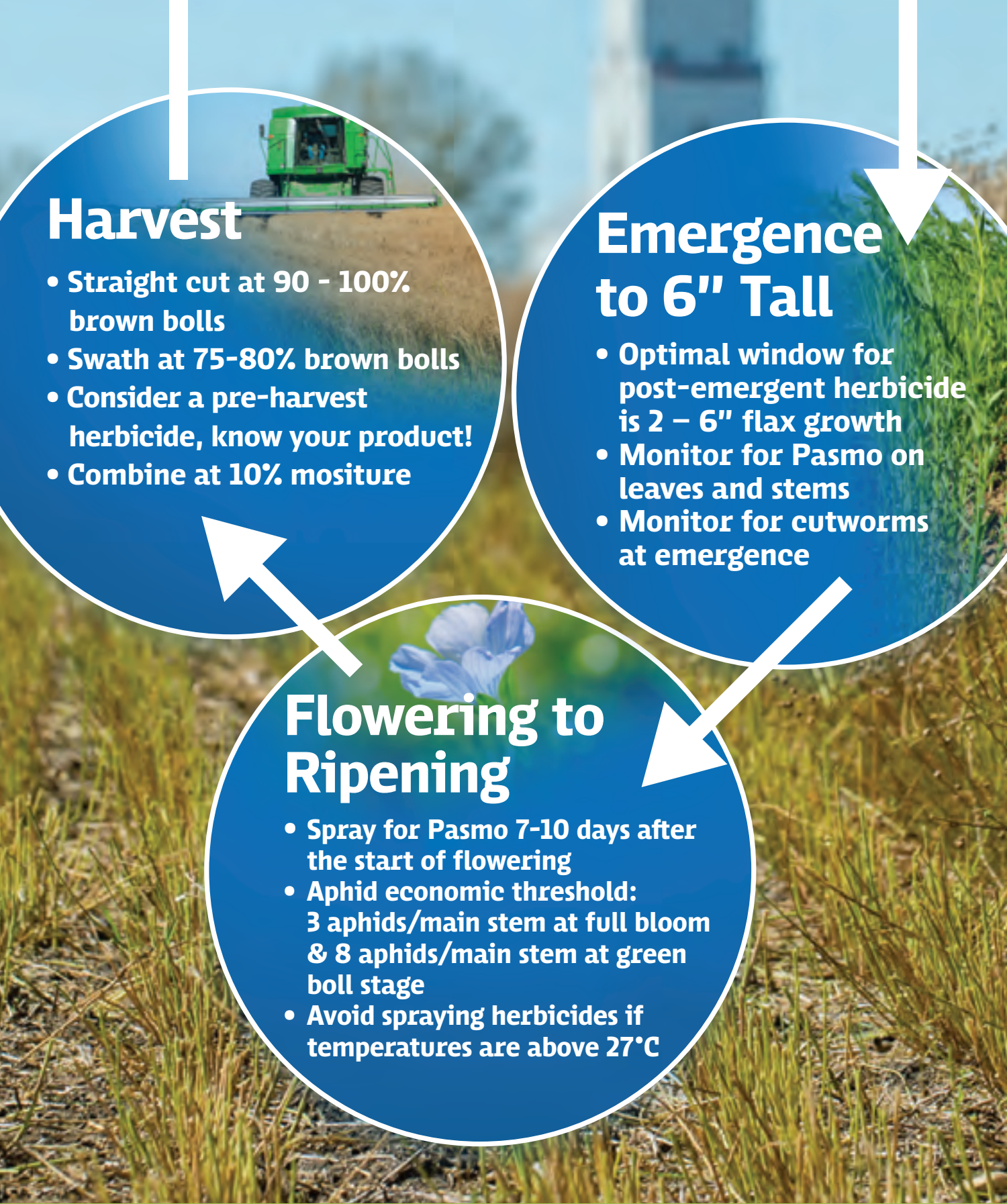
- Avoid seeding after canola
- Use certified seed
- Be mindful of herbicide residues

Storage

- Store at 8 - 9 % moisture
- Monitor frequently for first 6 weeks
- Keep it cool

Seeding

- Firm seed bed
- 40 - 50 lbs/ac seeding rate
- Seed mid-May for optimum yield
- Side-band fertilizer



Harvest

- Straight cut at 90 - 100% brown bolls
- Swath at 75-80% brown bolls
- Consider a pre-harvest herbicide, know your product!
- Combine at 10% mositure

Emergence to 6" Tall

- Optimal window for post-emergent herbicide is 2 – 6" flax growth
- Monitor for Pasmo on leaves and stems
- Monitor for cutworms at emergence

Flowering to Ripening

- Spray for Pasmo 7-10 days after the start of flowering
- Aphid economic threshold: 3 aphids/main stem at full bloom & 8 aphids/main stem at green boll stage
- Avoid spraying herbicides if temperatures are above 27°C

Before you seed

Crop Rotation

Crop rotation is an important management tool that has been shown to reduce disease presence, increase nutrient uptake and soil moisture availability. The table below is adapted from Manitoba Agricultural Services Corporation (MASC) "Harvested Acreage Reports" looking at yield of crops of previous crop stubble.

Table 1: Yield response (% 2000-2012 average yields) of Manitoba crops sown on previous crops

	Crop Planted					
Previous Crop	**Spring Wheat**	**Barley**	**Oat**	**Canola**	**Flax**	**Soybean**
Spring Wheat	88	100	101	104	103	102
Barley	90	87	93	100	98	95
Oat	89	87	84	92	95	104
Canola	103	105	104	84	88	102
Flax	96	106	99	100	77	89
Soybean	105	107	102	87	99	104
Yield (bu/ac)	42	61	88	32	20	28

Source: MASC Harvested Acreage Reports (2000-2012) from Manitoba contract holders

From the table, some of the key things to consider when planning what stubble to plant your flax on are:

- **Avoid Canola Stubble, but Go for Cereals!** Yields are lower (88%) when flax is planted on canola stubble. The main reason is Arbuscular mycorrhizal fungi (AMF), a symbiotic soil fungus that helps flax uptake early season phosphorus. In canola years, AMF are not needed, so populations decline, meaning when the flax needs them the following spring, the population is not there and phosphorus uptake can be reduced. Cereals do associate with AMP, so they are a better stubble seeding option.
- **Avoid Flax on Flax!** Yields are lower for most crops when planted on their own stubble. Reduced flax yields can be caused by build-up of diseases like fusarium wilt and pasmo which can cause them to infect the next crop earlier and with high levels of inoculums. As well, flax is a shallow rooted crop and very effectively leaves the soil rooting area dry, subsequent flax may be at a disadvantage in the dry soil zone if in-season rain is limited.

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- **Flax Makes a Great Stubble for the Next Crop!** As flax does not share the same diseases as many other crops it is a good 'disease break' crop in the rotation. Also, flax is shallow-rooted, which leaves moisture and nitrogen in lower soil depths for other deeper-rooted crops to access.

Re-Cropping Restriction with Residual Herbicide

The following table from the Manitoba Guide to Crop Protection, indicates herbicides to watch if used in years or months previous to flax.

More information on potential residue concerns may be released, so always check with the marketing company and Guide to Crop Protection if unsure http://www.gov.mb.ca/agriculture/crops/guides-and-publications/pubs/crop-protection-guide-herbicide.pdf

1 year re-crop	2 year re-crop	3 year re-crop	Fall applied only
2,4-D; Altitude FX/FX2; Amitrol; Retain; Trophy; AAtrex; Primextra II; Magnum; Barricade; Fluroxypyr + 2,4-D; Curtail M; Prestige XC; Eclipse III; Lontrel 360; Flucarbazone; Everest GBX; Imazamethabenz (Black soil); Infinity/Velo city m3; Kerb; Korrex; Metsulfuron (pH < 7, other soils); Muster; Paradigm; Pixxaro; Pulsar; Salute; Simplicity; Solo; Viper ADV; Tandem; Varro	Ares; Clever; Imazamethabenz (Brown soil); Mesulfuron (pH <7, brown and dark brown soils); Odyssey; Odyssey Ultra, Triton C	Metsulfuron (pH 7 – 7.9)	Trifluralin (can plant to flax in following spring)

Seed Source

Clean, disease-free seed with high germination is important to get the plant stand desired.

Use Certified Seed!

Ensures genetic purity for desired variety traits, such as disease resistance, lodging tolerance and maturity.

All current Canadian flax varieties are immune to rust, moderately resistant to Fusarium Wilt and Powdery Mildew. See the current issue for of SEED Manitoba current varieties and suppliers (www.seedmb.ca).

Be Careful of Damaging Seed Coats!

Use caution when seeding, the flax seed coat is fragile and can be damaged mechanically with excess augering, use of high of fan speeds in seeding equipment. Flax is also susceptible to environmental weathering.

Cracked seed

Split seed

Reductions in plant stand and seedling vigor will occur if seed coats are cracked, split, shriveled, weathered, frozen, or diseased.

Seed Treatment

Another thing to consider is the use of a seed treatment for flax, to reduce that impact of diseases such as seed rot, root rot and seedling blights caused by Rhizoctonia solani and Fusarium species. See your Provincial Crop Protection Guide for current products and rates. http://www.gov.mb.ca/agriculture/crops/guides-and-publications/pubs/crop-protection-guide-disease.pdf

Split seed

Weathered seed

Frozen seed

Seeding

Seed Bed Preparation

The ideal seed bed for flax is smooth, firm and moist for adequate soil to seed contact

Quick Tip! The foot print of a work boot should be no deeper than the thickness of the sole (i.e. ¾ - 1 inch)

Reduced Tillage

Flax has been found to have equal or better yields under reduced tillage (minimum or zero till) versus conventional tillage systems. This has been attributed to:

- Improved soil organic matter and soil moisture availability
- Increased arbuscular mycorrhiza colonization and rooting capacity
- Reduction of early weed emergence compared with conventional tillage systems.

Conventional Tillage

If spring tillage is required, shallow tillage is recommended in order to maintain a firm seedbed. Deep tillage can reduce stand establishment therefore packing before or after seeding may be required.

Seeding Rate

For maximum yield, farmers should generally seed between 40 and 50 pounds/acre.

- The optimum plant population is 30 plants/ft2 but stands of 15-20 plants/ft2 have shown to provide a good crop if occur after a frost
- Plant stands above 40 plants/ ft2 do not necessarily increase yield and may actually predispose the crop to lodging (see Photo Lodging).
- Yellow seeded varieties should be seeded at a slightly higher seeding rate, particularly if seed treatment is not used.

Seeding Depth

Flax should be sown into moist soil, 1.0 to 1.5 inches deep with row spacing 6 to 8 inches.

Flax seedlings are weaker and shallow seeding depth is more critical, however, too shallow and they may be prone to drought.

Soil crusting may result in poor stands and reduced yield potential.

Seeding Date

Generally, flax that is sown in early to mid-May results in maximum yield and minimal harvest challenges. Even though flax can be seeded until June 20 and receive full crop insurance, better yields occur if seeding is completed by June 1st. Seeding after June 1st usually results in:

- Decreased yield,
- Increased lodging,
- Lower oil content and oil quality,
- Increased prevalence of green stems and secondary growth, and
- May lead to difficulties in harvesting.

Table 2: Yield potential (% compared to average) for crops in Manitoba seeded on specific week/month

Seeding Week (week/month	Spring Wheat	Barley	Oat	Canola	Flax	Soybean
01/05	105	113	112	104	108	106
02/05	102	105	108	106	110	108
03/05	92	93	94	103	106	101
04/05	82	86	84	97	97	91
01/06	74	74	74	88	83	85
02/06	71	67	64	83	62	n/a
03/06	58	57	50	n/a	45	n/a
Average Yield (bu/ac)	45	59	83	33	21	31

Source: MASC Harvest Acreage Reports 2005-2013.

Frost Risk

- Emerging (cotyledon stage) plants: Can tolerate a frost to -3° Celsius if in short duration (<2 hours)
- Two leaf stage: Can tolerate approx. to -8°C for <2 hours, if hardened first.

Fertility

Soil tests should always provide the basis for fertilizer practices.

Placement

Side-banding or mid-row placement is this most effective method of fertilizer placement because:

- Flax is very sensitive to seed-placed fertilizer salts and even low rates may cause seedling injury.

Research has also shown that P-K-S in a single band did not negatively influence the response to nitrogen.

Flax Chlorosis

Table 3. Typical nutrient uptake (lbs/ac) by flax (based on 24 bu/ac) in Manitoba. Uptake refers to total nutrients contained in the crop.

N	P_2O_5	K_2O	S
62 - 76	18 - 22	39 - 48	12 - 15

Nitrogen

- Flax responds well to nitrogen (N) fertilizer when available soil N is low.
- Do not place N fertilizer with seed in seed row
- High rates of N may cause lodging

Phosphorus

- Flax prefers high soil phosphorus (P) levels originating from P fertilization of preceding crops (soil residual P)
- Follow ideal crop rotations for optimal nutrient uptake (i.e. do not follow canola with flax)

Potassium and Sulphur

- Potassium and sulphur deficiencies are soil specific, therefore knowing your soil type and soil testing is key to preventing these nutrient deficiencies

Iron and Zinc

- Iron chlorosis (yellowing of the leaves) is common in flax under wet soil conditions. Flax can grow out of this if wet conditions alleviated.
- Application of micronutrients is not recommended once symptoms have been observed as little benefit is provided
- Zinc chlorosis can often be confused for iron chlorosis, and can be confirmed with a soil test

For more detailed information regarding fertility in flax, contact your local agronomist, MAFRD specialist or check online at: http://www.gov.mb.ca/agriculture/crops/soil-fertility/index.html

Weed Management

Integrated Weed Management

Flax is a relatively uncompetitive crop with limited herbicide options for weed control. An integrated weed management (IWM) approach can be the most effective strategy for flax. Key factors to consider are:

- Controlling weeds in previous crops on the intended fields to reduce populations in the years when flax will be grown
- Planting a competitive variety (e.g. taller, short maturity)
- Use narrower row spacing (e.g. <10 inch spacing)
- Higher seeding rates (50-55 lbs/ac)
- Fertilizer placement to optimize uptake by the crop
- Early seeding dates (before 3rd week of May)
- Appropriately applied herbicides (e.g. right product, right stage, right conditions, right rate)

Crop Timing

Ideal weed control can occur at three stages of crop development.

- Pre-plant weed control
- Post-emergent weed control (flax is 2 to 6 inches)
- Pre-harvest or post-harvest weed control

The most effective time for control of annual grassy and broadleaf weeds is early in the growing season. Targeting perennial weeds early will delay flowering, but for the most effective control apply in the fall.

Most of the herbicides registered for post-emergent use in flax require a 60 day preharvest interval.

The Top 10 weeds in Manitoba flax[1]

1. **Wild/volunteer oats**
2. **(Wild) Buckwheat**
3. **Cleavers**
4. **Millet**
5. **Kochia**
6. **Pigweed**
7. **Chickweed**
8. **Lady's thumb**
9. **Wild/volunteer mustard/canola**
10. **Grasses - Other**

[1] Not in order of priority. According to the 2015 Grower Survey of Manitoba Flax Production, MFGA.

Herbicides for Weed Management in Flax

- Target weeds at the seedling stage
- Use at least 10 gal/ac (110L/ha) of water to ensure good coverage and reduce risk of injury to flax
- Always follow label instructions carefully. The following information was compiled from the 2015 Guide to Field Crop Protection (MAFRD) and should be referenced prior to application. https://www.gov.mb.ca/agriculture/crops/guides-and-publications/#gfcp

Pre-seeding and Pre-emergent Herbicides

Herbicide	Herbicide Group	Timing	Target weeds[2]
Authority	14	Pre-seeding	Kochia, Lamb's quarters, red-root pigweed, wild buckwheat
Avadex	8	Pre-seeding	Wild oat
Eptam 8-E	8	Pre-seeding	Annual and perennial broadleaf and grassy weeds
Fortress	3&8	Pre-seeding	Wild oat, green and yellow foxtail
Glyphosate	9	Pre-emergent	Annual and perennial broadleaf and grassy weeds

[2] For detailed information, reference the current Guide to Field Crop Protection.

Post-emergent Herbicides

Herbicide	Herbicide Group	Crop Staging	Target weeds[3]
Basagran	6	After 2 inches in height	Kochia, Lamb's quarters, redroot pigweed, wild buckwheat
Bromoxynil	6	2 to 4 inches	Wild oat
Buctril M	4&6	2 inches to early bud (best is 2 to 4 inches)	Annual and perennial broadleaf and grassy weeds
Clethodim	1	Tolerant at all growth stages (60 day Pre-Harvest Interval)	Wild oat, green and yellow foxtail
Curtail M	4	2 to 6 inches	Annual and perennial broadleaf and grassy weeds
Equinox	1	13.75 inches (35 cm)	Green foxtail, wild oat, volunteer cereals and quack grass
Lontrel 360	4	2 to 4 inches	Annual and perennial broadleaf weeds
MCPA/ MCPA K	4	2 inches to early bud (best is 2 to 4 inches)	Annual and perennial broadleaf weeds
Poast Ultra	1	Tolerant at all growth stages (60 day Pre-Harvest Interval)	Annual and perennial grassy weeds
Quizalofop	1	No leaf stage re-striction (82 day Pre-Harvest Interval)	Annual and perennial grassy weeds

[3] For detailed information, reference the current Guide to Field Crop Protection.

Pre-seeding and Pre-emergent Herbicides

Herbicide	Herbicide Group	Timing	Target weeds[4]
Glyphosate	9	Pre or post-harvest	Non-selective
Trifluralin	3	Post-harvest	Annual broadleaf and grassy weeds

[4] **For detailed information, reference the current Guide to Field Crop Protection.**

Environmental Considerations When Applying Herbicides

Flax can become more sensitive to herbicides when conditions become very hot and humid. This needs to be considered if spraying on days, when temperatures are exceeding 28°C. Specific herbicides list on their label (e.g. Buctril M) that they should not be applied when temperatures exceed 28°C and/or if temperatures exceed 28°C, 48 hours prior to application or are expected in the next 48 hours.

Even when it is not 28°C, a recommended time to spray flax is into the cool of the evening, not the going into the heat of the day to reduce the potential for crop injury.

Disease Management

Pasmo

When to look for

- Seedling stage to maturity
- Favored when conditions are hot and humid

Symptoms

- Can cause defoliation and premature ripening
- Circular brown lesions on leaves
- Brown to black bands that alternate with green, healthy bands on the stem

Factors favoring development

- High humidity and moisture
- Lodging favors development due to higher humidity
- Spores are dispersed by rain and wind

Pasmo on flax leaves

Control

- Seed early
- Use clean, disease free seed
- Use lodging-resistant varieties
- Good weed control to reduce humidity in the stand
- Maintain a crop rotation of at least 3 years
- Foliar fungicide applications around early flowering protect the crop, and reduce disease spread but may delay maturity

Pasmo brown banding on stems

Minor Diseases: Fusarium Wilt

When to look for

- Invades the roots at any growth stage, from seedling to boll formation

Flax fusarium wilt at seedling stage

Symptoms

- Look for browning, dead plants exhibiting downward turn like a "shepherd's crook"
- Roots turn ashy grey

Control

- Use a resistant/moderately resistant variety
- Maintain a crop rotation of at least 3 years
- Use a seed treatment

Flax fusarium wilt at adult stage

Seedling Blight and Root rot

When to look for

- Seedling to flowering stage

Symptoms

- Blighted seedlings turn yellow, wilt and die
- Single plants, patches or gaps in the row

Flax seedling blight

- Roots have red or brown lesions, dark, shriveled
- Flowering plants may wilt on hot days and turn brown prematurely

Control

- Use certified seed
- Reduce seed cracking at harvest by adjusting combine settings appropriately
- Use a seed treatment
- Maintain a crop rotation of at least 3 years
- Avoid legume
- Make sound agronomic choices at seeding

For more detailed information regarding disease in flax, contact your local agronomist, MAFRD specialist or check online at: http://www.gov.mb.ca/agriculture/crops/plant-diseases/index.html

Insect Management

Cutworms

When to look for

- Pre-emergence (Mid-May) to emergence (June)
- Can be found in the upper 3 – 4 inches of soil around damaged plants

Redbacked Cutworms

Symptoms

- Irregular pattern or patches in emergence
- Look for severed plants on the soil surface
- Damage may start on the highest part of the fields first

Pale Western Cutworms

Control

- Nominal threshold > 4 -5 larvae/m^2
- Determine if infestation is patchy or over the entire field
- If cutworms are 30 – 35mm, then they may have finished life cycle and may not warrant chemical control
- For best results, apply insecticides at night. Cutworms are nocturnal.

Potato aphid

When to look for

- Late June and early July, when the crop is flowering and developing seed
- Cut a minimum of 25 plants at flowering and 20 plants at early green boll stage at the soil surface and tap on a white surface. Count how many aphids fall off.

Potato Aphids

Symptoms

- Will cause reduced yield and reduced seed weight

Control

- Economic threshold is 3 aphids/main stem at flowering and 8 aphids/main stem at green boll stage
- Insecticides applied at full bloom will control aphids until harvest

For more detailed information regarding insects in flax, contact your local agronomist, MAFRD specialist or check online at: http://www.gov.mb.ca/agriculture/crops/insects/index.html

Getting Ready to Harvest

As the bolls turn brown, decisions need to be made about harvest operations. To increase ease of harvest, the crop needs to be swathed, desiccated or patience is needed to wait for a frost to kill the stalks.

Straight Cutting

- Straight-cutting flax with or without use of harvest aid product is common
- No risk of loss from flax rolling with strong fall winds
- Straight-cutting should occur when 90-100% of the field is at the brown boll stage.
- Use of a harvest aid can help speed up stalk dry down and kill green weeds in the field. Weeds can also increase the risk of spoilage in the bin.

Swathing

- Swath when bolls are 75 – 80 % brown (mature crop)
- Good alternative to straight cutting if re-growth occurs
- Maintain a stubble height of 4 to 6 inches
- Roll swaths to prevent from rolling in high winds

Frost Desiccation

- Immature seeds are damaged around -3 to -5°C range
- Leaves and stems are damaged around -4 to -7°C range
- Mature seeds are not damaged by frost

Delayed Harvest Concerns

- May result in weathering of seed (grey, dull, black) which can down grade flax, not making it eligible for better paying human consumption markets. Delayed crops or harvest can also make a crop more susceptible to experiencing a frost event.
- The most damage will occur to immature seeds in green bolls. Resulting immature seed could turn black or will be light test weight and lost at harvest. Immature seeds (>30% moisture) are damaged around -3 to -5°C range, mature seeds (<20% moisture) in brown bolls will not be damaged by a frost.

Combining

- Combine at 10% moisture
- Flax is more susceptible to damage due to a thin seed coat
- Adjust cylinder speed, fan speed, sieve opening and concave clearances to prevent cracking

- Use the manufacturer's recommendations to start and adjust setting depending on environmental and crop conditions.
- Usually early-sown flax is easier to thresh than late-sown flax

Harvest Aid Herbicides: What's the difference?

Product	Glyphosate	Reglone
What is it?	Pre-harvest herbicide	Desiccant
Mode of Action	Systemic	Contact
Application Timing Pre-harvest Interval	75% brown bolls 7 to 14 days (ideal conditions)	75% brown bolls When sample tests dry
Pros and Cons	• Slow acting • Kills crops and weeds, works on perennial weeds • Best on actively growing plants • Does not speed maturity • Low cost • Negatively affects seed germination	• Fast acting • Desiccates top growth of crops and weeds • Best on senescing plants • Does not speed maturity • Does not affect seed germination • High cost

Grain Storage

Dry commercial flax is 10% moisture, but flax should be **stored at 8 to 9% moisture**.

Moisture content in flax

- Damp > 13.5% moisture
- Tough 10.1 – 13.5% moisture
- Dry 10% moisture

Prevent heating and spoilage with these key steps:

Drying/Cooling

- Once in the bin, turn on the aeration fan for the first 24 hours in the bin, and then from 9 pm to 9 am to cool flax
- Consider moving grain into another bin, augering increases airflow through flax
- If seed is very tough or damp, consider using a grain drier
- Follow manufacturer's instructions for temperature and duration to avoid over-heating the flax and reduce the potential for fires.

Monitoring

- Check flax routinely for the development of hot spots at the top, bottom and middle of the bin
- If a hot spot is discovered or grain is not drying and cooling uniformly, consider moving grain out of the bottom of the bin and augering on the top to 'turn' the bin, as well augering increases airflow through flax.
- **First 6 weeks are critical because seed is still respiring (creates heat and moisture)**

Dockage:

- The presence of dockage can raise the moisture content of flax seeds enough to cause heating and moulding.
- When possible, dockage should be removed prior to long term storage.

Storage Insects

Storage insects in flax:

- **Saw-toothed grain beetle,**
- **Confused flour beetle,**
- **Merchant grain beetle, and**
- **Red flour beetle**

Storage insects are not typically a major problem in flax. The activity of insects is generally retarded below 18˚C. If flax seed is cool and dry, insects generally will not thrive.

Malathion should **not** be used for treating bins of flax and other oilseeds.

Straw Management

Poorly managed flax straw after harvest is going to cause headaches for the next crop. Flax straw is very fibrous and does not break down like cereal straw. Matted straw areas in subsequent years tend to have reduced plant stands due to the straw mat and the alleopathic exudates that the straw leaches out.

The options for straw management can include:

- Baling and removing straw;
- Chopping and spreading on the soil surface,
- Windrowing and burning straw.

Flax Straw Uses:

- Animal bedding,
- Winter insulation around homes,
- Chopped and blown onto nursery and fruit patches (e.g. strawberries),
- Unrolled onto septic fields
- In the industrial sector as specialty paper or as composite fibers.

NOTE: For the industrial purposes, straw must be adequately retted prior to baling. If interested in this market, the industrial company buying the straw will have specific requirements to be met. It is better to speak directly with them prior to baling so quality of the straw is not compromised. Baling and selling straw may not be an option, based on the straw market in the area. Issues with burning the straw is the reduced stubble on the fields to catch snow to replenish soil moisture for the next crop.

Metric/Imperial Conversions

Length	Weight	Volume
10 mm = 1 cm	1000 mg = 1 g	1000 ml = 1 L
100 cm = 1 m	1000 g = 1 kg	1000 L = 1 m3
1000 m = 1 km	1000 kg = 1 t	28.41 ml = 1 fluid oz
2.54 cm = 1 in	28.35 g = 1 oz	29.57 ml = 1 fluid oz (U.S.)
1 m = 39.40 in	1 kg = 2.20 lb	1 L = 1.76 pints
1 m = 3.28 ft	1 tonne = 2204 lb	1 L = 0.88 quart
1 m = 1.09 yd	1 tonne = 1.1 ton	4.55 L = 1 gal (Imp)
1 km = 0.62 mile	**Pressure**	3.79 L = 1 gal (U.S.)
Area	1 psi (lb/in2) = 6.90 kPa	1 m3 = 35.71 ft3
10,000 m^2 = 1 ha	**Power**	1 m3 = 1.3 yd3
1 ha = 2.47 acres	1 hp = 0.746 kW	1 bushel = 1.284 ft3 = 36.367 L
1 acre = 43,560 ft2	**Crop Bushel Weights**	
	56 lb/bu	
	39.368 bu/ tonne	

Export Grade Determinant Tables

Flaxseed, Canada Western/Canada Eastern

(Canadian Grain Commission, https://www.grainscanada.gc.ca/oggg-gocg/11/oggg-gocg-11f-eng.htm)

Grade name	Total removable material %	Foreign material included in dockage			
		Ergot %	Sclerotinia %	Stones %	Total including inseparable seeds %
No. 1CW/CE	2.5	0.05	0.10	0.05	1.0
No. 2CW/CE	2.5	0.05	0.20	0.05	1.5
No. 3CW/CE	2.5	0.05	*0.25*	0.05	2

Grade name	Brown seeded flax	Yellow seeded flax	Damage		
	Yellow seeded flaxseed and solin – CW only %	Brown seeded flaxseed and solin – CW only %	Broken %	Heated %	Total %
No. 1CW/CE	2	2	*12.5*	0.05	*12.5*
No. 2CW/CE	3	2	25	0.2	25
No. 3CW/CE	4	2	35	10	No limit within broken and heated tolerances

MANFLAX

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