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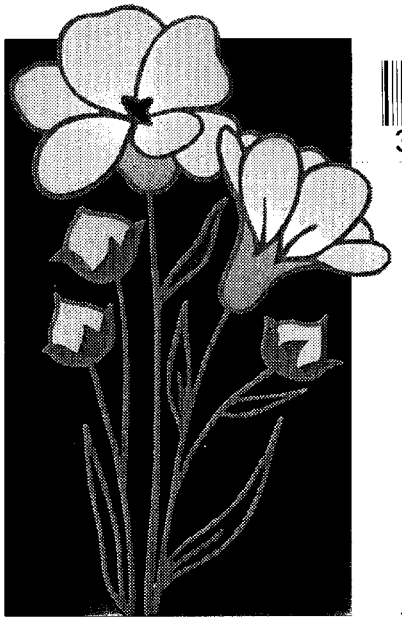

Flax Production in North Dakota

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History and Use

Flax *(Linum usitatissimum)* production goes back to ancient history. Flax remnants were found in Stone Age dwellings in Switzerland, and ancient Egyptians made fine linens from flax fiber. Flax production moved west across the northern United States and Canada during the 1800s. As settlers moved west, flax was one of the crops produced. North Dakota farmers have grown flax since the first sod was broken.

Two types of flax are grown, seed flax, for the oil in its seed, and fiber flax, for the fiber in its stem. Today producers in the Upper Midwest and the Prairie Provinces of Canada grow seed flax. Flax seed is crushed to produce linseed oil and linseed meal. Linseed oil has many industrial uses; linseed meal is used for livestock feed. The fiber in seed flax stems is used to make fine paper and as tow or padding in upholstered furniture. Cigarette paper is a major flax paper product.

Human consumption of flax seed is increasing rapidly for its high dietary fiber, omega 3 oils, and anticarcinogenic lignans. Flax seed oil is used as a vegetable oil by some consumers and processors say its use is doubling annually. Whole or (preferably)

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ground flax seed is consumed mostly in bakery products. "Omega eggs" from hens fed flax seed are produced and sold in the U.S. and Canada for their high omega 3 oil content. Much flax seed meal also is fed to pets and other animals. Research is being conducted to determine the health benefits of human consumption of flax seed products.

Fiber flax is grown in Europe and Asia. Its fiber is used to make fine linen cloth. Fiber flax varieties are very tall with few branches and low seed production. Seed flax is short, multiple branched and selected for high seed production. Straw from seed flax is harvested for fine paper products.

Growth and Development

Flax is an annual plant that has one main stem. At low plant populations, branching at the base similar to tillers in a cereal grain is seen. The stems terminate in a multi-branched inflorescence that bears blue to white flowers. Flax grows to a height of about 24-36 inches. The plant has a tap root, which may penetrate to 40 inches if growing conditions are good. It requires a 50-day vegetative period, 25-day flowering period, and about 35 days to mature. In years when moisture is available the maturation period may extend until a hard frost kills the crop. In a wet fall new flowers are often observed until frost.

Flax is a self pollinated crop. Seed is produced in a boll or capsule. A complete boll can have 10 seeds, but most bolls will have fewer, averaging around six seeds. Seed color can be brown, golden, or yellow. The seed is covered with a mucilaginous coating. This coating becomes sticky when wet. During a wet harvest, this coating may discolor, giving the seed a weathered appearance and a reduced test weight.

Growing the Crop

Flax is usually sown on the same type of land that grows wheat and barley. Poorly drained soils, soils subject to drought and erosion, and soils high in soluble salts should be avoided. Flax should fit into many small grain rotations. For optimum yields and disease control, do not plant flax closer than three years in any rotation. Also, try to avoid planting flax after potato, canola and sugarbeet.

Select a variety adapted to your area. Variety descriptions and recent yield performance can be obtained in NDSU Extension Circular A-1049, North Dakota Barley, Oat, Rye and Flax Variety Performance Descriptions, available at your county extension office. Consider planting certified seed. Certified seed is tested to ensure minimal weed content, high genetic purity and good seed viability. Certified seed consistently outyields bin run seed. All recent varieties have an adequate oil yield and oil quality (iodine number) to meet industry specifications.

Treating flax seed with a recommended fungicide is necessary. Seed treatment reduces seed decay and seedling blights and can significantly increase stand. A thicker and more uniform stand produces higher yields. Yellow-seeded varieties are more susceptible to seed decay than brown varieties. Treated seed stored for long periods needs to be retested for germination before use.

Flax can be grown under fertility levels similar to small grains. Use soil testing as a guide for applying fertilizer whenever possible. Recommendations for fertilizer use in flax are presented in NDSU Extension Circular SF-717, Fertilizing Flax. Zinc deficiency has been reported on flax in North Dakota, so information on zinc levels should be requested when soil testing.

Flax should be sown into firm, moist soil. A well-prepared, firm seedbed will ensure sowing at the proper depth. This, in turn, will result in

uniform germination and rapid, even emergence. A planting depth of ¾–1½ inches is recommended. Press drill packer wheels do a satisfactory job of firming the soil after planting. If other types of planters are used, special efforts are needed, such as a soil packer behind the drill or harrowing prior to planting to firm the seedbed. Avoid deep seeding as delayed emergence weakens seedlings, and weak seedlings are more likely to die. When pre-plant incorporated herbicides are used, shallow planting is a must to reduce stress on emerging flax seedlings. Flax seedlings are less able to force their way through a soil crust than wheat seedlings.

A stand of 70 plants per square foot is desired. However, if uniform, stands of 30 to 40 plants per square foot may provide a satisfactory yield. As stands drop below 30 plants per

■ North Dakota Flax Variety Descriptions

Variety[1]	Origin	Year Released	Relative Maturity[2]	Seed Color[3]	Plant Height	Wilt	Relative Yield Ability
NorLin	Can.	1982	early	br.	med.	MS	good
AC-Watson	Can.	1996	early	br.	short	MR	v.good
CDC-Valour	Can.	1996	early	br.	short	MR	v.good
Linton	ND	1985	early	br.	med.	R	v.good
Prompt	SD	1988	early	br.	med.	MR	good
AC-Emerson	Can.	1994	mid.	br.	med.	VR	v.good
CDC-Normandy	Can.	1995	mid.	br.	short	MR	v.good
Cathay	ND	1998	mid.	br.	med.	MR	v.good
Pembina	ND	1998	mid.	br.	med.	MR	v.good
Neche	ND	1988	mid.	br.	med.	R	good
Omega	ND	1989	mid	yel.	med.	MS	v.good
NorMan	Can.	1984	mid	br.	med.	MR	good
Rahab 94	SD	1994	mid	br.	med.	MR	good
CDC Arras	Can.	1999	mid.	br.	med.	MR	v.good
CDC Bethume	Can.	1999	mid./late	br.	med.tall	MR	v.good
AC Carnduff	Can.	1998	mid./late	br.	med.tall	MR	v.good
Flanders	Can.	1989	late	br.	med.	MS	good
Webster	SD	1998	late	br.	tall	MR	v.good
McDuff	Can.	1993	late	br.	med.tall	MR	v.good
AC Linora	Can.	1993	late	br.	tall	R	v.good
McGregor	Can.	1980	late	br.	tall	R	v.good
Selby	SD	2000	late	br.	tall	MR	good
York	ND	2002	late	br.	med.	R	v.good

[1] All varieties have resistance to prevalent races of rust; all have good oil yield and oil quality.
[2] Varieties listed order of mature.
[3] br=brown, yel=yellow.

For variety performance information, see NDSU Extension Circular A-1049, North Dakota Barley, Oat, Rye and Flax Variety Performance Descriptions (current year).

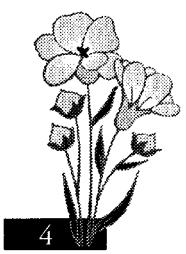
square foot, weed infestation and delayed maturity are added problems.

Seeding rates of 25 to 45 pounds per acre are common. In general, use lower rates in western North Dakota and higher rates in the east. Seed size varies among varieties and should also be considered. Yellow seeded varieties may require higher seeding rates because of lower seedling vigor. If untreated seed is used, then higher rates are necessary.

Early seeded flax generally produces the highest yields. This would be late April for all of the state except the northeast, where early May seeding is possible. Frost seldom kills flax seedlings. Plants just emerging (breaking ground) are the most tender but can withstand temperatures down to 28 degrees Fahrenheit for a few hours. After the seedlings have a second leaf they can take temperatures into the low 20F range. Deferred sowing may aid in weed control and labor-equipment utilization but almost always results in lower yields. Non-uniform maturity and ripening is a problem in late seeded fields and additional management at harvest is often needed. Flax varieties vary in response to date of planting. Full season varieties should be planted early.

Seed Flax Straw

Combines should be equipped with straw-choppers and spreaders to redistribute the straw evenly. It was once a common practice to burn flax residue. This is no longer recommended. If industrial markets develop for seed flax straw, other methods of collecting straw and transporting it from the field will be identified. Green flax straw may have a prussic acid problem if used as livestock feed. Caution should especially be taken immediately after a frost.



Pest Control

Weed Control

Flax is less competitive with weeds than small grains and should be grown on relatively weed-free fields. Control weeds in and following harvest of the preceding crop. Post-harvest tillage of small grain stubble will prevent weed seed production, suppress perennial weeds and encourage annual weed seed germination prior to freeze-up. Flax should be seeded directly or with shallow spring tillage in fields. Deep tillage on such fields could bring dormant seeds to the surface and increase weed problems. For weedy fields, moldboard plow the soil to bury the weed seeds, reducing the weed infestation the following crop season. Moldboard plowing can reduce infestations of small-seeded weeds like foxtails and kochia, which have short seed survival.

Delayed seeding of flax with tillage prior to seeding will control wild oat and reduce infestations of other early germinating weeds. However, delayed seeding generally reduces flax yields. Early maturing flax varieties should be used with late seeding. Weed control is needed by flax emergence to reduce yield losses since flax is a poor competitor with weeds. Soil applied herbicides reduce weed emergence and minimize early weed competition to maximize flax yields. POST herbicides applied soon after weed emergence to small weeds and flax usually give better control and allow more time for flax recovery from possible herbicide injury than to larger weeds and flax.

Bromoxynil at 1 pt/A on 2- to 8-inch flax controls some broadleaf weeds. Some flax leaf burn may occur if applied during high temperatures. Bromoxynil plus MCPA may cause flax injury if applied during hot, humid conditions.

■ FLAX — Herbicides for Weed Control

Herbicide	Product/A (lb ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Trifluralin	1 to 2 pt 5 to 10 lb 10G (0.5 to 1)	Grass and some broadleaf weeds.	Fall: PPI	Use higher rates on fine textured soils. Incorporate once in the fall within 24 hours after application. Keep spring tillage depth shallower than fall.
Spartan (sulfentrazone) Section 18 Registration Pending	2.67 to 5.33 oz WDG (0.125 to 0.25)	Annual small-seeded broadleaf weeds including kochia, pigweed, lambsquarters, nightshade, and biennial wormwood.	EPP, PPI, or PRE	Make EPP application up to 30 days prior to planting. Adjust rate to soil type. Requires precipitation for activation. Close furrow at planting. Temporary flax injury may occur in coarse, low organic matter soils with pH greater than 8.0. May give 6 to 8 weeks residual weed control. Check for Sec. 18 status prior to use.
Bromoxynil	1 pt 5 A/pack (0.25)	Broadleaf weeds including wild buckwheat.	Flax: 2 to 8 inches tall.	Use for wild buckwheat control. Weak on wild mustard. Flax injury is possible.
MCPA	0.5 pt of a 4 lb/gal conc. (0.25)	Broadleaf weeds		Use MCPA ester on hard-to-kill weeds. Early application is less injurious to flax.
Bromoxynil + MCPA	0.9 pt (0.23 + 0.23)			Apply to small weeds prior to bud stage of flax. Risk of crop injury. Commercial mixtures available: Bison, Bromac, Bronate, Bronate Advanced.
Curtail M (clopyralid + MCPA) Section 18 Registration Pending	1.33 to 1.75 pt (2 to 3 oz)	Broadleaf weeds including Canada thistle and perennial sowthistle.	POST. Flax: 2-6 inches tall. Canada thistle: 4-6 inches tall.	Apply after most thistle shoots have emerged. Allow a 72 day PHI. Follow rotational crop interval and other precautions on product label. Check for Sec. 18 status prior to use.
Poast (sethoxydim)	0.5 to 1.5 pt (0.1 to 0.3)	Annual grasses.	POST. Flax: Prior to bloom.	Apply with 1 qt/A oil additive to actively growing grasses. See narrative for rates to control different weed species. May be tank-mixed with bromoxynil or MCPA ester for broad spectrum weed control. Allow a 75 day PHI.
Select Prism (clethodim)	4 to 5 fl oz 8.5 to 11 fl oz (1 to 1.25 oz)		Grass weeds: 2 to 6 inches tall.	

Preharvest Application

Glyphosate (Only certain brands are registered i.e. Roundup Ultra Max, Glyphomax Plus, Gly Star, Touchdown)	2 pt of a 3 lb ae/gal conc. or 1.6 pt of a 3.7 lb ae/gal conc or 1.5 pt of a 4 lb ae/gal conc or 18.5 oz of a 65% SG (0.75)	Emerged grass and broadleaf weeds including Canada thistle and perennial sowthistle.	Preharvest. Flax: Physiologically mature. Seed contains 30% or less moisture.	Greater perennial weed control will result if at least 10 to 14 days are allowed between application and harvest. Allow a minimum 7 day PHI. Apply with AMS fertilizer. Refer to label for adjuvant use. **Do not apply to flaxgrown for seed because reduced germination/vigor may occur.**
Drexel Defol (sodium chlorate)	1 gal of a 6 lb/gal conc. (6)	Desiccant	7 to 10 days prior to harvest. 70 to 80% of the bolls should be brown.	Thorough spray coverage of vegetation is essential. Do not graze or feed treated straw. Apply in 5 to 10 gpa by air or 20 to 30 gpa by ground.

Curtail M may be labeled in flax through Section 18 emergency exemption registration. Apply Curtail M at 1.33 to 1.75 pt/A for Canada thistle control and 1.75 pt/A for perennial sowthistle control. Apply when flax is 2 to 6 inches tall. Extreme growing conditions prior to, at, and following application may reduce weed control and increase risk of flax injury. *Check for Section 18 status before using.

MCPA at 0.5 pt/A on 2- to 6-inch flax controls broadleaf weeds. MCPA ester or high MCPA amine rates should be used in flax for improved kochia and Russian thistle control.

Spartan (sulfentrazone) may be registered in flax through Section 18 emergency registration. Spartan applied PRE at 2.67 to 5.33 oz WDG/A controls most annual small-seeded broadleaf weeds. *Check for Section 18 status before using.

Trifluralin at 1 to 2 pt/A or 10 to 12 lb 10G/A may be fall applied for foxtail and broadleaf weed control on fields to be planted to flax. Granular formulations may be applied to standing stubble. Use liquid or granular formulations when residue will not interfere with incorporation. Seed flax less than 1.5 inches deep into a moist seedbed. Incorporate shallow and seed deep or seed shallow with deep incorporation to maximize crop safety.

Insects

Insect problems and yield loss may occur any year. A program of timely field monitoring should be followed. Know the economic threshold levels for the various insects and apply control measures promptly. The following insects have been identified as a problem in prior years:

- **Grasshoppers.** Grasshoppers are a problem, especially near or at harvest. Flying adults invade from neighboring fields. Damage is caused by chewing through the succulent portion of the small stems below the bolls, with bolls dropping to the ground. Seedling feeding may be a problem in late seeded fields.
- **Cutworms and armyworms.** Larvae of one or more cutworm species are known to cut and consume the seedling at the soil level. Damage is often severe by the time infestation is identified. Armyworm larvae feed on foliage in midseason.
- **Aster leafhopper.** Leafhoppers feed on the plant juices. This insect infects the plant with the aster yellow mycoplasm when feeding. The aster yellow disease is also observed on canola, sunflower and several broadleaf weeds.
- **Aphids.** Aphid populations can increase rapidly and have been observed on flax. Their numbers most years are not high enough to cause economic loss.
- **Wireworm.** This insect, while mostly a pest of cereal grains, can occasionally be identified as the cause of reduced stand in flax.

For information on insect control, contact your local county extension office for information on approved control practices, available labeled insecticides and economic thresholds for the major insects.

Diseases

Losses from diseases are largely responsible for the concept that flax is a risky crop and is "hard on the land." In recent years, due to the widespread use of disease resistant varieties, disease losses have been smaller in flax than in most other annual crops. To guard against flax diseases, grow resistant varieties, use seed treatments, plant early, use sound disease-free seed, and avoid planting flax after flax in the rotation.

Contact your county extension office for recommended disease control measures. Consult NDSU Extension Circular PP-533, Symptoms of and Controls for Crop Diseases.

The diseases most often associated with flax production are:

Disease	Control
flax wilt	resistant variety
flax rust	resistant variety
Pasmo	crop rotation
Aster yellows	early seeding
damping off-seedling blight	clean seed
root rot	clean seed, seed treatment rotation

Heat canker is a physiological reaction of the young seedling to high temperature at the soil surface. Thin stands on dark colored soils are most susceptible. If plants are injured when small, the plants fall over and die. When plants are larger, the outer stem tissue responds by producing additional cork tissue at the damage site. This wound tissue is often brittle and plants may break over at the soil line from strong wind. Early planting and surface residues help reduce heat canker incidence most years.

Harvesting and Storage

Flax maturity can be judged by the color of the bolls. Flax should be harvested when 90 percent of the bolls turn brown. The stems may remain green after the bolls are ready to harvest. Flax with green stems is the most difficult of all grains to cut. Sharp, well adjusted cutter bars are essential. Flax can be straight combined if maturity is uniform and green weeds not a problem. If flax is swathed and pickup combined later, a tall stubble is desired. Using swath rollers can help settle the swaths into the stubble to reduce wind damage and aid pickup combining. Manufacturers' recommendations should be followed to reduce seed damage during combining. Some combines have special rolls ahead of the cylinder to fracture the flax boll. The seedcoat of flax is easily damaged or broken, so proper adjustments are necessary. Yellow seeded varieties are more susceptible to seed damage because of their thinner seedcoat.

Flax seed is safe to store at 10 percent moisture for short term storage and at 8 percent moisture for long term storage. Higher moisture will result in heating and mold formation. Flax seed often comes from the combine with large amounts
of green weed seed dockage. It is a good management practice to remove green dockage before storage.

Flax is more difficult to manage in storage than cereal grains. Systematic monitoring is recommended. Flax seed has a low angle of repose. Care must also be taken to have tight storage bins. Even small holes and cracks will result in bin leakage. Enter flax bins with caution. Flax seed in storage flows easily and supports limited weight. Lives have been lost by people falling into seed flax bins to become engulfed and die from suffocation. Stored grain insects are not a general problem in short time storage. If flax seed is stored for a year or more, then monitoring for the hard bodied grain weevils is advised.

For more information on this and other topics, see: www.ag.ndsu.nodak.edu

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