A1038 (Revised)

Flax Production
in North Dakota

Revised by

Hans Kandel
Agronomist
NDSU Extension Service

Irene Graves
NDSU Extension Agent
McLean County

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Flax variety descriptions are listed on Page 6.

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History and Use

Flax *(Linum usitatissimum)* production has a long 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 U.S. and Canada during the 1800s. As settlers moved west, flax was one of the crops produced. North Dakota farmers have grown flax since prairie sod was broken.

Producers grow two types of flax: seed flax for the oil in its seed and nutritional value, and fiber flax for the fiber in its stem.

Today producers in the upper Midwest and the Prairie Provinces of Canada grow seed flax. North Dakota is the leading producer of flax for oil and food use in the U.S.

Interest in healthful diets for humans and animals is increasing the demand for flax seed. Flax seed is crushed to produce linseed oil and linseed meal. Linseed oil has many industrial uses; linseed meal is used for livestock feed *(see NDSU Extension publication AS1283, "Using Flax in Livestock Diets").*

Flax seed and meal also are fed to pets, swine, chickens and horses. In addition, 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 anti-carcinogenic lignans. Some consumers use flax seed oil as a vegetable oil. Whole, (preferably) ground flax seed is consumed mostly in bakery products. Hens fed flax seed produce "omega eggs," which are sold in the U.S. and Canada for their high omega-3 oil content. 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.

Growth and Development

Flax is an annual plant that has one main stem. At low plant populations, branching is seen at the base similar to tillers in a cereal grain. The stems terminate in a multibranched inflorescence that bears blue to white flowers. Flax grows to a height of 24 to 36 inches.

The plant has a tap root that may penetrate to 40 inches if growing conditions are favorable. 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 often are observed until frost.

Flax is a self-pollinating 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. Seeds 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 Flax

Flax usually is sown on the same type of soil that grows wheat and barley. Poorly drained soils, soils subject to drought and erosion, and soils high in soluble salts should be avoided. Flax fits in a rotation with many small-grain crops. For optimum yields and disease control, do not plant flax more often than one in three years in any rotation. Also, try to avoid planting flax after potatoes, canola and sugarbeets.

Select a variety adapted to your area. *Variety descriptions and recent yield performance can be obtained in NDSU Extension publication A1105, "North Dakota Alternative Crop Variety Trial Results and Selection Guide,"* available at your county Extension office or on the NDSU Extension website.

Consider planting certified seed. It is tested to ensure minimal weed content, high genetic purity and good seed viability. Certified seed consistently yields more than 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 increase stand significantly. 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.

Fertilizing Flax

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 publication SF717, "Fertilizing Flax."*

Zinc deficiency has been reported on flax in North Dakota, so information on zinc levels should be requested when soil testing. If soil zinc levels (DTPA extract) are less than 1 part per million (ppm), application of zinc is recommended.

The phosphorus application recommendation for flax production was removed recently. Research data suggested flax had no yield response to added phosphorous fertilizer. Phosphorus can be applied, but no yield increase should be expected regardless of the soil test level.

Seeding Flax

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. We recommend a planting depth of 0.75 to 1.5 inches.

Press drill packer wheels do a satisfactory job of firming the soil after planting. If other types of planters are used, producers need to use special efforts, such as a soil packer behind the drill or harrowing, prior to planting to firm the seedbed. Avoid deep seeding because delayed emergence weakens seedlings, and weak seedlings are more likely to die.

When using preplant-incorporated herbicides, 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 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 (25 to 35 pounds) in western North Dakota and higher rates (35 to 45 pounds) in the east. Seed size varies among varieties, which also should be considered. Yellow-seeded varieties may require higher seeding rates because of lower seedling vigor. If untreated seed is used, then higher seeding rates are necessary.

Table 1. Flax nutrient recommendations based on soil tests (N and K).

		Soil Test Potassium, ppm				
Yield goal	Soil N plus fertilizer N required	VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
bu/a	lb/acre (2 ft.)	K_2O, lb/acre				
30	80	58	41	24	7	0
40	80	77	54	32	10	0
50	80	96	68	40	12	0

Nitrogen recommendation = 80 pounds of nitrogen (N) per acre minus STN minus PCC.

STN is soil test nitrate nitrogen sampled to 2 feet in depth.

PCC is previous crop nitrogen credit (40 pounds of N per acre if the previous crop was an annual legume).

N is limited to 80 pounds per acre (lb/a) due to the risk of lodging. If the environment is favorable for higher yield, a higher N release from organic matter will provide the additional N needed in most situations.

Source: NDSU Extension publication SF717, "Fertilizing Flax"

Early seeded flax generally produces the highest yields. Early seeding normally occurs in late April for all of the state except the northeast, where early May seeding is possible. Frost seldom kills flax seedlings. Seedling plants just emerging (breaking ground) are the most susceptible to injury but can withstand temperatures down to 28 F for a few hours. After the seedlings have a second leaf, they can withstand temperatures into the low 20 F range.

Delayed sowing may aid in weed control and reduce labor or equipment use, but it almost always results in lower yields. A lack of uniform maturity and ripening is a problem in late-seeded fields, so additional management at harvest often is needed. Flax varieties vary in response to the date of planting. Full-season varieties should be planted early.

Pest Control

Weed control

Flax is less competitive with weeds than small grains and should be grown on relatively weed-free fields. Control weeds following the harvest of the preceding crop. Postharvest 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, deep till the soil to bury the weed seeds, reducing the weed infestation the following crop season. Deep tillage can reduce infestations of small-seeded weeds, such as foxtails and kochia, which have short seed survival. Delayed seeding of flax with tillage prior to seeding will control wild oats 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 because 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 to small weeds and flax soon after weed emergence usually give better control and allow more time for the flax to recover from possible herbicide injury than they do if the weeds and flax are larger.

Post-applied Grass Herbicides

Assure II, Targa, Poast, Clethodim and Select Max or 2EC are all grass-controlling herbicides that are labeled for controlling grasses in flax. See individual labels for mixing guidelines when using broadleaf herbicides, such as bromoxynil and MCPA ester formulations.

For more information on all herbicides labeled for weed control use in flax, refer to the "North Dakota Weed Control Guide," NDSU publication W253 (current year). Always read and follow the label in the use of all pesticides.

Insects

Insect problems and yield loss may occur any year. Follow a program of timely field monitoring. Know the economic threshold levels for the various insects and apply control measures promptly. The following insects can be problematic in flax:

- **Grasshoppers** – They are a problem, especially near or at harvest. Flying adults invade from neighboring fields. Damage is caused by grasshoppers 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 seedlings at the soil level. Damage often is severe by the time the 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 mycoplasma when feeding. The aster yellow disease also is 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, occasionally can cause reduced stands 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, or consult NDSU publication E1143, "Field Crop Insect Management Guide."

Diseases

Losses from diseases largely are responsible for the perception 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 or consult NDSU Extension publication PP622, "North Dakota Field Crop Plant Disease Management Guide."

The diseases most often associated with flax production are:

Disease	Control Practice
• Flax wilt	plant resistant variety
• Flax rust	plant resistant variety
• Pasmo	crop rotation
• Aster yellows	early seeding
• Damping off-seedling blight	clean seed
• Root rot	clean seed, seed treatment and rotation

Heat canker is a physiological reaction of the young seedling to high temperature at the soil surface. Thin stands on dark 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 often is 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 are 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.

Follow manufacturers' recommendations to reduce seed damage during combining. Some combines have special rollers ahead of the cylinder to fracture the flax boll. The flax seed coat is damaged or broken easily, so proper adjustments are necessary. Yellow-seeded varieties are more susceptible to seed damage because of their thinner seed coat.

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

We recommend systematic monitoring because flax is more difficult to manage in storage than cereal grains. Flax seed has a low angle of repose. Producers also must 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 and becoming engulfed and dying 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 we advise monitoring for the hard-bodied grain weevils.

Seed Flax Straw

Combines should be equipped with straw choppers and spreaders to redistribute the straw evenly. Burning flax residue once was a common practice. This no longer is recommended. If industrial markets develop for seed flax straw, other methods of collecting straw and transporting it from the field will need to be identified.

Green flax straw may pose a prussic acid problem if used as livestock feed. Use caution in feeding flax straw or grazing, especially immediately after a frost.

Table 2. Flax Variety Descriptions.

Variety[1]	Origin[2]	Year Released	Relative Maturity	Seed Color	Plant Height	Wilt[3]
AC Lightning	Can.	2002	Late	Brown	Med. tall	R
Carter	ND	2004	Med.	Yellow	Med.	R
Cathay	ND	1998	Med.	Brown	Med.	MR
CDC Arras	Can.	1999	Med.	Brown	Med.	MR
CDC Bethune	Can.	1999	Med. late	Brown	Med. tall	MR
CDC Glas	Can.	2012	Med.	Brown	Med. tall	MR
CDC Mons	Can.	2003	Med. late	Brown	Med.	MR
CDC Neela	Can.	2013	Med. late	Brown	Med.	MR
CDC Sanctuary	Can.	2012	Med.	Brown	Med. tall	MR
CDC Sorrel	Can.	2007	Med. late	Brown	Med. tall	MR
Gold ND	ND	2014	Med.	Yellow	Med. tall	MR
Hanley	Can.	2002	Med. early	Brown	Med.	R
Linott	Can.	1966	Med. early	Brown	Med.	MS/MR
McGregor	Can.	1980	Late	Brown	Med. tall	MR
Neche	ND	1988	Med.	Brown	Med.	R
Nekoma	ND	2002	Late	Brown	Med.	MR
Omega	ND	1989	Med.	Yellow	Med.	MS
Pembina	ND	1998	Med.	Brown	Med.	MR
Prairie Blue	Can.	2003	Med. late	Brown	Med. tall	MR
Prairie Grande	Can.	2008	Med. early	Brown	Med.	MR
Prairie Sapphire	Can.	2012	Med.	Brown	Med.	MR
Prairie Thunder	Can.	2006	Med.	Brown	Short	MR
Rahab 94	SD	1994	Med.	Brown	Med.	MR
Selby	SD	2000	Late	Brown	Tall	MR
Shape	Can.	2010	Med.	Brown	Med.	R
Webster	SD	1998	Late	Brown	Tall	MR
York	ND	2002	Late	Brown	Med.	R

[1] All varieties have resistance to prevalent races of rust; all have good oil yield and oil quality.
[2] Can. = Canada; ND = North Dakota State University; SD = South Dakota State University.
[3] R = resistant; MR = moderately resistant; MS = moderately susceptible.

This publication was authored by
Duane R. Berglund, professor emeritus and former Extension agronomist,
and Richard K. Zollinger Extension weed specialist, NDSU, 2007.

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

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