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Flax Production in North Dakota

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Flax has two types: seed flax grown for the oil and nutritional value of its seed, and fiber flax grown for the fiber in its stem. In North Dakota, only seed flax is grown commercially.

Flax variety descriptions are listed on Page 7.

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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 first crops produced. North Dakota farmers have grown flax since prairie sod was broken.

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

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

While fiber flax used to be an important crop in the U.S., almost none is grown commercially now. Fiber flax production dropped dramatically during the 19th century as cotton replaced flax as the country's dominant plant fiber. Some fiber flax still is grown in Canada.

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, including oil-based paints and linoleum flooring, and linseed meal is used for livestock feed *(see NDSU Extension publication AS1283, "Using Flax in Beef and Dairy Cattle Diets").*

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Flax seed and meal also can be included in food for pets, swine, chickens and horses. In addition, the fiber in seed flax stems can be used to make fine paper and as tow, or padding, in upholstered furniture. Cigarette paper is a major flax fiber product.

Human consumption of flax seed is increasing rapidly because of its high dietary fiber, omega-3 oils and anti-carcinogenic lignans. Some consumers use flax seed oil as a vegetable oil. Whole, or more often 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 primarily 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, highly 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 (or rarely 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 may be 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. Heat stress during flowering may reduce the pollen viability and pollination, which results in a reduced number of seeds per boll and or fewer bolls per plant.

Seeds can be brown, golden or yellow. Producers growing golden or yellow flax varieties must take care to avoid contaminating their harvest with brown flax. The presence of off-color seeds in a flax sample can result in steep discounts.

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. Wet flax is very difficult to thresh and can clog combines.

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 once in three years in any rotation. Also, try to avoid planting flax after potatoes, canola and sugarbeets.

Select a variety adapted to your area **(Table 2, Page 7)**. Variety descriptions and recent yield performance can be obtained in *NDSU Extension publication A1105, "North Dakota Flax Variety Trial Results and Selection Guide,"* available on the NDSU Extension website.

Consider planting certified seed because 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 fungicide is recommended. Seed treatment reduces seed decay and seedling blights and can increase stand significantly. A thicker and more uniform stand produces higher yields.

Yellow-seeded flax 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; however, we recommend a maximum of 80 pounds per acre of nitrogen (soil and fertilizer) in a conventional tilled field and 50 pounds per acre N in a long-term no-tilled field. Nitrogen should be limited to these levels to avoid excessive vegetative growth and lodging **(Table 1)**.

If the environment is favorable for higher yield, a higher N release from organic matter will provide the additional N needed in most situations. Use soil testing as a guide for applying fertilizer whenever possible. Recommendations for fertilizer use in flax are 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 before or at seeding.

Phosphorus application is not recommended for flax production. Research data suggested flax had no yield response to added phosphorus fertilizer. Phosphorus can be applied to flax to maintain soil levels needed for more responsive crops such as wheat or corn, but no flax yield increase should be expected regardless of the soil test level.

Table 1. Nitrogen and potassium nutrient recommendations for flax.

	Soil Test Potassium, ppm				
Soil N plus fertilizer N required[1]	VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
lb/acre (top 2 feet)	K_2O lb/acre				
80	77	54	32	10	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).

[1] N is limited to 80 pounds per acre for flax grown with conventional tillage and 50 pounds per acre for flax grown in a long-term no-tilled field.

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 harrowing prior to planting or a soil packer behind the drill, to firm the seedbed.

Avoid deep seeding because delayed emergence weakens seedlings, and weak seedlings are more likely to die. Flax can be grown successfully in no-till systems and does well planted into high-residue conditions as long as seeding depth is maintained.

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 competition and delayed maturity are potential 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 recommended.

Early seeded flax generally produces the highest yields. Early seeding normally occurs in late April for most of the state except the northeast, where early May seeding is more likely.

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, 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. If planting late, an early maturity variety should be used.

Pests

Weed Control

Flax is less competitive with weeds than small grains and should be grown on relatively clean 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.

In no-till production, fall weed control the season prior to planting flax is key. A late fall application that controls emerged winter annuals and provides soil residual activity helps ensure optimal conditions for flax establishment.

Flax can be seeded no-till or following shallow spring tillage. Deep tillage prior to seeding flax can bring dormant seeds to the surface and increase weed problems, and therefore is not recommended.

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 when seeding late.

Weed control is needed by flax emergence to reduce yield losses because flax is a poor competitor with weeds. Soil-applied herbicides such as Callisto and Spartan reduce weed emergence and minimize early weed competition to maximize flax yields.

If using Spartan, adjust the rate for soil type and be aware that this herbicide is more active when soil pH is greater than 7. 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 weed control options in flax include Bromoxynil, MCPA and Curtail M (or generic clopyralid).

Grass Weed Control

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

Preharvest Weed Control

For preharvest herbicides, selection should be made based on intended use of the crop and weed control needs. Glyphosate can be used for preharvest control of perennial weeds; however, it should not be applied to flax grown for seed because reduced germination may occur.

Desiccants labeled for use in flax in North Dakota include Defol, Sharpen, Valor SX and Valor EX. Pay attention to the required preharvest interval for each product. Do not apply Sharpen to flax grown for seed because reduced germination may occur.

For more information on all herbicides labeled for 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 in any year. Follow a program of timely field monitoring to catch problems early. Know the economic threshold levels for the various insects and apply control measures promptly.

The following insects can be problematic in flax:

Grasshoppers – Can be 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 stems below the bolls, causing bolls to drop 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 apparent. 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, sunflowers and several broadleaf weeds.

Aphids – Aphid populations can increase rapidly and have been observed on flax. However, most years, their numbers 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 county's NDSU Extension office or consult *NDSU publication E1143, "Field Crop Insect Management Guide."*

Diseases

In the past, losses from diseases were largely responsible for the perception that flax is a risky crop. 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 the Extension office in your county 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, fungicide application
• Aster yellows	early seeding
• Damping off-seedling blight	clean seed, seed treatment
• Root rot	clean seed, seed treatment and crop 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 is brittle and plants may break at the soil line from strong wind. Early planting and surface residues help reduce heat canker in most years.

Flax variety trials are conducted at NDSU's Research Extension Centers.

Photo by Hans Kandel, NDSU.

Harvesting and Storage

Flax maturity can be judged by the color of the bolls. Flax should be harvested when 90% 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 (4 to 6 inches) is desirable to hold the swath off the ground and allow for even drying. 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 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% moisture short term and at 8% long term. Higher moisture will result in heating and mold growth. 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 bin monitoring because flax is more difficult to manage in storage than cereal grains. Producers also must have tight storage bins because 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.

Insect pests in stored grain are not usually a problem in short-term storage. If flax seed is stored for a year or more, then we advise monitoring for 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, but 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 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. Selected Flax Variety Descriptions.

Variety[1]	Origin[2]	Year Released	Days to Flower Avg.[3]	Seed Color	Plant Height	Plant Height Avg.[3]	Fusarium Wilt[4]
						(inch)	
AAC Bright	Can.	2017	53	Yellow	Med.tall	23	MR
Carter	ND	2004	53	Yellow	Med.tall	23	MS/MR
CDC Buryu	Can.	2016	52	Brown	Med.	22	MR
CDC Dorado[5]	Can.	2019	53	Yellow	Med.	21	MS/MR
CDC Glas	Can.	2012	54	Brown	Med.tall	23	MR
CDC Neela	Can.	2013	53	Brown	Med.	22	MR
CDC Plava	Can.	2015	53	Brown	Med.	21	MR
Gold ND	ND	2014	53	Yellow	Tall	24	MR/R
ND Hammond	ND	2018	53	Brown	Med.tall	23	MS
Omega	ND	1989	54	Yellow	Med.	22	MS/MR
Prairie Thunder	Can.	2006	53	Brown	Tall	23	MR
Webster	SD	1998	53	Brown	Tall	24	MR
York	ND	2002	52	Brown	Med.tall	23	MR/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] Average of three locations: Carrington, Langdon, Minot.
[4] R = resistant; MR = moderately resistant; MS = moderately susceptible.
[5] Based on comparisons made in Canda.

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