Organic Flax Production in Iowa

Windrower/swather used to harvest flax. Photo courtesy of K. Delate.

Introduction

Flax, *Linum usitatissimum* (Linaceae), was grown over several decades in the Midwest prior to the 1940s, but became less common in Iowa as markets shifted to commodity corn and soybeans. High in oil (40 percent on average), flax is pressed into industrial oils (linseed oil) and food-grade oils. Flax straw has been used for textiles, fiberboard, and paper products.

In recent years, there has been an increased interest in food grade flaxseed and flaxseed oil consumed directly or used in baked products because of flax's high content of omega-3 fatty acids. These acids are associated with lowering blood cholesterol levels and risk of heart disease, among other health–promoting aspects. Flaxseed meal, used in livestock rations, can supply up to 35 percent protein, and has been used to produce what manufacturers market as "Omega-3 eggs."

Flax is an unusual plant with a distinct main stem that grows to a height of 12-36 inches with numerous branches at the top where flowers are produced. Flax is a spring annual crop in Iowa with a 90- to 100-day growing season, a 45- to 60-day vegetative period, a 15- to 25-day flowering period, and a 30- to 40-day maturation period.

Flax straw is not recommended for livestock feed because of high prussic acid (cyanide) content in green straw and high cellulose and lignin in dried straw.

Weed management is a concern in organic flax production because of flax's limited leaf area with many tiny leaves and short stature that contribute to the non-competitive nature of the flax plant. Because of its non-competitive nature, however, flax has been reported to be a good companion crop to plant with small-seeded grasses and legumes.

Flax flowers of the oil-seed varieties are bluish purple with five petals, which develop into a five-celled boll or capsule containing six to 10 seeds. Flax breeders have developed varieties with semi-tight bolls that resist shattering in the field but open upon combining. Flax normally is self-pollinated but insects also may be involved in dispersing pollen between plants. An interesting phenomenon of flax is that its flowers open in the morning and drop their petals by noon. Flax-seed color can range from golden to dark brown, with most commercial flaxseed oil varieties being brown seed.

Photo courtesy of K. Delate

Flax blossoms appear as a sea of blue 45 to 60 days after planting.

In addition to a renewed interest in flaxseed oil, a demand for organic flax, grown and processed without synthetic fertilizers or pesticides, or food processing aids, such as hexane, has occurred in recent years. An organic flaxseed oil crushing facility opened in Cherokee, Iowa, in 2004, to meet increasing worldwide demand for the oil. The facility sources organic flax from Iowa farmers and other organic growers.

Production Practices

Planting

Extra care must be taken with organic flax production. In conventional flax production, seed fungicides and insecticides are used against wireworms. Since organic flax is grown without chemicals, seeds should be examined before planting to ensure that you have clean, whole seeds that can resist insects and diseases. Seeds for the organic flaxseed oil facility currently must be secured through the buyer to obtain varieties with desired quantities of oil and fatty acid content.

A well-worked seedbed, which has been disked or harrowed, is essential to obtain good seed-to-soil contact. If flax follows a cover crop or green manure, such as oats or alfalfa, plowing may first be necessary before secondary tillage. Rolling the field also is an option. Plant as early as possible, at the same time as oats, because the earlier you plant, the higher the yield. Frost seldom kills flax seedlings, but temperatures below freezing can injure young plants. If weeds are a particular problem in the field where flax will be planted, you may want to delay planting until a flush of weeds has been cultivated because you will not be able to control weeds once the flax is planted.

A seeding rate of 50 to 70 pounds per acre is recommended, which is higher than the conventional rate of 42 to 50 pounds per acre. In organic farming, a higher seeding rate and thicker flax stand can provide more competition against weeds. Presswheel-type grain drills are recommended, or roller type seeders used in legume planting, to ensure optimal seed-to-soil contact.

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Table 1. Flax performance with compost in the organic flax trial, Neely-Kinyon Farm, Greenfield, Iowa, 2005.

Compost Presence	Stand (plants/ft²)	Plant height (cm)	Broadleaf (weeds/m²)	Grass (weeds/m²)	Flax dry weight (pounds/acre)	Weeds dry weight (pounds/acre)	Yield[1] (bushels/acre)
No Compost	77.1	60.6b[2]	15.4	0.54	4,451	30.7	23.5b
Compost	74.5	63.3a	14.9	1.00	4,504	41.2	28.0a
LSD* 0.05	NS**	1.37	NS	NS	NS	NS	2.82

[1] Yield was calculated at 9% moisture.
[2] Letters that are the same following the means equal no statistical difference between these means at a 95% confidence level.
* Least significant difference
** Not statistically significant

Fertility Requirements

Flax prefers a pH of 6.0 to 6.5, so lime should be applied if soils are in a lower range. Nitrogen recommendations include a range of options, based on existing soil fertility, previous crop, and organic-compliant nitrogen source. Flax prefers a fertile soil, but excessive nitrogen can result in increased weed growth and lodging. Research at Iowa State University identified a 5 bushel/acre increase in yield with a nitrogen application of 50 pounds/acre derived from composted chicken manure (Table 1). Compost also increased plant height with no additional effect on weed populations.

Phosphorus or potassium may need to be applied if you are underseeding a legume with the flax. (See the red clover underseeding section of this publication.) With soils containing organic matter of 2 to 5 percent, 20 pounds/acre of phosphate and potash are recommended, if your soils' P and K content is in the low range. If organic compost and fertilizer are applied, it is recommended that these materials are applied prior to flax planting and not in the drill row. Crop rotations are equally important: flax following a barley/red clover crop produced greater yields than flax following corn (Table 2). Flax biomass also was greater in fields following barley/red clover. For these reasons, it is recommended that flax follows a legume crop, such as oats/alfalfa, wheat/red clover, or soybeans, which may not provide much N for the flax crop, but the soil will not be as deprived of N as it would be following a corn crop.

Table 2. Organic flax plant performance, Crawfordsville, Iowa, 2005.

Previous Crop in Rotation	Stand (plants/ft²)	Plant height (cm)	Flax dry weight (pounds/acre)	Yield[1] (bushels/acre)
Barley/red clover	89.8b[2]	61.9a	3,554a	33.1a
Corn	91.2b	52.6b	1,639c	13.6c
Soybeans	114.3a	61.7a	2,784b	25.8b
LSD* 0.05	15.7	3.0	727	3.71

[1] Yield was calculated at 9% moisture.
[2] Letters that are the same following the means equal no statistical difference between these means at a 95% confidence level.
* Least significant difference

Variety Selection

The first item of business for organic flax growers in Iowa is to check with their buyers on the required flax varieties. Despite the vast number of flax varieties, flax grown for the organic flaxseed oil market must meet food grade oil specifications, limiting the seed choice to brown seeds high in oil and polyunsaturated fatty acids. Currently, two varieties are the most widely grown for the organic flaxseed oil market: CDC Bethune and NorLin, bred in Canada for flax rust resistance and high yields. No organically grown seed was available at the time of this report, so organic producers are permitted to use untreated conventional seed for the organic flaxseed oil market.

Research at Iowa State University has shown no differences in terms of yields and biomass (Table 3). Lodging also was not a problem in the three years of the research with these varieties.

Table 3. Variety performance in the organic flax trial, Neely-Kinyon Farm, Greenfield, Iowa 2005.

Variety	Stand (plants/ft²)	Plant height (cm)	Flax dry weight (pounds/acre)	Yield[1] (bushels/acre)
CDC Bethune	69.6b[2]	60.4b	4,375	27.1
NorLin	82.0a	63.46a	4,581	24.5
LSD* 0.05	5.28	1.35	NS**	NS

[1] Yield was calculated at 9% moisture.
[2] Letters that are the same following the means equal no statistical difference between these means at a 95% confidence level.
* Least significant difference
** Not statistically significant

Weed Management

In conventional flax production, weeds are controlled with pre-and post-emergent synthetic herbicides, which are not allowed in organic production. Without herbicides, weeds can become a major constraint in producing high organic flax yields. Organic flax producers' weed management strategies include crop rotation, planting flax on land free of quackgrass and Canada thistle, and planting an underseeding of red clover (Figure 1). It is essential to till weeds that germinate early in the spring before flax planting. Also included in these strategies is planting a disease-resistant, high- yielding variety in warm soils that facilitate rapid flaxseed germination.

Red clover underseeding

Red clover is recommended as an underseeded crop planted with flax at a rate of 10 lb/acre. While no statistical differences were obtained in yields between fields with red clover and those without an underseeding, the red clover crop produced significant biomass after the flax harvest, serving as a soil-building crop in the rotation—a requirement for certified organic production.

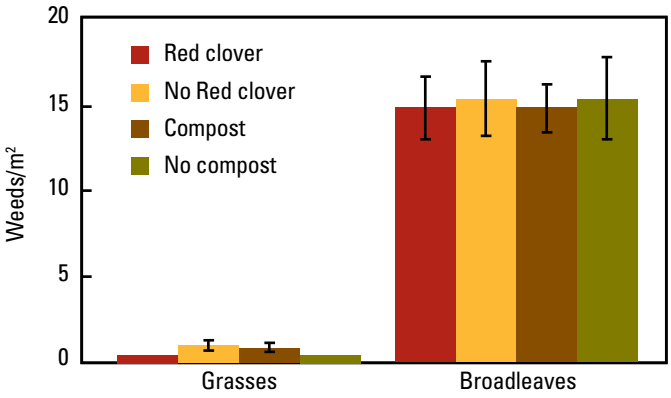

Figure 1. Weeds can be a major problem in organic flax production. In this trial in Greenfield, Iowa, a red clover underfeeding was effective in lowering grass weed populations. Broadleaf weeds averaged 16 weeds/m² while grass weeds were less than 3 weeds/m² in the red clover sub-treatments.

Disease Management

Fortunately for organic flax producers, disease problems have been limited, due to the excellent flax breeding programs across Canada, North Dakota, and Minnesota, which have produced varieties resistant to flax rust, the most significant fungal disease. Another disease mitigated through resistance or tolerance programs includes pasmo, a fungus that can overwinter on flax plant debris. Plowing or disking flax fields following harvest is recommended to destroy any harmful fungi. Resistant varieties also should be used to prevent wilt, a soil-borne fungus. Seedling blights, such as *Pythium* and *Rhizoctonia*, are only problematic in very cool, wet weather. Insects can infect flax with aster yellows, a mycoplasma-like organism, and crinkle, a virus. However, Iowa farmers have not reported aster yellows or crinkle in their fields.

Insect Management

As with diseases, insect pests have not been a problem in organic flax fields in Iowa. Nevertheless, you should inspect your fields on a regular basis for any potential problems. In conventional fields, cutworms and wireworms have been reported in the flax seedling stage, destroying plant roots and cutting whole seedlings. Aphids, aster leafhoppers, tarnished plant bugs, and grasshoppers also have been reported in conventional flax, causing damage ranging from distorting flax tips to chewing bolls off a plant. Beet webworms may eat flax plant parts. While no single tactic is recommended for each of these pests, management strategies for insect pests, should they arise, have been developed in organic agriculture, such as the application of *Bacillus thuringiensis* against caterpillar pests. Inspect regularly for insect activity. Collect any insect pests in alcohol or freeze in a closable plastic bag and take to your Extension office for identification. Then call the Iowa State University Organic Agriculture Program, (515) 294-7069, to report any insect pests and to receive recommendations.

Harvesting

While flax does not shatter or lodge as easily as other small grains, follow additional harvest considerations in order to obtain the highest quality organic flax. Because herbicides cannot be used, and excessive green weeds in organic fields at harvest can interfere with combining, flax usually is windrowed and allowed to dry before combining. Combining without windrowing is only recommended for weed-free fields.


Photo courtesy of K. Delate


Photo courtesy of K. Delate

The best method for harvesting organic flax is to windrow the flax first with a swather, then use a pick-up combine after weeds have dried down from green (left) to brown (right) and the moisture in the flax in the windrows has decreased to at least 10 percent.

If you harvest flax too early, the yield will be decreased, but waiting too long can reduce oil quality. Harvest your flax when 90 percent of the bolls are brown and the seed moisture drops to 10 to 12 percent and seeds can be threshed easily. If flax stems are still green and plants are blooming due to extended wet weather, you should wait until all but the very late bolls are ripe. Make the decision to harvest based on the experience of your buyer or other organic flax growers in your area.

Flaxseed should dry down in the windrow until reaching 8 to 10 percent moisture—a requirement for long-term storage. If possible, after combining, run your seeds through a seed cleaner to remove all unopened bolls, cracked seeds, and green weed seeds, which will reduce your selling price. Weed seeds can be a problem: Pennsylvania smartweed seeds are the same size as flax and will require special attention.

In addition, any green matter can cause problems with your stored flax, inviting insects and diseases, such as mold. Immature white or green flaxseeds result from harvesting too early or from poor growing conditions that delayed normal seed development, while black or discolored seeds result from a late harvest, poor growing conditions, or plant disease. Your buyer will require a sample of your flax in a plastic bag. Send a representative sample because you want to know what your clean-out or dockage rate will be. A clean-out rate of 10 to 15 percent is considered a good rate for organic production.

Broken or split seeds may result from poor growing conditions or damage by harvesting equipment. To separate the seed from the boll without cracking the seeds, use the following settings on your combine: cylinder speeds of 1100 to 1200 rpm with a

1/16 to 1/4-inch concave clearance; a fan speed of 300 to 500 rpm; and a ground speed of 2 to 3 mph. Flax straw can be spread across the field but most organic farmers bale it to use as livestock bedding or mulch in horticultural operations.

Storage and Transport

For short-term storage, store flax at 10 percent moisture, but dry down to 8 percent moisture for long-term storage. It is a good management practice to remove any green dockage before storage to avoid mold. If your flax is destined for organic livestock feed and you are storing it for a while, use diatomaceous earth (e.g., INSECTO) to prevent infestation by Indian meal moth or beetles.

Use airtight storage bins and transport vehicles, since even small holes and cracks will result in flaxseed leakage. Duct tape can be used to seal small openings. Ideally, you will want to deliver your flax as soon as possible after combining and cleaning if processing facilities are available.

Economics

It is critical that you secure your organic market and track your costs of production to ensure your flax crop is a viable operation. Table 4 lists 2008 costs and the returns for certified organic flax used for organic flaxseed oil. (Note: These estimates are based on $2.75 per gallon diesel fuel. As the cost of gasoline changes, you need to make the necessary adjustments. To adjust custom rates, refer to ISU Extension publication PM 709, Fuel Required for Field Operations.) Machinery costs for field operations are estimated using the 2008 Iowa Farm Custom Rate Survey (FM 1698). Note that the compost charge is for application only. The overall economic returns represent the return to land and management. Labor is taken into consideration through the use of custom rates. Land, however, has been excluded because land costs are highly variable across Iowa. However, producers evaluating flax production should subtract their cost of land to determine crop profitability.

Table 4. Economic analysis of organic flax production in Iowa.*

Input	Cost per unit	Cost per acre
Flax seed	$1.00/pound x 56 pounds/Acre	$56.00
Red clover seed	$3.60/pound x 12 pounds/Acre	$43.20
Field cultivate	$10.10	$10.10
Compost	$3.75	$3.75
Drill	$12.00	$12.00
Windrow	$11.40	$11.40
Combine	$25.30	$25.30
Hauling	$0.07/bushel x 20 bushels/Acre	$1.40
Handling	$0.05/bushels x 20 bushels/Acre	$1.00
Total costs		$164.15
Revenue	$0.50/pound	$560 (at 20 bushels or 1120 pounds/acre)
Return to land and management		$395.85

*These costs are based on diesel fuel at $2.75 per gallon.

Final Considerations

The positive aspects of growing flax include diversifying your farming operation, and a favorable economic return if your flax crop meets the specifications for the organic flaxseed oil market. The trade-offs, however, include contending with weed management for a poorly competitive crop, harvesting issues (purchasing, renting, or locating a custom operator of a windrower/swather), and weather. Crop rotations are essential—both from an organic certification standpoint and for maintaining soil quality. Preceding flax with soybean or a small grain or legume mixture, such as oats and alfalfa, will aid in improving soil fertility for optimal organic flax production. An underseeding of red clover with flax at planting has been reported by several farmer-cooperators to be helpful in managing weeds in flax, and a trend toward decreased grass weed populations in the red clover sub-treatments was observed in ISU research trials. In addition to free nitrogen sources from legumes in crop rotations and in underseedings, nitrogen from on-farm or local sources of composted manure also can lead to increases in organic flax yields. If your flax does not meet organic flaxseed oil standards, selling into the organic livestock feed market will reduce your returns to $339.85 per acre because the price for organic feed flaxseed is $0.45/pound. Considering that flax would be used as a replacement for the small grain in your rotation, it is important to compare the costs and returns from organic oats, alfalfa, or any other crop you would replace. Information on organic prices and budgets is available in the ISU Extension publication, Organic Crop Production Enterprise Budgets (FM 1876), and the USDA-AMS Livestock and Grain Market News. (See references below.)

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References

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