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Evaluation of Varieties, Fertility Treatments, and Red Clover Underseeding for Certified Organic Flax Production - Neely-Kinyon Trial, 2005

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Abstract
Flax (*Linum usitatissimum* [Linaceae]—linen family) is an ancient crop that had been grown in Iowa for many years, but was displaced by the emphasis on commodity corn and soybeans. Flax has many uses, including industrial oils from oilseed flax, food-quality flaxseed oil, linen products, fiberboard, and paper products from the straw. Flaxseed oil is high in omega-3 fatty acids, which are associated with lowered risk of heart disease and lowered blood cholesterol levels. Flax has a 50-day vegetative period, a 25-day flowering period, and a 35-day period to maturity. Seeds are produced in bolls that contain 6–10 seeds. Seed color can be brown, golden, or yellow. A mucilaginous coating covers the seed. The flax crop responds to up to 50 lb/acre nitrogen, similar to organic small grains. Mycorrhizal association may increase the ability of flax to take up phosphorus from the soil, so growing flax after mycorrhizal wheat rather than after nonmycorrhizal canola may improve its phosphorus uptake. Early-seeded flax generally produces the highest yields, when using the same planting dates as small grains. Frost seldom kills flax seedlings. Nonuniform maturity and ripening are problems in late-seeded fields. With the introduction of a processing facility, organic flaxseed oil can now be processed in Iowa and sold around the world. There is, in turn, a potential for increased organic flax production in Iowa.

Keywords
Horticulture, Agronomy

Disciplines
Agricultural Science | Agriculture | Agronomy and Crop Sciences | Horticulture

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Introduction

Flax (*Linum usitatissimum* [Linaceae]—linen family) is an ancient crop that had been grown in Iowa for many years, but was displaced by the emphasis on commodity corn and soybeans. Flax has many uses, including industrial oils from oilseed flax, food-quality flaxseed oil, linen products, fiberboard, and paper products from the straw. Flaxseed oil is high in omega-3 fatty acids, which are associated with lowered risk of heart disease and lowered blood cholesterol levels. Flax has a 50-day vegetative period, a 25-day flowering period, and a 35-day period to maturity. Seeds are produced in bolls that contain 6–10 seeds. Seed color can be brown, golden, or yellow. A mucilaginous coating covers the seed. The flax crop responds to up to 50 lb/acre nitrogen, similar to organic small grains. Mycorrhizal association may increase the ability of flax to take up phosphorus from the soil, so growing flax after mycorrhizal wheat rather than after nonmycorrhizal canola may improve its phosphorus uptake. Early-seeded flax generally produces the highest yields, when using the same planting dates as small grains. Frost seldom kills flax seedlings. Nonuniform maturity and ripening are problems in late-seeded fields. With the introduction of a processing facility, organic flaxseed oil can now be processed in Iowa and sold around the world. There is, in turn, a potential for increased organic flax production in Iowa.

Materials and Methods

In 2005, an organic flax experiment was continued at the Neely-Kinyon Farm. Plots measuring 20 ft × 110 ft were laid out in a split-split-plot design. Varieties (Norlin and CDC Bethune) were the main plots, with fertility treatments (compost versus no compost) as split-plots and underseeding treatments (red clover versus no red clover) as split-split plots. Flax was seeded on April 5, at 50 lb/acre. Cherokee red clover was underseeded in half of the flax plots at 10 lb/acre at the same time. Compost was applied at 4 tons/acre on March 16.

Flax height was taken on June 2 by measuring three random plants in each plot. Flax population counts were also taken on June 2 by placing a 1-ft^2 quadrat in three random areas of each plot and counting the number of plants inside the quadrat. Weed counts were taken on June 2 by placing a 1-ft^2 quadrat in three random areas of each plot and counting the number of broadleaf and grass weeds. On June 9, biomass samples were taken by randomly clipping three 1-ft^2 sections from each plot. The biomass samples were weighed, separated into flax, red clover, and weeds, and placed in a dryer at 155°F for 48 hours, after which separate dry weights were taken for each. Flax was windrowed with a 20-ft self-propelled windrower on August 1, and windrows were harvested with a combine on August 8, 2005. Soil samples were taken on August 11, 2005, from five random locations within each plot (6-in. depth).

Results and Discussion

Organic flax yields at the Neely-Kinyon Farm were excellent in 2005, with Norlin producing 24.5 bushels/acre and CDC Bethune yielding

27.1 bushels/acre (Table 1). There was no significant difference between varieties. Subtreatments, however, had a mixed effect on yield: Compost applications significantly increased yields by an average of 5.0 bushels/acre, while the red clover did not significantly increase yields (Tables 2 and 3). In 2004 several farmers reported red clover to be helpful in managing weeds. A decrease in grass weed populations in the red clover subtreatments was observed, but differences in overall weed populations were not seen among any treatments in 2005 (Tables 2 and 3). Specifically, red clover did not noticeably affect weed biomass (Table 3). The red clover crop, however, produced significant biomass after the flax harvest (Table 3), serving as a soil-building crop in the rotation–a requirement for certified organic production. The compost and red clover did not appear to impact soil fertility (Tables 4, 5, and 6) in the first year of this experiment.

The increase in average flax yield at the Neely-Kinyon Farm (from 15.9 bu/acre in 2004 to 25.7 bu/acre in 2005) may be associated with the following factors: earlier planting date (April 5, 2005, versus May 4, 2004); windrowing the flax before combining; and/or more supportive weather conditions. Both Norlin and CDC Bethune varieties yielded well across the state of Iowa in 2005. Early recommendations for maximum yield developed from this research include the use of a red clover interseeding at flax planting and applying compost. Organic flax was sold for $0.35/lb in 2004, with net returns reported at $419/acre – significantly greater than conventional prices.

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Table 1. Variety performance in the organic flax trial, Neely-Kinyon Farm, 2005.

Variety	Stand plants/ft^2	Plant height (cm)	Broadleaf weeds/m^2	Grass weeds/m^2	Flax dry weight (lb/ac)	Red clover dry weight (lb/ac)	Weed dry weight (lb/ac)	Yield[1] (bu/ac)
CDC Bethune	69.56b	60.44b	15.79	0.88	4,374.7	43.12	33.54	27.07
Norlin	82.04a	63.46a	14.52	0.67	4,580.8	20.12	38.33	24.48
LSD 0.05	5.28	1.35	NS	NS	NS	NS	NS	NS

[1]Yield was calculated at 9% moisture.

Table 2. Flax performance with compost in the organic flax trial, Neely-Kinyon Farm, 2005.

Compost presence	Stand plants/ft^2	Plant height (cm)	Broadleaf weeds/m^2	Grass weeds/m^2	Flax dry weight (lb/ac)	Red clover dry weight (lb/ac)	Weed dry weight (lb/ac)	Yield[1] (bu/ac)
No Compost	77.06	60.58b	15.42	0.54	4,451.4	32.58	30.67	28.01a
Compost	74.54	63.31a	14.90	1.00	4,504.1	29.71	41.21	23.54b
LSD 0.05	NS	1.37	NS	NS	NS	NS	NS	2.82

[1]Yield was calculated at 9% moisture.

Table 3. Flax performance with red clover in the organic flax trial, Neely-Kinyon Farm, 2005.

Red clover presence	Stand plants/ft^2	Plant height (cm)	Broadleaf weeds/m^2	Grass weeds/m^2	Flax dry weight (lb/ac)	Red clover dry weight (lb/ac)	Weed dry weight (lb/ac)	Yield[1] (bu/ac)
No red clover	76.75	62.35	15.44	1.04a	4,574.1	0.00b	26.83	27.22
Red clover	74.85	61.54	14.88	0.50b	4,382.4	62.29a	45.04	24.34
LSD 0.05	NS	NS	NS	0.52	NS	18.21	NS	NS

[1]Yield was calculated at 9% moisture.

Table 4. Soil quality among varieties in the organic flax variety trial, Neely-Kinyon Farm, 2005.

Variety	NO_3-N (ppm)	NH_4-N (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Na (ppm)
CDC Bethune	5.06	5.16	236.94	3259.13	352.50	13.22
Norlin	5.16	5.69	230.72	3260.41	353.69	12.78
LSD 0.05	NS	NS	NS	NS	NS	NS

Table 5. Soil quality with compost in the organic flax compost trial, Neely-Kinyon Farm, 2005.

Compost presence	NO_3-N (ppm)	NH_4-N (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Na (ppm)
No compost	5.00	5.28	237.06	3256.00	346.28b	12.25
Compost	5.22	5.56	230.59	3263.53	359.91a	13.75
LSD 0.05	NS	NS	NS	NS	9.99	NS

Table 6. Soil quality with red clover in the organic flax red clover trial, Neely-Kinyon Farm, 2005.

Red clover presence	NO_3-N (ppm)	NH_4-N (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Na (ppm)
No red clover	6.06a	5.69	232.22	3283.63	355.38	13.31
Red clover	4.16b	5.16	235.44	3235.91	350.81	12.69
LSD 0.05	0.47	NS	NS	NS	NS	NS