Evaluation of Varieties, Fertility Treatments, and Red Clover Underseeding For Certified Organic Production Flax Production—Neely-Kinyon Trial, 2006

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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, and 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. The seed is covered with a mucilaginous coating. The flax crop responds to up to 50 lb/A 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 non-mycorrhizal canola may improve phosphorus uptake by flax. Early seeded flax generally produces the highest yields, using the same planting dates as small grains. Frost seldom kills flax seedlings. Non-uniform maturity and ripening is a problem in late–seeded fields.

Organic flaxseed oil can now be processed in Iowa to be sold around the world. With the introduction of this processing facility came a need for increased organic flax production in Iowa.

Materials and Methods

In 2006, an organic flax experiment was continued at the Neely-Kinyon Farm. Plots measuring 18 x 100 ft. were laid out in a split-split-plot design. Varieties ('Norlin' and 'CDC Bethune') were the main plots, with fertility treatments (compost vs. no compost) as split-plots and underseeding treatments (red clover vs. no red clover) as split-split plots. Flax was seeded on April 13 at 50 lb/acre. Cherokee red clover was underseeded in half of the flax plots at 8 lbs/acre at the same time. Compost was applied at 4 tons/acre on April 6, 2006.

Flax height was taken on June 1 by measuring 3 random plants in each plot, and flax population counts were also taken on June 1 by placing a 1-square-foot quadrat in three random areas of each plot and counting the number of plants inside the quadrat. Weed counts were taken on June 1 by placing a 1-square-meter quadrat in three random areas of each plot and counting the number of broadleaf and grass weeds. On June 29, biomass samples were taken by randomly clipping three 1-ft^2 sections from each plot. The biomass samples were weighed, placed in a room at 75 °F and weighed daily until proper dry weight was achieved, after which dry weights were taken for each sample. Flax was windrowed with a 12-ft. self-propelled windrower on July 27, flax was turned with a windrow inverter on August 14, and harvested with a combine on August 14, 2006. Soil samples were taken on September 6, 2006, from five random locations within each plot (6-in. depth).

Results and Discussion

Because of drought conditions in 2006, flax yields at the N-K Farm averaged 14 bu/acre. compared to the excellent yields of 26 bu/acre in 2005. There was no significant difference between varieties, with 'Norlin' producing 13.6 bu/acre and 'CDC Bethune' yielding 14.5 bu/acre (Tables 1 and 7). Sub-treatments, however, had a mixed effect on yield: Compost applications significantly increased yields by an average of 5.0 bu/acre (Tables 2 and 7), similar to 2005 results. The underseeding of red clover did not significantly increase yields (Tables 3 and 7), similar to 2005 results. Red clover was reported by several farmer-cooperators to be helpful in managing weeds, and a trend towards decreased grass weed populations in the red clover sub-treatments was observed, but differences in overall weed populations were not seen between treatments in 2006 (Tables 3 and 7). The red clover crop, however, produced significant biomass after the flax harvest, 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 5 and 8), similar to 2005 results.

In the three years of organic flax production at the Neely-Kinyon Farm, yields have ranged from 16 bu/acre in 2004 to 26 bu/acre in 2005 and 14 bu/acre in 2006. Lower yields in 2006 may be associated with the following factors: drought-like conditions during boll–filling; and rains during the period the flax was in windrows. In the northern part of the state where rains were adequate, yields of 30 bu/acre were achieved. Recommendations for maximum yield developed from this research include the use of compost for maximum yield. Red clover is also encouraged to keep legumes in the soil-building crop rotation requirement for certified organic farms. Organic flax was sold for $0.32/lb in 2006, with net returns in high yield areas 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, 2006.

Variety	Stand plants/ft^2	Plant height (cm)	Broadleaf weeds/m^2	Grass weeds/m^2	Biomass dry weight (lb/ac)	Yield[1] (bu/ac)
CDC Bethune	20.79	43.79	19.31	3.50	4104.08	14.46
Norlin	21.31	45.06	20.83	2.60	4145.38	13.60
LSD 0.05	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, 2006.

Compost Presence	Stand plants/ft^2	Plant height (cm)	Broadleaf weeds/m^2	Grass weeds/m^2	Biomass dry weight (lb/ac)	Yield[1] (bu/ac)
No Compost	20.17	43.44	22.60	2.29	3929.38	11.37b
Compost	21.94	45.42	17.54	3.81	4320.08	16.55a
LSD 0.05	NS	NS	NS	NS	NS	1.90

[1] Yield was calculated at 9% moisture.

Table 3. Flax performance with red clover in the organic flax trial, Neely-Kinyon Farm, 2006.

Red Clover Presence	Stand plants/ft^2	Plant height (cm)	Broadleaf weeds/m^2	Grass weeds/m^2	Biomass dry weight (lb/ac)	Yield[1] (bu/ac)
No Red Clover	22.10	45.33	19.75	3.50	4,099.86	14.42
Red Clover	20.00	43.52	20.40	2.60	4,149.41	13.69
LSD 0.05	NS	NS	NS	NS	NS	NS

[1] Yield was calculated at 9% moisture.

Table 4. Soil quality among varieties in the organic flax variety trial, Neely-Kinyon Farm, 2006.

Variety	NO3-N (ppm)	NH4-N (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Na (ppm)	Total N (%)	B-P (ppm)
CDC Bethune	13.87	6.58	273.52	2,999.81	403.31	20.89	0.216	60.94
Norlin	15.38	6.77	277.38	2,978.63	395.32	20.09	0.217	62.13
LSD 0.05	NS	NS	NS	NS	NS	NS	NS	NS

Table 5. Soil quality with compost in the organic flax compost trial, Neely-Kinyon Farm, 2006.

Compost presence	NO3-N (ppm)	NH4-N (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Na (ppm)	Total N (%)	B-P (ppm)
No compost	14.19	6.65	289.72a	3,002.75	391.38	20.20	0.216	56.81
Compost	15.06	6.70	261.18b	2,975.69	407.25	20.77	0.218	66.25
LSD 0.05	NS	NS	21.30	NS	NS	NS	NS	NS

Table 6. Soil quality with red clover in the organic flax red clover trial, Neely-Kinyon Farm, 2006.

Red clover presence	NO3-N (ppm)	NH4-N (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Na (ppm)	Total N (%)	B-P (ppm)
No red clover	14.99	6.64	277.43	3,018.13	404.19	20.84	0.218	65.56
Red clover	14.26	6.71	273.47	2,960.31	394.44	20.14	0.216	57.50
LSD 0.05	NS	NS	NS	NS	NS	NS	NS	NS

Table 7, Flax performance by variety, compost, and red clover interaction in the organic flax trial, Neely-Kinyon, 2006.

Variables	Stand plants/ft^2	Plant height (cm)	Broadleaf weeds/m^2	Grass weeds/m^2	Biomass dry weight (lb/ac)	Yield[1] (bu/ac)
Bethune, compost, no red clover	22.58	46.25	14.00	3.67	4,810.63	16.71a
Bethune, compost, red clover	20.83	43.00	17.92	3.83	4,226.07	17.98a
Bethune, no compost, no red clover	21.33	44.67	26.08	3.75	3,666.43	11.91cd
Bethune, no compost, red clover	18.42	41.25	19.25	2.75	3,713.38	11.24d
Norlin, compost, no red clover	22.83	46.42	15.75	5.50	3,979.79	16.19ab
Norlin, compost, red clover	21.50	46.00	22.50	2.25	4,264.40	15.33abc
Norlin, no compost, no red clover	21.67	44.00	23.17	1.08	3,943.37	12.35bcd
Norlin, no compost, red clover	19.25	43.83	21.92	1.58	4,394.73	10.23d
LSD 0.05	NS	NS	NS	NS	NS	3.97

Table 8. Soil quality by variety, compost, and red clover interaction in the organic flax compost trial, Neely-Kinyon Farm, 2006.

Variables	NO3-N (ppm)	NH4-N (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Na (ppm)	Total N (%)	B-P (ppm)
Bethune, compost, no red clover	17.03	6.78	269.59	3,036.38	424.25	22.59	0.220	60.75
Bethune, compost, red clover	12.13	6.24	255.46	2,950.38	400.89	20.10	0.216	62.00
Bethune, no compost, no red clover	13.96	6.34	279.64	3,066.88	402.59	21.24	0.216	64.38
Bethune, no compost, red clover	12.37	6.94	289.38	2,945.63	385.53	19.63	0.213	56.63
Norlin, compost, no red clover	15.18	6.72	259.04	2,918.50	399.53	20.46	0.218	82.25
Norlin, compost, red clover	15.91	7.06	260.61	2,997.50	404.34	19.94	0.217	60.00
Norlin, no compost, no red clover	13.80	6.73	301.44	3,050.75	390.39	19.08	0.216	54.88
Norlin, no compost, red clover	16.61	6.58	288.43	2,947.75	387.01	20.87	0.219	51.38
LSD 0.05	NS	NS	NS	NS	NS	NS	NS	NS