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

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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 2005, an organic flax experiment was continued at the Neely-Kinyon Farm. Plots measuring 20 x 110 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 5, at 50 lb/acre. Cherokee red clover was underseeded in half of the flax plots at 10 lbs/acre at the same time. Compost was applied at 4 tons/acre on March 16.

Flax height was taken on June 2 by measuring 3 random plants in each plot, and flax population counts were also taken on June 2 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 2 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 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 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 N-K Farm were excellent in 2005, with ‘Norlin’ producing 24.5 bu/acre and ‘CDC Bethune’ yielding 27.1

bu/acre (Table 1), with no significant difference between varieties. Sub-treatments, however, had a mixed effect on yield: Compost applications significantly increased yields by an average of 5.0 bu/acre, while the red clover did not significantly increase yields (Tables 2-3). Red clover was reported by several farmers in 2004 to be helpful in managing weeds, and a decrease in grass weed populations in the red clover sub-treatments was observed, but differences in overall weed populations were not seen among any treatments in 2005 (Tables 2-3). Specifically, there was no noticeable effect from red clover on 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 4-6) in the first year of this experiment. There was a significant interaction among the three variables regarding flax stand/ft^2 (Table 7). A significant interaction was also evident between the three variables regarding ppm NH^4-N (Table 8).

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 vs. May 4, 2004); wind-rowing 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)	Weeds 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)	Weeds 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	23.54b
Compost	74.54	63.31a	14.90	1.00	4,504.1	29.71	41.21	28.01a
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)	Weeds dry weight (lb/ac)	Yield[1] (bu/ac)
No Red Clover	76.75	62.35	15.44	1.04b	4,574.1	0.00b	26.83	27.22
Red Clover	74.85	61.54	14.88	0.50a	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	NO3-N (ppm)	NH4-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	NO3-N (ppm)	NH4-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	NO3-N (ppm)	NH4-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

Table 7, Flax performance by variety, compost, and red clover interaction in the organic flax trial, Neely-Kinyon, 2005.

Variables	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)	Weeds dry weight (lb/ac)	Yield[1] (bu/ac)
Bethune, compost, no red clover	74.67bc	62.67	16.92	1.42	4,798.6	0.0	41.4	31.32
Bethune, compost, red clover	66.92c	62.08	13.67	0.83	4,172.1	82.0	25.9	27.11
Bethune, no compost, no red clover	66.83c	59.00	16.58	0.50	4.391.8	0.0	22.3	26.90
Bethune, no compost, red clover	69.83c	58.00	16.00	0.75	4,157.9	90.0	43.0	22.94
Norlin, compost, no red clover	75.42bc	64.75	12.08	1.42	4,489.7	0.0	43.0	27.23

Norlin, compost, red clover	81.17ab	63.75	16.92	0.33	4,577.4	36.5	54.2	26.37
Norlin, no compost, no red clover	90.08a	63.00	16.17	0.83	4,637.4	0.0	0.0	23.40
Norlin, no compost, red clover	81.50ab	62.33	12.92	0.08	4,641.6	42.2	56.9	20.93
LSD 0.05	5.15	NS	NS	NS	NS	NS	NS	NS

Table 8. Soil quality by variety, compost, and red clover interaction in the organic flax compost trial, Neely-Kinyon Farm, 2005

Variables	NO3-N (ppm)	NH4-N (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Na (ppm)
Bethune, compost, no red clover	5.88	5.75b	235.25	3271.63	356.63	12.13
Bethune, compost, red clover	4.75	6.00b	235.25	3264.13	358.75	18.00
Bethune, no compost, no red clover	5.63	4.50cd	237.25	3288.25	347.75	13.00
Bethune, no compost, red clover	4.00	4.38d	240.00	3212.50	346.88	9.75
Norlin, compost, no red clover	6.00	5.00cd	222.63	3261.38	364.00	12.75
Norlin, compost, red clover	4.25	5.50bc	229.25	3257.00	360.25	12.13
Norlin, no compost, no red clover	6.75	7.50a	233.75	3313.25	353.13	15.38
Norlin, no compost, red clover	3.63	4.75cd	237.25	3210.00	337.38	10.88
LSD 0.05	NS	0.88	NS	NS	NS	NS