2013

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2013 OILSEED MEAL AS A FERTILITY AMENDMENT IN SWEET CORN

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Many Northeast growers are integrating oilseed crops such as canola, soybeans, and sunflower into their operation, in hopes of on-farm fuel production, value-added products, and/or livestock feed. Many producers are using small-scale presses to mechanically separate oil from the seed. Oilseed meal, the high-protein byproduct left after the extrusion of oil, can be milled and used as a soil amendment to increase fertility and organic matter. This material has the potential to replace high-cost imported fertilizers, especially for organic growers.

MATERIALS AND METHODS

A trial was initiated at Borderview Research Farm in Alburgh, Vermont to assess the effectiveness of using oilseed meals as a fertility amendment in sweet corn (Table 1). The experimental design was a randomized complete block with three replications. Treatments consisted of four fertility amendment types (three different oilseed meals and a control of synthetic Chilean nitrate) at two different application rates each (50 and 100 lbs per acre).

Table 1. Agronomic information for oilseed meal trial, 2013, Alburgh, VT.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Covington silty clay loam, 0-3% slope
Previous crop	Silage corn
Soil amendments	Canola meal, soybean meal, sunflower meal, Chilean N
Amendment rates (lbs ac^{-1})	50, 100
Replications	3
Plot size (ft)	10 x 25
Sweet corn variety	Johnny's 'Sugar Buns' (F1, 70 days, treated)
Soil amendment date	5-Jun
Planting date	9-Jul
Planting equipment	John Deere 1750 MaxEmerge planter
Planting rate (seeds ac^{-1})	24,000
Row width (in.)	30
Harvest date	25-Sep

All oilseed crops were grown in Vermont and harvested in 2012. Subsamples of the oilseed meals were sent to Cumberland Valley Analytics in Hagerstown, MD for wet chemistry analysis of nitrogen (N), phosphorus (P), and potassium (K) values (Table 2). Meal was extruded with a KernKraft 40 cold-press oil mill and hammer-milled for consistent texture. Meal was broadcast by hand on 5-Jun in 10’ by 25’ plots and lightly incorporated with harrows. The sweet corn, planted 9-Jul, was the Johnny’s Selected Seeds variety ‘Sugar Buns’ (sugary-enhanced plus, treated with Captan, Thiram, Apron, Dividend, Vitavax, and Polymer). The corn was seeded in 30” rows at a rate of 24,000 seeds per acre with a John Deere 1750 MaxEmerge planting system.

Table 2. Nutrient analysis of canola, soybean, and sunflower meals, and Chilean Nitrate.

Crop	Variety	N	P	K
		%	%	%
Canola	5535 CL	4.8	1.0	1.2
Soybean	Boyd	6.4	0.5	1.8
Sunflower	Syngenta 3480	3.9	0.7	1.1
Chilean Nitrate		16.0	0.0	0.0

Soil samples were collected weekly through June and July, then biweekly until harvest (25-Sep). Nitrate levels were measured in the Agricultural and Environmental Testing Lab at the University of Vermont. On 14-Aug, sweet corn populations were measured. Sweet corn was picked by hand on 25-Sep, and measurements on yield, number of ears per plot, and ear length were collected. Stalk samples were sent to the University of Massachusetts for analysis of stalk nitrate levels.

Data were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within trials were treated as random effects, and soil amendment treatments were treated as fixed. Mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$).

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among treatments is real or whether it might have occurred due to other variations in the field. At the bottom of each table a LSD value is presented for each variable (i.e. yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown, except where analyzed by pairwise comparison (t-test). Where the difference between two treatments within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the two treatments. Treatments that were not significantly lower in performance than the top-performing treatment in a particular column are indicated with an asterisk. In the example below, hybrid C is significantly different from hybrid A but not from hybrid B. The difference between C and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these hybrids did not differ in yield. The difference between C and A is equal to 3.0, which is greater than the LSD value of 2.0. This means that the yields of these hybrids were significantly different from one another. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C, indicated in bold.

Treatment	Yield
A	6.0
B	7.5*
C	**9.0***
LSD	2.0

RESULTS

Weather data was collected with an onsite Davis Instruments Vantage Pro2 weather station equipped with a WeatherLink data logger. Temperature, precipitation, and accumulation of Growing Degree Days (GDDs) are consolidated for the 2013 growing season (Table 3). Historical weather data are from 1981-2010 at cooperative observation stations in Burlington, VT, approximately 45 miles from Alburgh, VT. For the most part, it was colder and wetter than average in the spring of 2013, when sweet corn was planted. In fact, the corn was planted on 6-Jun, then plowed under due to crop failure, and replanted 9-Jul. In June 2013, there were 5.54 more inches of precipitation than normal. After June, however, the summer of 2013 was drier than normal, with an average of 5.20 inches fewer than average in July, August, and September. GDDs are calculated at a base temperature of 50°F for sweet corn. Between the months of planting and harvesting, there were an accumulated 1520 GDDs for corn, 19 fewer than the 30-year average.

Table 3. Consolidated weather data and GDDs for sweet corn, Alburgh, VT, 2013.

Alburgh, VT	June	July	August	September
Average temperature (°F)	64.0	71.7	67.7	59.3
Departure from normal	-1.8	1.1	-1.1	-1.3
Precipitation (inches)	9.23 *	1.89	2.41	2.20
Departure from normal	5.54	-2.26	-1.50	-1.44
Growing Degree Days (base 50°F)	427	677	554	289
Departure from normal	-47	37	-27	-29

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

* June 2013 precipitation data based on National Weather Service data from cooperative stations in South Hero, VT.

Nitrate levels throughout the season varied significantly on most sample dates (Table 4). There was a significant difference in nitrate levels on six of the nine sampling dates. In the earliest dates (13-Jun and 3-Jul) the Chilean Nitrate at 100 lbs per acre was higher in nitrates than all other treatments. By 11-Jul, the greatest nitrate level was in soybean meal at 100 lbs per acre, though this was statistically similar to three other treatments. There was no statistically significant difference in nitrates by treatment on 18-Jul, though the greatest level was in sunflower meal applied at 100 lbs per acre. On 2-Aug, the greatest nitrate level was in soybean meal at 100 lbs per acre, though this was not statistically greater than canola meal at 50 lbs per acre. On 14-Aug, Chilean N at 100 lbs per acre had the highest level of nitrates (83.2 mg per kg) of the entire study, significantly greater than all other treatments from that date. At this time, when sweet corn would normally be side-dressed, all treatments had NO_3 (nitrates) levels above 30 ppm, the point at which UVM Extension Pre-Sidedress Nitrate Tests (PSNTs) would recommend no application of sidedress N. On 27-Aug, the greatest level of nitrates (in canola at 50 lbs per acre) was not statistically different than four other treatments, and nitrate levels in September did not differ significantly by soil amendment treatment. The average nitrate levels for the trial peaked in mid-August and then decreased and leveled out by September (Figure 1).

Table 4. Effects of soil amendment treatments on nitrate levels, Alburgh, VT, 2013.

Soil amendment and rate	Nitrate (NO_3) levels								
	13-Jun	3-Jul	11-Jul	18-Jul	2-Aug	14-Aug	27-Aug	13-Sep	27-Sep
	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}
Canola, 50 lbs ac^{-1}	4.2	11.2	19.4	21.4	53.9*	51.2	**39.8***	11.8	11.9
Canola, 100 lbs ac^{-1}	3.0	12.6	25.0*	11.6	32.2	45.8	36.0*	13.2	10.0
Sunflower, 50 lbs ac^{-1}	3.9	10.9	18.5	22.4	32.5	33.7	15.3	6.6	9.2
Sunflower, 100 lbs ac^{-1}	3.8	13.9	20.7	**31.9**	34.4	31.4	17.7	8.4	7.6
Soybean, 50 lbs ac^{-1}	5.1	16.8	27.7*	28.2	36.0	50.8	25.4*	9.5	13.8
Soybean, 100 lbs ac^{-1}	5.1	14.0	**31.2***	13.7	**60.9***	45.4	21.3	11.2	16.5
Chilean N, 50 lbs ac^{-1}	10.2	12.1	21.0	25.6	26.5	34.6	28.8*	8.3	9.3
Chilean N, 100 lbs ac^{-1}	**19.1***	**32.0***	24.6*	12.4	40.2	**83.2***	37.2*	**15.8**	**17.0**
LSD (0.10)	3.6	7.9	6.8	NS	19.2	22.9	15.4	NS	NS
Trial mean	6.8	15.4	23.5	20.9	39.6	47.0	27.7	10.6	11.9

Treatments in **bold** were top performers for the given variable.
NS – There was no statistical difference between treatments in a particular column (p=0.10).
*Treatments marked with an asterisk did not perform statistically worse than the top performing treatment (p=0.10).

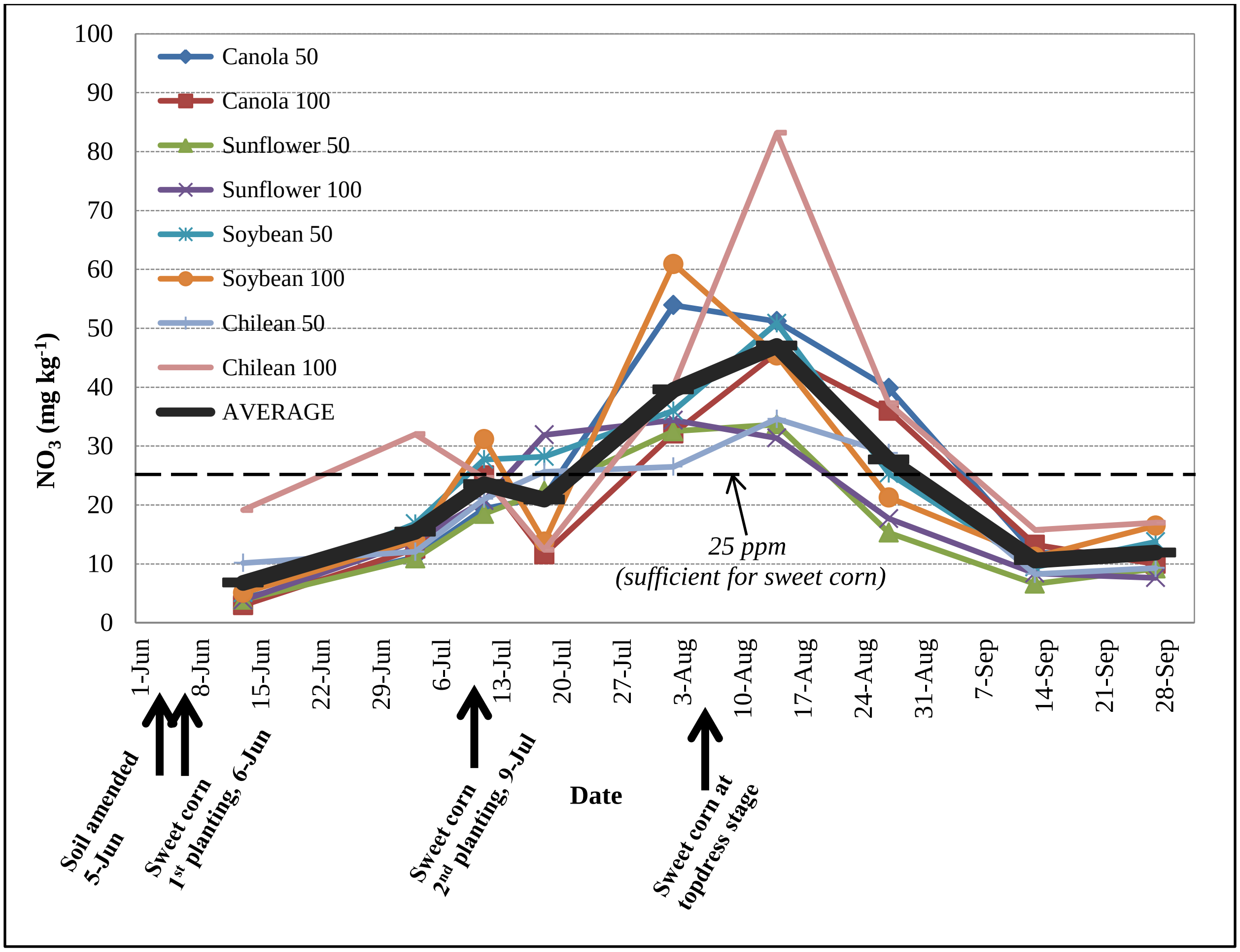

Figure 1. Nitrate levels from 13-Jun to 27-Sep 2013, Alburgh, VT. There was a significant difference in NO_3 level by treatment for six out of the nine sample dates ($p=0.10$). The thick black line represents the trial mean.

There were no statistically significant impacts of soil amendment treatment on sweet corn populations, yield, or corn quality (Table 5, Figure 2). Plant populations on 14-Aug averaged 22,426 plants per acre; the greatest population was where soil had been amended with 100 lbs per acre of Chilean N, but this was not statistically significant. Sweet corn yield did not differ significantly by treatment and averaged 6978 lbs per acre. There was no significant difference in the number of ears of corn per plot, though where Chilean N was applied at 100 lbs per acre, there was the greatest number (54.3 ears per plot, or 5.43 ears per 10’ row). Ear length (averaging 24.1 cm) did not vary significantly by treatment, nor did stalk nitrate levels, which averaged 1981 ppm.

Table 5. Effects of soil amendments on population and yields of sweet corn, Alburgh, VT, 2013.

Soil amendment and rate	14-Aug population	Yield	Corn ears	Ear length	Stalk N
	plants ac^{-1}	lbs ac^{-1}	per plot	cm	ppm
Canola, 50 lbs ac^{-1}	22942	7063	53.3	23.5	**2868**
Canola, 100 lbs ac^{-1}	20676	6435	47.7	25.2	1666
Sunflower, 50 lbs ac^{-1}	23813	6993	51.7	24.6	1604
Sunflower, 100 lbs ac^{-1}	22070	6435	45.7	23.3	1938
Soybean, 50 lbs ac^{-1}	21490	6110	49.7	23.7	1930
Soybean, 100 lbs ac^{-1}	22070	7713	52.3	**25.5**	1816
Chilean N, 50 lbs ac^{-1}	22651	**7736**	50.0	23.6	1596
Chilean N, 100 lbs ac^{-1}	**23697**	7341	**54.3**	23.5	2433
LSD (0.10)	NS	NS	NS	NS	NS
Trial mean	22426	6978	50.6	24.1	1981

Treatments in **bold** were top performers for the given variable.
NS – There was no statistical difference between treatments in a particular column (p=0.10).

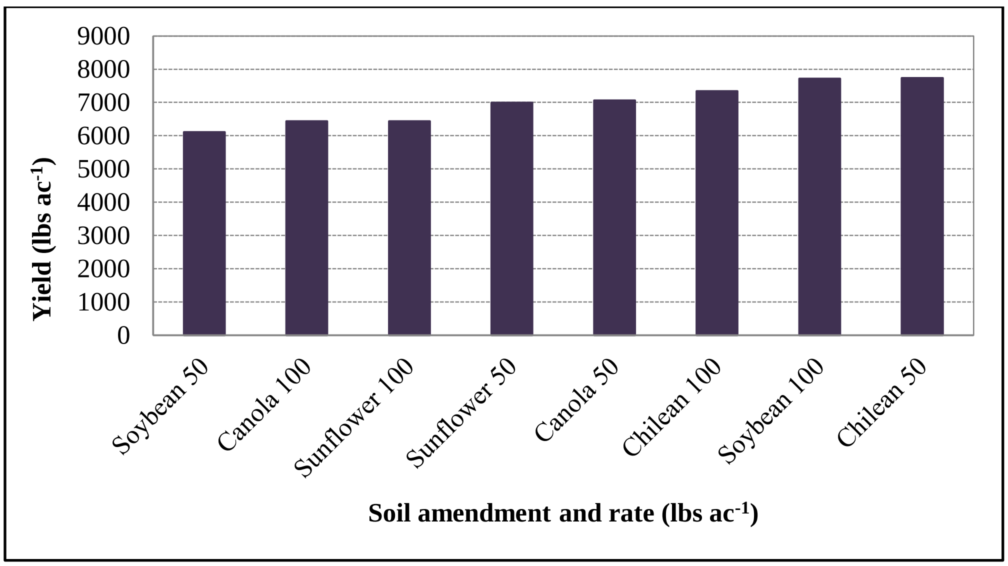

Figure 2. Sweet corn yields by soil amendment treatment. There were no statistically significant differences in yield (p=0.10).

DISCUSSION

This research trial shows that oilseed meals have the potential to be used as replacements for high-cost organic fertility inputs. Average sweet corn yields for this trial were 9583 ears per acre, or 6978 lbs of corn (about 200 bushels) per acre. This is a bit lower than national average yields for organic sweet corn (12,000 ears per acre). However, there were no statistically significant differences between oilseed meal amendments and commercial Chilean N, which can be cost-prohibitive for many organic growers, and have limited organic uses, according to NOP regulations. There were no statistically significant differences in plant populations, yield, number of ears, ear length, or stalk nitrates, indicating that oilseed meals can be used as soil amendments to produce a sweet corn crop comparable to the use of Chilean N. Interestingly, the soybean and canola meal had peak nitrate release near the time of topdress (3-Aug) indicating that the amendments needed almost 60 days to mineralize adequate nitrogen for sweet corn production. Hence, a grower would need to plan to add oilseed meals well in advance of sweet corn planting. It does appear from this preliminary work that 100 lbs of meal per acre would provide adequate N for sweet corn production. However, soil conditions and weather conditions would also greatly impact the amount of amendment required to meet the crop needs. UVM Extension estimates the cost of Chilean N at $1.56 per lb of N. This could be less expensive than producing oilseed meals, but oilseed growers would also be able to utilize their oil as a food-grade product or a biofuel.

Not surprisingly, canola (4.8% N), soybean (6.4% N), and sunflower (3.9% N) all had lower nitrate levels in the first two soil sample dates (one and two weeks after amending soils) than Chilean N (16.0% N). However, through the eventual process of nitrogen mineralization, the organic N added to the soil in the form of oilseed meals and Chilean N was broken down into ammonium nitrate and nitrate. Soil sample results from this study show NO_3 (nitrates), the most accessible form of nitrogen for plants. By the time sweet corn would have been sidedressed (early to mid-Aug), nitrate levels were all above 30 ppm, indicating that they did not need additional N applications (some treatments were 'Excessive' in NO_3, or above 50 ppm). In addition, all post-harvest stalk nitrate concentrations were at optimum or excessive levels ('Optimum' is 500 to 1700 ppm N; 'Excessive' is greater than 1700 ppm N). This indicates that the soil amendments provided adequate, or more than adequate, N for sweet corn growth and development. It is important to remember that these data represent only one year of research, and in only one location. More data should be considered before making agronomic management decisions.

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