2014 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 sodium nitrate) at two different application rates each (50 and 100 lbs per acre).

Table 1. Agronomic information for oilseed meal trial, Alburgh, VT, 2014.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam, 8-15% slope
Previous crop	Silage corn
Soil amendments	Canola meal, soybean meal, sunflower meal, and Chilean Nitrate
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	29-May
Herbicide application	Lumax 3qt. on 5-Jun
Planting date	30-May
Planting equipment	John Deere 1750 MaxEmerge planter
Planting rate (seeds ac^{-1})	22,000
Row width (in.)	30
Sidedress	200 lbs ac^{-1} 46-0-0 on 2-Jul
Harvest date	22-Aug

Meal was extruded with a KernKraft 40 cold-press oil mill and hammer-milled for consistent texture. 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 broadcast by hand on 29-May in 10’ by 25’ plots and lightly incorporated with harrows. The sweet corn, planted 30-May, 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 22,000 seeds per acre with a John Deere 1750 MaxEmerge planting system.

Table 2. Nutrient analysis of canola, soybean, 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
Sodium Nitrate		16	0	0

Soil samples were collected weekly through June and July, then biweekly until harvest (22-Aug). Soil-nitrate levels were measured in the Agricultural and Environmental Testing Lab at the University of Vermont. On 16-Jun, sweet corn populations were measured by counting the number of plants in the center two rows of each plot. Sweet corn was picked by hand on 22-Aug, 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 2014 growing season (Table 3). Historical weather data are from 1981-2010 at cooperative observation stations in Burlington, VT, approximately 45 miles from Alburgh, VT. When the corn was planted in May, temperatures were slightly above normal and there were 1.45 more inches of precipitation than normal. Throughout the rest of the growing season (June-August), this trend continued with relatively normal temperature and 3.47 more inches of precipitation. A total of 1902 GGDs were accumulated, 9 more than the 30-year average.

Table 3. Consolidated weather data and GDDs for sweet corn, Alburgh, VT, 2014.

Alburgh, VT	May	June	July	August
Average temperature (°F)	57.4	66.9	69.7	67.6
Departure from normal	1.0	1.1	-0.9	-1.2
Precipitation (inches)	4.90	6.09	5.15	3.98
Departure from normal	1.45	2.40	1.00	0.07
Growing Degree Days (base 50°F)	238	501	613	550
Departure from normal	40	27	-27	-31

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.

Soil-nitrate levels throughout the season varied significantly by treatment on most sample dates (Table 4, Figure 1). There was a significant difference in soil-nitrate levels on five of the seven sampling dates. In the earliest dates (9-Jun and 16-Jun), the sodium nitrate at 100 lbs per acre was higher in soil-nitrates than all other treatments. By 23-Jun and 30-Jun, the greatest nitrate level was still in sodium nitrate at 100 lbs per acre, though this was statistically similar to five other soil amendment treatments. On 7-Jul, sodium nitrate at 100 lbs per acre was again higher in soil-nitrates than all other treatments. Just prior to 2-Jul, when sweet corn would normally be side-dressed, only the 100 lbs per acre of sodium nitrate had NO_3 (nitrates) levels above 25 ppm, the point at which UVM Extension Pre-Sidedress Nitrate Tests (PSNTs) would recommend no application of sidedress N. On 21-Jul, the greatest soil-nitrate level was in canola meal at 100 lbs per acre, though this was not statistically greater than canola meal at 50 lbs per acre and three other treatments. On 4-Aug, soil amendment treatments did not significantly differ in soil-nitrate levels.

Table 4. Effects of soil amendment treatments on nitrate levels, Alburgh, VT, 2014.

Soil amendment and rate	Nitrate (NO_3) levels						
	9-Jun	16-Jun	23-Jun	30-Jun	7-Jul	21-Jul	4-Aug
	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}	13.7	12.8	19.4*	18.8*	15.3	13.3*	**8.4**
Canola, 100 lbs ac^{-1}	20.4	14.7	16.1	19.3*	16.2	**18.0***	8.0
Sunflower, 50 lbs ac^{-1}	10.1	9.1	13.5	16.5	15.3	7.2	6.8
Sunflower, 100 lbs ac^{-1}	17.3	17.3	22.1*	22.7*	19.0	11.4	8.1
Soybean, 50 lbs ac^{-1}	15.5	10.2	17.6*	19.8*	11.7	9.3	6.1
Soybean, 100 lbs ac^{-1}	18.9	16.0	21.6*	21.8*	18.3	16.9*	6.0
Sodium N, 50 lbs ac^{-1}	36.1*	14.8	22.3*	19.5*	14.3	13.5*	6.9
Sodium N, 100 lbs ac^{-1}	**36.3***	**26.5**	**24.8***	**25.1***	**27.1***	16.9*	8.3
LSD (0.10)	7.3	6.0	7.7	8.4	6.2	6.3	NS
Trial mean	19.7	14.5	18.8	19.4	16.2	12.6	7.2

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).

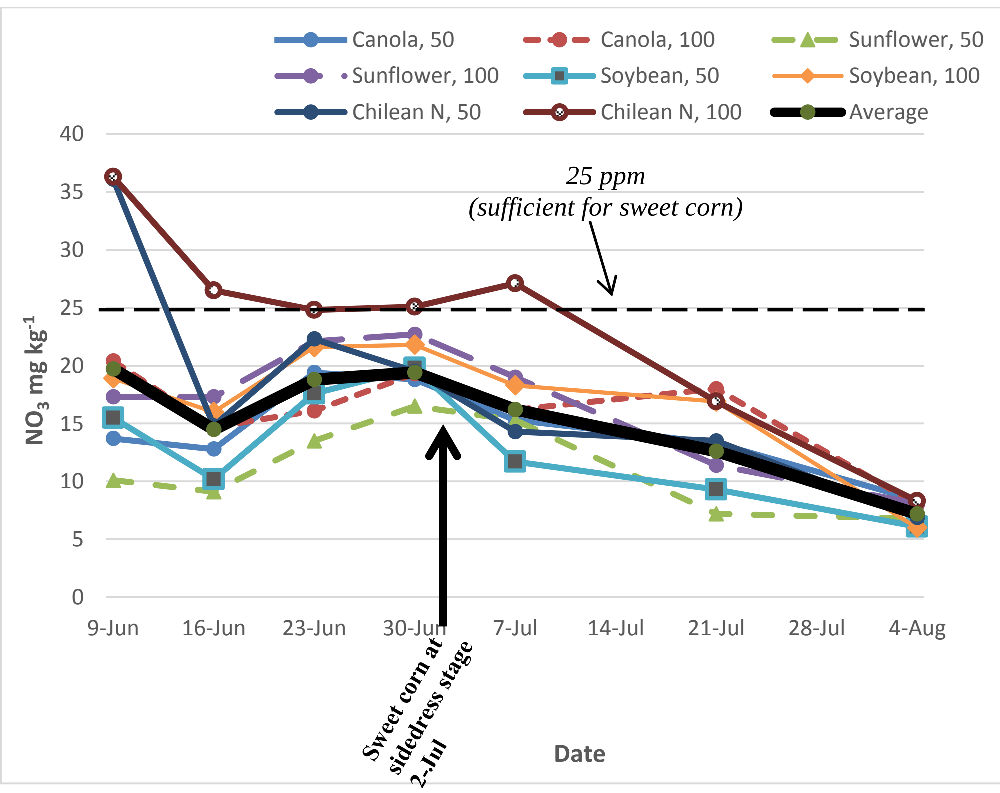

Figure 1. Nitrate levels from 9-Jun to 4-Aug 2014, Alburgh, VT. There was a significant difference in NO_3 level by treatment for six out of the seven sample dates (p=0.10). The thick black line represents the trial mean.

There were no statistically significant impacts of soil amendment treatment on sweet corn populations, corn ear per plot, and ear length (Table 5, Figure 2). Sweet corn populations averaged 20,754 plants per acre. Only the Sunflower meal at 50 lbs per acre had significantly lower yields than the highest yielding treatment of sodium nitrate at 50 lbs per acre. Stalk nitrate level was highest where Canola meal was applied at 50 lbs per acre, however, this was not statistically different from five of the other treatments.

Table 5. Effects of soil amendments on population and yields of sweet corn, Alburgh, VT, 2014.

Soil amendment and rate	16-Jun population	Yield	Corn ears	Ear length	Stalk N
	plants ac^{-1}	lbs ac^{-1}	per plot	cm	ppm
Canola, 50 lbs ac^{-1}	**22883**	16077*	64.7	**19.2**	**7589***
Canola, 100 lbs ac^{-1}	18819	15612*	67.3	19.0	2206
Sunflower, 50 lbs ac^{-1}	20793	11256	51.3	18.3	2929
Sunflower, 100 lbs ac^{-1}	20793	14323*	61.3	18.7	5699*
Soybean, 50 lbs ac^{-1}	21373	11988*	55.7	18.3	4353*
Soybean, 100 lbs ac^{-1}	21373	13626*	62.7	18.4	4293*
Chilean N, 50 lbs ac^{-1}	22187	**16994***	**72.7**	17.8	4552*
Chilean N, 100 lbs ac^{-1}	20219	15426*	64.7	18.8	5989*
LSD (0.10)	NS	5668	NS	NS	3850
Trial mean	20754	14557	63.4	18.6	4614

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).

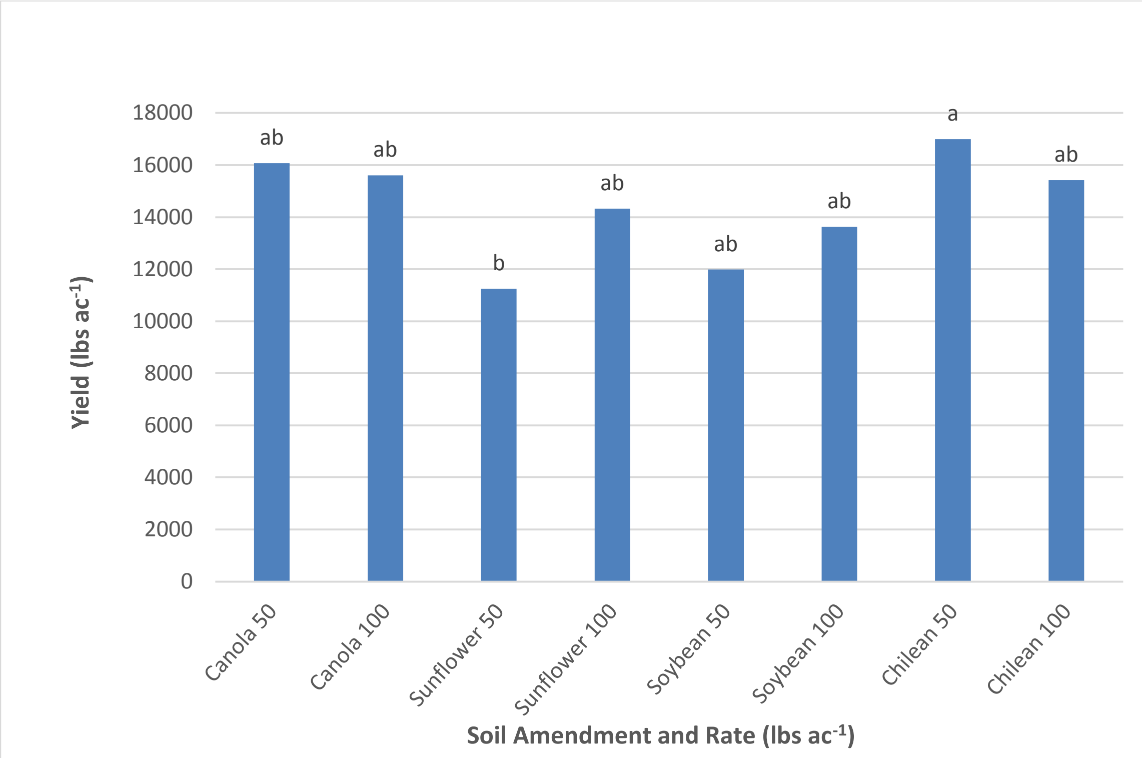

Figure 2. Sweet corn yields by soil amendment treatment. There were no statistically significant differences in yield (p=0.10).

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 11,047 ears per acre, or 14,557 lbs of corn (about 200 bushels) per acre. This is slightly lower than national average yields for organic sweet corn (12,000 ears per acre). However, there were few statistically significant differences between oilseed meal amendments and commercial sodium nitrate, which can be cost-prohibitive for many organic growers, and has a limit to its use, according to the USDA National Organic Program (NOP) regulations. There were no statistically significant differences in plant populations, yield for most treatments, number of ears, or ear length, indicating that oilseed meals can be used as soil amendments to produce a sweet corn crop comparable to the use of sodium nitrate.

Interestingly, the soybean, sunflower, and canola meal had peak nitrate release near the time of topdress (2-Jul) indicating that the amendments needed nearly 30 days to mineralize adequate nitrogen for sweet corn production. It does appear from this preliminary work that 50 or 100 lbs of N per acre applied through oilseed meals 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 sodium nitrate 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.

In addition, all post-harvest stalk nitrate concentrations were at excessive levels (‘Optimum’ is 500 to 1700 ppm N; ‘Excessive’ is greater than 1700 ppm N). This indicates that the soil amendments provided more than adequate N for sweet corn growth and development and there was excess N left in the soil at the end of the season. This is likely the case since it is very difficult to time organic amendment N mineralization with crop N demand. Organic amendments also tend to mineralize their N more slowly across the season, which can lead to excess soil-nitrates outside of the growing season. Hence, it is important to utilize cover crops to capture this residual nitrogen.

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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