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2015 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 sodium nitrate) at two different application rates (50 and 100 lbs nitrogen per acre) and a control that received no fertility. Application rates were adjusted based on the percentage of plant available nitrogen (PAN) at 70 days. The PAN at 70 days for the canola is 52.0%, for the soybean is 52.9%, for the sunflower is 39.0%, and for the sodium nitrate is 84.1%.

Table 1. Agronomic information for oilseed meal trial 2015, Alburgh, VT.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam, 8-15% slope
Previous crop	Spring wheat
Soil amendments	Canola meal, soybean meal, sunflower meal, sodium 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	19-May
Planting date	25-May
Planting equipment	John Deere 1750 MaxEmerge planter
Planting rate (seeds ac^{-1})	24,000
Row width (in.)	30
Harvest date	20-Aug

Sunflower and canola oilseed crops used to obtain the meal were grown in Vermont and New York. To obtain the meal, the oilseed 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 and the sodium nitrate was broadcast by hand on 19-May in 10’ by 25’ plots and lightly incorporated with a tineweeder. The sweet corn, planted 25-May, was the Johnny’s Selected Seeds variety ‘Sugar Buns’ (sugary-enhanced plus, treated with Apron, Captan, Dividend, Extreme, Thiram, and Vitavax). The corn was seeded in 30” rows at a rate of 24,000 seeds ac[1] with a John Deere 1750 MaxEmerge planting system.

Table 2. Nutrient analysis of canola, soybean, and sunflower meals, and sodium nitrate.

Crop	Variety	N	P	K
		%	%	%
Canola	5535 CL	5.8	1.0	0.8
Soybean	Boyd	5.7	0.6	1.5
Sunflower	Syngenta 3480	3.8	1.0	1.3
Sodium nitrate		16	0	0

Soil samples were collected weekly through June, and then biweekly until harvest (20-Aug). Nitrate levels were measured in the Agricultural and Environmental Testing Lab at the University of Vermont. On 20-Aug, 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 20-Aug, and measurements on yield, number of ears per plot, and ear length were collected (Table 5).

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 ($p<0.10$).

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

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 above, 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.

RESULTS

Seasonal precipitation and temperature was recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger, at Borderview Research Farm in Alburgh, VT. June was a wet month with 2.73 more inches of precipitation than normal (Table 3). The remainder of summer was relatively dry with 6.61 fewer inches of precipitation than normal over July and August. Temperature varied with May being much warmer than the 30 year average. Overall, there were an accumulated 2031 Growing Degree Days (GDDs) May – August, approximately 137 more than the historical average.

Table 3. Consolidated weather data and GDDs for sweet corn, Alburgh, VT, 2015.

Alburgh, VT	May	June	July	August
Average temperature (°F)	61.9	63.1	70.0	69.7
Departure from normal	5.5	-2.7	-0.6	0.9
Precipitation (inches)	1.94	6.42	1.45	0.00
Departure from normal	-1.51	2.73	-2.70	-3.91
Growing Degree Days (base 50°F)	376	399	630	626
Departure from normal	177	-75	-10	45

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.

There was a significant difference in nitrate levels on eight of the nine sampling dates (Table 4, Figure 1). From 29-May to 10-Jun and for 26-Jun, sodium nitrate at 100 lbs ac^{-1} was higher in nitrates than all other treatments. On 17-Jun soybean at 100 lbs ac^{-1} had the greatest nitrate level, which was statistically similar to five other treatments. On 2-Jul the greatest nitrate level was in canola at 100 lbs ac^{-1}, which was statistically similar to soybean and sodium nitrate each at 100 lbs ac^{-1}. On 17-Jul, the canola at 100 lbs ac^{-1} still had the greatest nitrate level, and was statistically similar to the sodium nitrate at 100 lbs ac^{-1}. By 31-Jul, canola at 100 lbs ac^{-1} maintained the greatest nitrate level, though this was statistically similar to six other treatments. On 2-Jul, when sweet corn would normally be side-dressed, all treatments had NO_3 (nitrates) levels below 25 ppm, the point at which UVM Extension Pre-Sidedress Nitrate Tests (PSNTs) would recommend no application of sidedress N.

Table 4. Effects of soil amendment treatments on nitrate levels, Alburgh, VT, 2015.

Soil amendment & rate	Nitrate (NO_3) levels								
	29-May	3-Jun	10-Jun	17-Jun	26-Jun	2-Jul	17-Jul	31-Jul	13-Aug
	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}	16.2	12..6	19.2	28.0*	16.9	17.0	28.1	11.3*	4.7
Canola, 100 lbs ac^{-1}	14.3	14.4	22.7	40.5*	25.7	**27.9***	**41.6***	**15.6***	5.2
Sunflower, 50 lbs ac^{-1}	15.7	9.1	14.0	18.4	15.7	11.3	25.6	12.9*	5.8
Sunflower, 100 lbs ac^{-1}	15.0	15.6	31.4*	31.6*	19.2	16.5	22.1	6.3	3.9
Soybean, 50 lbs ac^{-1}	17.6	16.9	24.0	28.6*	20.5	15.4	30.0	9.1*	5.9
Soybean, 100 lbs ac^{-1}	14.6	13.3	21.2	**40.8***	22.7	20.2*	29.6	8.2*	5.1
Sodium N, 50 lbs ac^{-1}	29.9	26.8	20.4	23.8	20.6	13.6	28.8	11.2*	4.2
Sodium N, 100 lbs ac^{-1}	**57.7***	**48.1***	**41.0***	33.9*	**37.4***	20.5*	35.5*	12.0*	6.5
Control	15.9	16.2	22.8	17.8	13.4	11.1	22.0	7.8*	6.0
LSD (0.10)	12.3	12.0	14.3	13.3	6.1	8.6	10.7	8.1	NS
Trial mean	21.9	19.2	24.1	29.3	21.3	17.0	29.2	10.5	5.3

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).

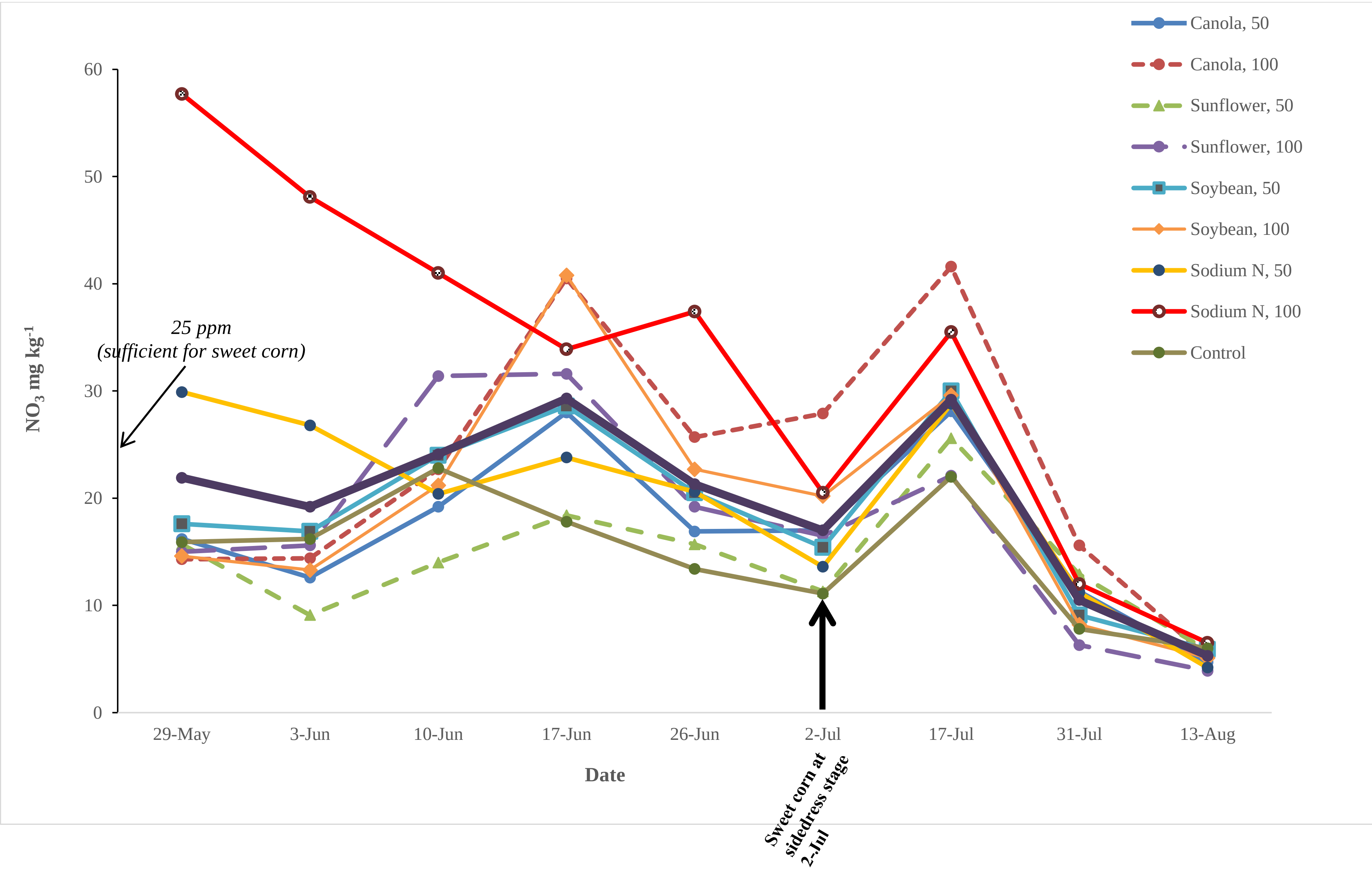

Figure 1. Nitrate levels from 29-May to 13-Aug 2015, Alburgh, VT. There was a significant difference in NO_3 level by treatment for eight of the nine sample dates ($p=0.10$). The thick black line represents the trial mean.

Sweet corn populations tended to be low, with the sodium nitrate at 100 lbs ac^{-1} having the highest population at 25903.7 plants ac^{-1}, though this was not statistically different from three other treatments (Table 5). The canola at 100 lbs ac^{-1} had the highest number of ears per plot, which was not statistically different from three other treatments. Ear length also varied significantly by treatment, with sunflower at 100 lbs ac^{-1} being the highest, though not significantly different from three other treatments. The canola at 100 lbs ac^{-1} had the highest yield, at 2.8 tons ac^{-1}, which was not statistically different from sunflower at 100 lbs ac^{-1}, soybean at 100 lbs $acre^{-1}$, sodium nitrate at 100 lbs $acre^{-1}$, or the control (Figure 2).

Table 5. Effects of soil amendments on population and yields of sweet corn, Alburgh, VT, 2015.

Soil amendment and rate	20-Aug population plants ac^{-1}	Yield tons ac^{-1}	Corn ears per plot	Ear length cm
Canola, 50 lbs ac^{-1}	11732	1.0	14.3	16.0
Canola, 100 lbs ac^{-1}	23348*	**2.8***	**36.0***	16.6*
Sunflower, 50 lbs ac^{-1}	15798	0.7	14.3	16.8*
Sunflower, 100 lbs ac^{-1}	11732*	1.5*	17.0	**17.1***
Soybean, 50 lbs ac^{-1}	11848	1.2	15.7	15.9
Soybean, 100 lbs ac^{-1}	16959	2.0*	23.3*	16.6*
Sodium N, 50 lbs ac^{-1}	18934*	1.3	18.0*	15.4
Sodium N, 100 lbs ac^{-1}	**25904***	2.4*	29.3*	15.6
Control	24626*	1.7*	23.0*	15.8
LSD (0.10)	10007	1.5	18.4	1.0
Trial mean	17876	1.6	21.2	16.2

Treatments in **bold** were top performers for the given variable.
*Treatments marked with an asterisk did not perform statistically worse than the top performing treatment (p=0.10).

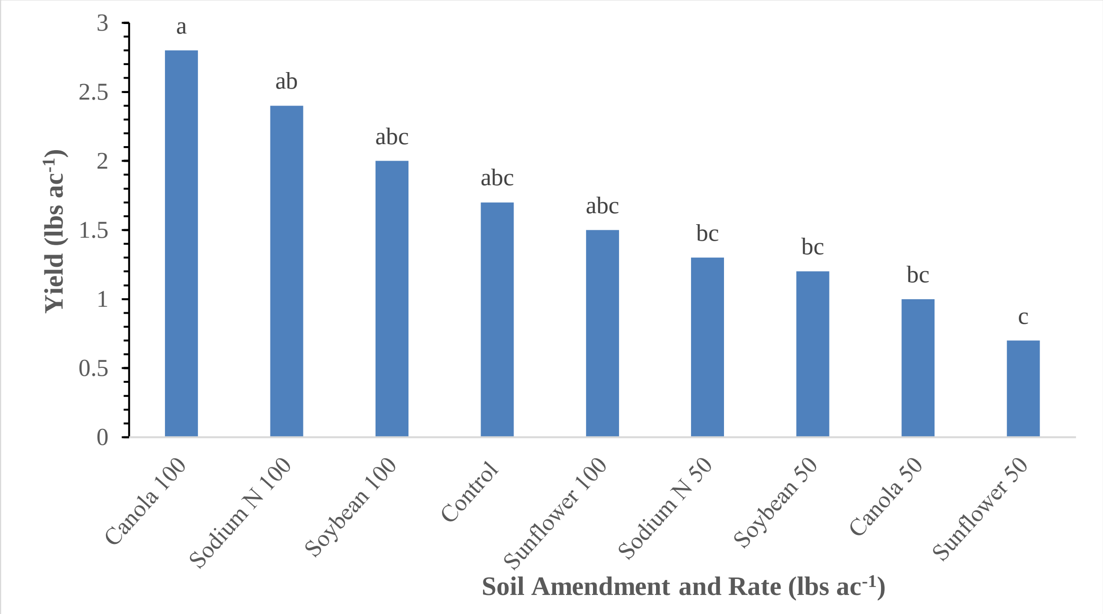

Figure 2. Sweet corn yields by soil amendment treatment. Treatments with the same letter did not differ significantly from each other (p=0.10).

DISCUSSION

Based on this study, oilseed meal has the potential to deliver adequate N to crops. Not surprisingly, canola (5.8% N), soybean (5.7% N), and sunflower (3.8% N) all had lower nitrate levels in the first two soil sample dates than sodium nitrate (16.0% N), at both application rates (Table 4). Interestingly, the soybean, sunflower, and canola meal had a peak in nitrate release on 17-Jun (about 30 days after fertilizing) and another peak on 17-Jul (Figure 1). This indicates that the fertilizers required about one month before providing a peak level of PAN. Also, nitrate release rates may have decreased in June due to it being extremely wet and cool. The N in the canola and soybean meal mineralized more rapidly than other meals especially when applied at high rates.

Overall, the sweet corn yields were poor and was likely due to high weed pressure at the site. Extreme wet and cool weather during the month of June made it difficult to control weeds during early season corn development. Poor crop performance was also reflected in the variation in ear lengths and relatively low number of ears per plot, averaging 3694 ears ac^{-1}, whereas the national averages for organic sweet corn is 12,000 ears ac^{-1}. Although yields were low, canola, sunflower, and soybean meal each at 100 lbs ac^{-1} yielded comparably to commercial sodium nitrate at 100 lbs ac^{-1}, which has a limit to its use, according to NOP regulations. UVM Extension estimates the cost of sodium nitrate at $3.31 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.

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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