NORTHWEST CROPS & SOILS PROGRAM

2018 Oilseed Meal Fertility Trial

Dr. Heather Darby, UVM Extension Agronomist
Rory Malone and Abha Gupta
UVM Extension Crops and Soils Technicians
(802) 524-6501

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THE UNIVERSITY OF VERMONT EXTENSION

2018 OILSEED MEAL FERTILITY TRIAL

Dr. Heather Darby, University of Vermont Extension
heather.darby[at]uvm.edu

Oilseed meal can provide a source of plant-derived nitrogen fertilizers. Agronomic research is needed to help farmers implement these alternative fertility sources. Seed meals are a high-protein byproduct of seed oil extraction from crops such as soybean, hemp, and peanut. While they are a byproduct, seed meals still retain nutrient value after the oil pressing process, and are high in protein. Hence, seed meals are often utilized as livestock feed. Seeds meals can also be used as organic soil amendments, and can act as fertility sources to farmers. In order to examine the efficacy of several seed meals as fertilizers, the University of Vermont Extension Northwest Crop and Soils (NWCS) Program conducted a trial in the 2018 field season in which sweet corn yield and soil nitrate-N (NO_3) levels were evaluated.

MATERIALS AND METHODS

The trial was conducted at Borderview Research Farm in Alburgh, VT in the 2018 field season 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 four replicates. The previous crop was hemp and plot dimensions were 10' x 20'. The soil series was Benson rocky silt loams with 8-15% slopes. Treatments included feed grade soybean meal purchased from LD Oliver Seed Company (Milton, VT), cold pressed soybean meal obtained from the Borderview Research Farm (Alburgh, VT), peanut meal (LD Oliver Seed Company, Milton, VT), cold pressed hemp meal (Borderview Research Farm), synthetic nitrogen source urea, and an untreated control. To obtain the meal of the seed that was grown on-farm at Borderview Research Farm, the seed were cleaned with a small Clipper M2B cleaner (A.T. Ferrell, Bluffton, IN), and the oilseed was extruded with a KernKraft 40 cold-press oil mill and hammer-milled for consistent texture. Prior to planting, treatments were broadcast by hand into the plots at a rate that would supply 100 lbs nitrogen ac^{-1} and incorporated with harrows. Sweet corn (var 'Trinity', 68 RM) was planted with a 1750 John Deere corn planter at 22,000 seeds per acre on 11-Jun.

Table 1. Agronomic information for the meal fertility trial, Alburgh, VT, 2018.

	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam 8-15% slopes
Previous crop	Hemp
Planting date	11-Jun
Planting equipment	1750 John Deere corn planter
Plot size (feet)	10 x 20
Replicates	4
Sweet corn variety	Trinity (F1, 68 days RM, treated)
Sweet corn seeding rate (viable seeds ac^{-1})	22,000
Fertilizer treatment application rate (lbs N ac^{-1})	100
Harvest date	20-Aug

The nutrient content of oilseed meals were determined at the Dairy One Forage Testing Laboratory (Ithaca, New York) on 1-Jun. The nitrogen, phosphorus, and potassium values are displayed by treatment in Table 2. Application rates were adjusted based on the percentage of plant available nitrogen (PAN) at 70 days. Soil samples were taken from each plot with a soil probe to a depth of 10 inches on 21-Jun, 3-Jul, 19-Jul, and 30-Jul and analyzed for nitrate-N at the University of Vermont's Agricultural and Environmental Testing Laboratory.

Table 2. The N-P-K values by fertilizer treatment (dry matter).

Treatment	N-P-K
Soybean feed meal	6.5-0.7-1.8
Soybean seed meal-Borderview	7.7-0.8-2
Peanut seed meal	8.8-0.8-1.5
Hemp seed meal	5.7-1.4-1
Urea	46-0-0
Control	N/A

Corn was harvested by hand on 20-Aug. Plant populations were counted for the two middle rows of each plot. Ears from the middle two rows were collected and weighed to determine yield, and the length of 5 ears from each plot were measured.

Data were analyzed using a general linear model procedure of SAS (SAS Institute, 1999). Replications were treated as random effects, and treatments were treated as fixed. Mean comparisons were made using the Least Significant Difference (LSD) procedure where the F-test was considered significant, at $p<0.10$. Variations in genetics, soil, weather, and other growing conditions can result in variations in yield and quality. Statistical analysis makes it possible to determine whether a difference between treatments is significant or whether it is due to natural variations in the plant or 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. This means that when the difference between two treatments within a column is equal to or greater to the LSD value for the column, there is a real difference between the treatments 90% of the time. Treatments that were not significantly lower in performance than the highest value in a particular column are indicated with an asterisk. In the example to the right, treatment C was significantly different from treatment A, but not from treatment B. The difference between C and B is 1.5, which is less than the LSD value of 2.0 and so these treatments were not significantly different 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 treatments were significantly different from one another. The asterisk indicates that treatment B was not significantly lower than the top yielding treatment, indicated in bold.

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

RESULTS

Weather data were recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 3). The summer 2018 field season was hotter and drier than normal, with above average and record-setting temperatures from July to

August. From June to August precipitation was 2.62 inches less than the 30-year normal. Between June and August 2018, there were 1871 Growing Degree Days (GDDs), 176 above the average.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2018.

Alburgh, VT	June	July	August
Average temperature (°F)	64.4	74.1	72.8
Departure from normal	-1.38	3.51	3.96
Precipitation (inches)	3.70	2.40	3.00
Departure from normal	0.05	-1.72	-0.95
Growing Degree Days (50°F-86°F)	447	728	696
Departure from normal	-27	88	115

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.

Sweet corn grown in the Borderview soybean meal has populations significantly lower than the control and peanut meal (Table 4). There were no significant differences between treatments for harvest yields or average ear lengths. The peanut meal had the highest yield, and the Borderview soybean meal had the longest average ear length.

Table 4. Seed meal fertility harvest results, Alburgh, VT, 2018.

Treatment	Harvest population	Yield	Average ear length
	plants ac^{-1}	lbs ac^{-1}	cm
Soybean feed meal	11108[ab†]	7187	17.3
Soybean seed meal-Borderview	10019[b]	6643	**19.1**
Peanut seed meal	**11652**[a]	**7405**	18.6
Hemp seed meal	10999[ab]	7275	18.1
Urea	10454[ab]	6708	18.8
Control	**11652**[a]	7013	17.8
LSD (0.10)	1559	NS	NS
Trial Mean	10981	7039	18.3

[†]Treatments within a column with the same letter are statistically similar. Top performers are in **bold.**
LSD – Least significant difference.
NS- Not significant.

The hemp seed meal had the highest soil nitrate concentrations on 21-Jun and 3-Jul (Table 5; Figure 1). On 3-Jul, the hemp seed meal treatment nitrate concentrations were significantly higher than the other treatments, with the exception of the urea, and it was the only one significantly different from the control. Both the hemp seed meal and the urea has soil nitrate-N concentrations that peaked on 3-Jul. On 21-Jun and 19-Jul, soil nitrate was statistically similar across treatments. Urea had the highest nitrate concentrations on 19-Jul.

Table 5. Soil nitrate concentrations by treatment and date, Alburgh, VT, 2018.

Treatment	Nitrate (mg N kg^{-1})			
	21-Jun	3-Jul	19-Jul	30-Jul
Soybean feed meal	22.4	54.4^{b†}	56.3	**76.0^{a}**
Soybean seed meal-Borderview	20.8	50.6^{b}	52.5	47.6^{bc}
Peanut seed meal	27.4	56.9^{b}	55.5	58.8^{abc}
Hemp seed meal	**28.7**	**80.4^{a}**	54.0	60.3^{abc}
Urea	26.5	69.8^{ab}	**60.0**	66.5^{ab}
Control	23.7	53.0^{b}	46.7	41.3^{c}
LSD (0.10)	NS	20.7	NS	22.5
Sample date mean	24.9	60.8	54.2	58.4

†Treatments within a column with the same letter are statistically similar. Top performers are in **bold.**
LSD – Least significant difference.
NS- Not significant.

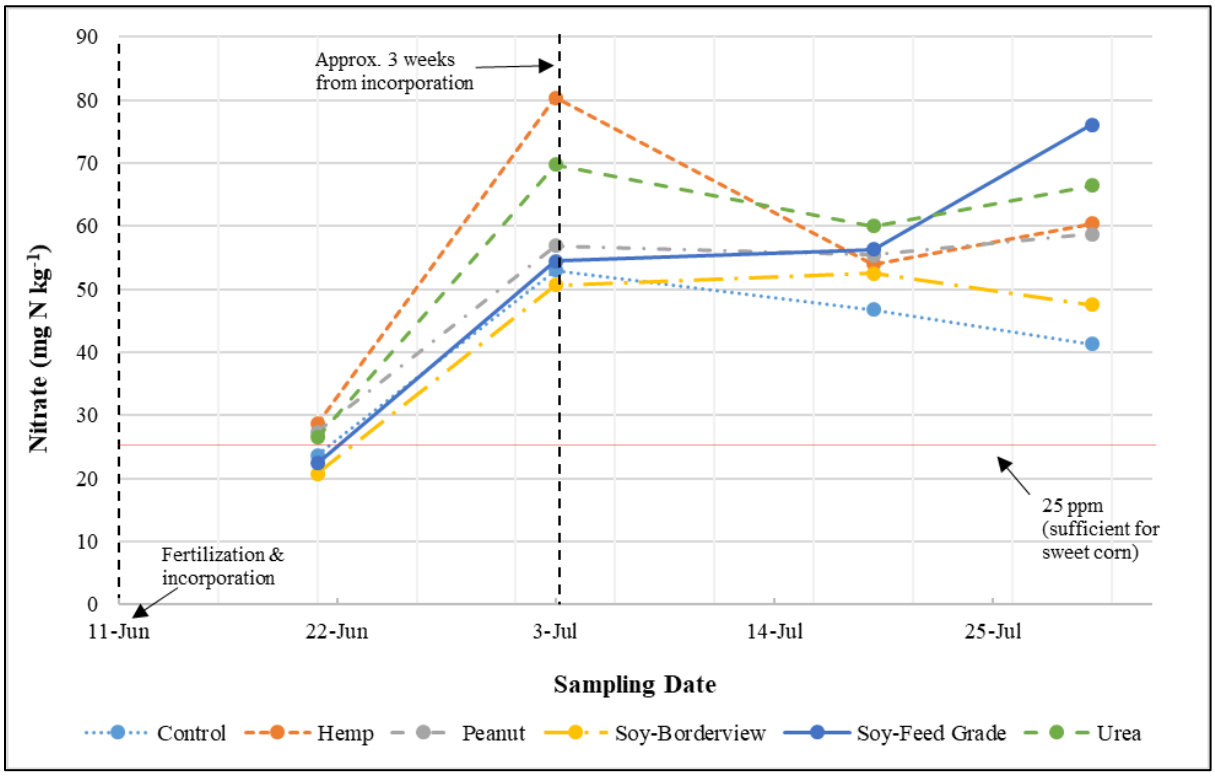

Figure 1: Soil nitrate-N concentrations from 21-Jun to 30-Jul, Alburgh, VT 2018.

On 30-Jul, the feed grade soybean meal had the highest nitrate concentrations, significantly higher than the Borderview soybean meal and the control. The urea had the second highest nitrate concentration on this date. Only the feed grade soybean treatment and the urea significantly differed from the control. The feed grade soybean meal and peanut meal nitrate concentrations peaked 30-Jul. After the first sampling

date, all nitrate concentrations rose to and remained above 25 ppm, which indicated that there was an adequate amount of soil nitrate-N for producing high yielding sweet corn.

DISCUSSION

This study suggests oilseed meals have the potential to deliver adequate N to crops. The soil amended with hemp seed meal and urea fertilizer reached the soil nitrate-N peak on 3-Jul. This indicates that the hemp seed meal mineralizes much quicker than the other oilseed meals. The soybean and peanut meals had peak soil nitrate-N concentrations approximately 2 weeks later than the hemp seed meal. After the first sampling date, all nitrate concentrations rose to above 25 ppm, which is required at the critical uptake period of corn in order to meet the nitrogen demand of the crop for the season. Sweet corn was used as a test crop since it requires significant amounts of N to produce high yields.

The N in the hemp seed meal and the urea mineralized more rapidly than other meals early in the season, while the feed-grade soybean meal did so later. The statistically similar yields suggest that oilseed meals could be used as a replacement for other fertilizers, like urea, while providing a sufficient amount of N and not impacting crop yields. The hemp seed meal and feed grade soybean meal in particular performed similarly to urea.

It is important to remember this trial only represents one season of data. Future research should evaluate oilseed nitrogen mineralization rates over a longer period of time. This study had limited soil nitrate-N sampling and it would be advantageous to further understand the nitrogen release curve of the oilseed meals.

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