UNIVERSITY OF VERMONT EXTENSION

CULTIVATING HEALTHY COMMUNITIES

Assessing the value of oilseed meals for soil fertility and weed suppression

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SUMMARY

Recent projects in New England have shown that growing oilseed crops for on-farm biofuel production has the potential to increase the economic viability of farms through diversification. Oilseed meals would net the highest return if sold as a source of protein for a livestock ration, but there have been several barriers preventing the establishment of this market. There are small amounts of local oilseed meals that are inconsistent in quality detracting from the value of the meal to the feed industry. Farmers producing oilseeds need to find other markets and/or uses for their seed meal. There is a potential market for the oilseed meal to be used for fertilizer and weed control. In order to develop a market for the seed meal it will be necessary to determine the value of the meals as a fertilizer source and weed suppressant. The objective of this project was to determine the potential of local canola, mustard, and sunflower meals to provide nitrogen and suppress weeds in a high value sweet corn crop.

INTRODUCTION

Recent projects in New England have shown that growing oilseed crops for on-farm biofuel production has the potential to increase the economic viability of farms through diversification (Grubinger, 2007; Stebbins 2007). Research trials in Vermont, New Hampshire and Maine have found that the most promising oilseed crops for production in New England are sunflower (*Helianthus annuus*), canola (*Brassica napus*), and mustard (*Sinapis alba)* (Grubinger, 2007). An important factor in the economic viability of oilseed production is the ability to market the meal, which is a "by-product" of oil production. Oilseed meals would net the highest return if sold as a source of protein for a livestock ration, but there have been several barriers preventing the establishment of this market.

Oilseed meal produced by Vermont on-farm biofuel processing facilities differs from meal produced at a large commercial seed crushing facility. The primary difference is due to the fact that on-farm oilseed presses are not able to reduce the fat and moisture content of the meal enough to make it marketable as a livestock feed and to prevent spoilage during storage. In addition, meal produced from on-farm oilseed presses tends to lack consistency between batches because the meals are of secondary importance to the main process (in this case vegetable oil for bio-fuel). This inconsistency as well as the relatively small quantities produced by Vermont's fledgling oilseed pressing facilities detracts from the value of the meal to the feed industry. Farmers producing oilseeds need to find other markets for their seed meal.

There is a potential market for the oilseed meal to be used for fertilizer and weed control. Because oilseeds are high in protein, they contain nitrogen. In addition to their fertilizer value, meals from brassica crops (such as mustard and canola) have unique biochemical properties and have shown promise in other areas of the country as a soil amendment used for suppressing weeds (Haramoto and Gallandt, 2004; Rice et al., 2007), plant parasitic nematodes (Rahman and Somers, 2005), and fungal pathogens (Kirkegaard et al., 1996). We propose that the meal may have the most value as a soil amendment for high value crops such as sweet corn and vegetables.

References:

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OBJECTIVES

In order to develop a market for the seed meal in Vermont it will be necessary to determine the value of seed meals as a fertilizer source and weed suppressant under local conditions. The objective of this project was to determine the impact of local oilseed meals (sunflower, canola, and mustard) on soil nitrogen availability and weed suppression in sweet corn production.

MATERIALS AND METHODS

The on-farm research trial was conducted in 2008 and 2009 at Borderview farm located in Alburg, VT on an Armenia silt loam. Alburg is located in the Northwest tip of Vermont. The crop grown in the three years prior to this experiment is silage corn. The experimental design was a randomized complete block with four replicates. Plot size was 10 x 25 ft. Treatments were three types of local oilseed meal amendment as well as a control consisting of conventional nitrogen fertilizer. Oilseed meals were obtained from cooperating farmers. The meals were analyzed for nutrient content through standard wet chemistry analysis (Table 1). From the meal analysis and crop requirement oilseed meal amendment rates were determined. Spreading rates

Table 1. Nutrient Analysis of local oilseed meal

Nutrient content (dry matter basis)	**Sunflower**	**Canola**	**Mustard**
% dry matter	81.3	92.3	91
% Crude Protein	34.9	28.7	37.8
% N	5.6	4.6	6.0
%P	1.26	0.74	1.02
%K	1.49	0.68	1.02
%Mg	0.64	0.30	0.42
%Ca	0.76	0.48	0.52
%S	0.39	0.40	1.50
Lb per plot (wet wt)	12.6	13.4	10.4
Lb/acre (wet wt)	2195	2335	1812

*Analysis by Dairy One Lab, Ithaca NY

were adjusted in order to provide nitrogen (N) at a rate of 100 lbs per acre. In 2008, application rates were based on total N content of the meal. In 2009, the application rates were increased due to the fact that there was not enough available N for the sweet corn in 2008. Based on the results from 2008, the rate was tripled with an assumption that 1/3 of the total N might be available in the first year. Application rates are shown in Table 2.

Table 2. Oilseed meal application rates in 2008 and 2009

	Sunflower	**Canola**	**Mustard**
2008 - lb/acre (wet wt)	2195	2335	1812
2009 - lb/acre (wet wt)	6585	7005	5436

Applying meals based on nitrogen requirements resulted in over application of other nutrients such as phosphorus. However, this project was conducted to document if the meals have the ability to supply enough nitrogen for the corn crop without negatively impacting growth. A full crop nutrient budget is shown in Table 3.

Seedbed preparation consisted of spring chisel plowing followed by harrowing. In 2008 amendments were applied on May 23rd and sweet corn planted on June 9th. In 2009, amendments were applied on May 18th and sweet corn planted on June 9th. The plots that were amended with oilseeds had less than 5% germination. The control plots had 70% germination. Therefore the entire study was replanted on June 25, 2009. Amendments were harrowed into the plots prior to sweet corn planting. All plots were seeded at 32,000 kernels to the acre and a depth of 1.5 inches.
Percent weed emergence was recorded two weeks after planting in each plot by counting the number of emerged seedlings in two 2 x 2 ft areas.

During the growing season, soil nitrate analysis was conducted to determine plant available nitrogen for the corn crop. Nitrates were measured using the pre-sidedress nitrate test (PSNT) at 2, 4, and 8 weeks after planting. The PSNT is a tool for determining how much nitrogen is available for the corn crop. Farmers use this test to determine how much nitrogen to sidedress. We used this test to determine how much of the nitrogen in the meal is mineralizing and available to the corn at various points in the season. Soils were collected by taking cores 12 inches deep from between the rows. The sample was then air-dried and sent to the UVM soil test lab. Final nutrient status of the sweet corn was determined through post-harvest tissue analysis (stalk nitrate test).

In 2008, ears from the center two rows of the plots were hand harvested on August 20th. The sweet corn ears were weighed to determine yield. In 2009, sweet corn did not develop to harvest due to poor weather conditions and raccoon damage.

Mixed model analysis will be calculated using the mixed procedure of SAS (SAS Institute, 1999). All treatment factors in this experiment will be considered fixed with the exception of replicates. Mean separation among treatments involving oilseed meals will be obtained using the Least Significant Difference (LSD) procedure when significant F-tests ($P<0.05$) are observed.

RESULTS

WEED SUPPRESSION

In 2008, the oilseed meal amendments were not effective at suppressing either grass or broadleaf weeds in this experiment. We purposefully chose an extremely weedy location for this experiment, a fact that caught up to us in the end when the weeds were threatening to take over the plot. Interestingly in 2009, the mustard meal had significantly less weeds than the other treatments. Mustard meal has been reported to have high glucosinolate levels even when compared to its related relative canola. The break down products of gulcosinolates has been shown to suppress weeds. The higher amendment rates in 2009 may have increased the level of glucosinolates to a level that suppressed weeds. Interestingly, this level may have also caused damage to the corn crop in 2009. Amended plots had an average of 5,000 plants to the acre. The control plots had 25,000 plants to the acre. The number of kernels seeded per acre was 32,000.

Table 3. Weed counts in oilseed amended plots in 2008 and 2009.

Amendment	2008	2009
	Weed count**	Weed count
Sunflower meal	218a	33b
Canola meal	368a	38b
Mustard meal	269a	15a
Control (synthetic N)	272a	52c

**Within each column, numbers followed by the same letter are not significantly different ($P<0.05$).

SOIL NITRATE

Soil nitrate was measured using the PSNT, which measures nitrates available to the plant in the soil. In 2008 and 2009, two weeks after planting, the plots amended with canola meal had significantly higher soil nitrates than the control, sunflower meal, and mustard meal. This demonstrates that nitrogen from the canola meal is mineralized at a faster rate than other meals. At the time of sidedressing (which would have been at the 4 week measurement), a nitrate level of 25 ppm or higher would indicate that no additional N needs to be applied. In 2008, none of the plots reached the 25 ppm level of nitrates. However, the canola and mustard meal overall had more nitrates than the other treatments. In 2009, all oilseed meal amended plots reached the 25ppm level of nitrates. We would assume that the amendment rate was more than sufficient to supply the amount of N required by the sweet corn. Interestingly, in both years mustard meal had higher levels of nitrates at 4 weeks after planting. From the data it appears that the mustard meal mineralized nitrogen most closely to the needs of the sweet corn crop. In 2008, Eight weeks after planting, the differences in soil nitrate levels were no longer significantly different. In 2009, the oilseed meal amended plots had significantly higher nitrate levels as compared to the control 8 weeks after planting. This would suggest that too much N was added and the corn did not utilize all of the nutrients. Lastly, sunflower meal appears to have the slowest N mineralization rate as compared to the other oilseed meals. This could be related to the fact that the sunflower hull is more fibrous and would breakdown slower. Additional research needs to be conducted to determine mineralization rates of the oilseed meals. This will help farmers apply rates to meet the needs of the crop while minimizing their impact on ground and surface water.

Table 4. 2008 - Impact of oilseed meal amendments on soil nitrate levels at 2, 4, and 8 weeks after planting.

Amendment	2 week NO_3 (ppm)	4 week NO_3 (ppm)	8 week NO_3 (ppm)
Sunflower meal	6.75b	13.0c	10
Canola meal	14.75a	18.75ab	10.5
Mustard meal	10.0b	21.5a	10.8
Control (synthetic N)	6.75b	14.0bc	6.3

**Within each column, numbers followed by the same letter are not significantly different ($P<0.05$).

Table 5. 2009 - Impact of oilseed meal amendments on soil nitrate levels at 2, 4, and 8 weeks after planting.

Amendment	2 week NO_3 (ppm)	4 week NO_3 (ppm)	8 week NO_3 (ppm)
Sunflower meal	30.1b	41.2a	28.6b
Canola meal	37.9a	49.7a	37.5a
Mustard meal	25.8b	53.1a	38.5a
Control (synthetic N)	15.1c	17.8b	9.38c

**Within each column, numbers followed by the same letter are not significantly different ($P<0.05$).

POST-HARVEST STALK ANALYSIS

In 2008, there were no significant differences in percent nitrogen or nitrate levels in the stalks, indicating that there was not a significant difference in nitrogen status between treatments. This is consistent with the yield results. Due to crop loss stalk nitrate analysis was not conducted in 2009.

Table 6. Impact of oilseed meal on post season nitrate levels in sweet corn, 2008.

Amendment	% Total N in stalk	NO_3 in stalk (ppm)
Sunflower meal	1.3a**	3690a
Canola meal	1.2a	2991a
Mustard meal	1.3a	3622a
Control (none)	1.1a	2941a

**Within each column, numbers followed by the same letter are not significantly different ($P<0.05$).

SWEET CORN YIELDS

In 2008, the addition of oilseed meal to the sweet corn plots didn’t significantly increase sweet corn yields as compared to the control. Our yields ranged from 2788 to 3206 lbs/acre of marketable weight. These relatively low yields were most likely due to factors such as uneven germination, weed pressure, and corn smut. Sweet corn yields were not recorded in 2009. Poor weather conditions and wildlife damage resulted in significant plot loss.

Table 7. The impact of oilseed meals on sweet corn yield, 2008.

Amendment	marketable wt (lbs/acre)
Sunflower meal	2788a
Canola meal	3136a
Mustard meal	3206a
Control (synthetic N fertilizer)	2892a

**Within each column, numbers followed by the same letter are not significantly different (P<0.05).

IMPACT OF OILSEED MEAL ON SOIL AND CROP NUTRIENT BUDGETS

Because phosphorus loading is a problem on many farms in Vermont, we wanted to see if the use of oilseed meals as a primary N source would contribute to a build-up of P in the soil. We were especially interested to compare oilseed meal to other commonly used organic N sources such as poultry compost. The budgets were based on an application rate of 100 lbs of total N from the amendments. Overall, the use of oilseed meals as an N source would ultimately lead to less P build-up in the soil as compared to poultry compost. Overall, canola meal would contribute the least amount of P to the soil.

Table 8. Impact of oilseed meal on crop and soil nutrient budgets for sweet corn.

	Sunflower	**Canola**	**Mustard**	**Poultry Compost ***	**Crop Removal – Sweet Corn (for 11,000 lbs/acre harvest wt)**
Lb/acre (wet wt)	2195	2335	1812	4290	--------------------
N (lb/acre)	100	100	100	100	31
P (lb/acre)	22.5	16	33	85	10
K (lb/acre)	26.6	15	33	68	55

*based on analysis of local poultry manure compost from Chazy, NY.

CONCLUSIONS

Overall, local oilseed meal can provide adequate levels of nitrogen for crops. In addition, these meals may have the increased advantage of suppressing weeds. However, high rates of these meals applied to the soil may also cause damage to the crop. Additional research needs to be conducted to determine proper oilseed meal application rates that will meet crop nutrient demands while minimizing negative impacts on the crop and the environment. This study has collected valuable data that demonstrates mustard and canola meals release the largest quantities of plant available N compared to sunflower meal. It is also obvious from the project that more than one-third of the total N is release in a season. Further projects should look towards fine-tuning the mineralization rates.

UVM Extension would like to thank the Rainville family and High Mowing Seeds for their generous help with the trials. The information is presented with the understanding that no product discrimination is intended and no endorsement of any product mentioned, or criticism of unnamed products, is implied.

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