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NORTHWEST CROPS & SOILS PROGRAM

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2017 CRICKET FRASS AS A POTENTIAL NITROGEN FERTILITY SOURCE

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In the summer of 2017, the UVM Extension Northwest Crops and Soils team conducted a trial to determine the potential nitrogen (N) fertility value of cricket frass. Currently, there is an emerging trend of farming crickets to produce high protein food products such as snack bars, protein shakes and powder products. This trend of farming crickets for their high protein content is creating a surplus of cricket frass. Cricket frass is the term used for the excrement of the cricket and is a byproduct of the cricket protein industry. The organic material contains cricket feces, shed exoskeletons, and waste feed. In recent years, several companies have been producing well balanced (2-2-2) organic fertilizers composed of this byproduct. Agronomic research is needed to help farmers succeed in using cricket frass as an alternative fertilizer source. This trial tested cricket frass as an N amendment in sweet corn with two rates of application compared to a control. We evaluated sweet corn yield and soil nitrate (NO_3^-) levels to determine impact of the cricket frass on the crop and soil.

MATERIALS AND METHODS

Table 1. Agronomic information for cricket frass on sweet corn trial 2017, Alburgh, VT.

Location	**Borderview Research Farm Alburgh, VT**
Soil type	Benson rocky silt loam, over shaley limestone, 8 to 15 percent slopes
Previous crop	Dry beans
Plot size (ft)	10'x10'
Planting date	26-Jun
Row spacing	30"
Planting equipment	John Deere 1750
Harvest date	21-Sep

The trial was conducted at Borderview Research Farm in Alburgh, Vermont (Table 1) to evaluate the impact of cricket frass application rate on sweet corn yield. The experimental design was three treatments with two replicates. Cricket frass was applied at two different rates (125 lbs and 150 lbs of N per acre) and tested against a non-fertilized control (Table 3) on 20-Jun. Cricket frass was sourced from Flourish Farms in Williston, Vermont. A sample of cricket frass was submitted to UVM's Agricultural & Environmental Testing Laboratory to determine nutrient content (Table 2). Sweet corn (var 'Bodacious') was planted on 26-Jun. Soil samples were collected to a depth of 12 inches on 30-Jun, 14-Jul, 3-Aug, 27-Aug, and 21-Sep and were analyzed for soil nitrate-N content by the University of Vermont Extension soil analysis lab. Sweet corn was hand harvested and yield determined on 21-Sep.

Table 2. Cricket frass nutrient content

Component	lbs ton^{-1}
Total nitrogen	97.1
Ammonium nitrogen (included in total nitrogen)	4.3
Organic nitrogen (included in total nitrogen)	92.8
Phosphorus (P_2O_5)	60.8
Potassium (K_2O)	28.2
Calcium	51.6
Magnesium	6.6
Sodium	7.2
Copper	0.04
Zinc	0.38
Iron	1.28
Manganese	0.22
Boron	<0.01

Table 3. Cricket frass application rates evaluated in the cricket frass fertilizer trial 2017, Alburgh, VT.

Rate	Total lbs N ac^{-1}	Cricket frass tons ac^{-1}
125	125	1.28
150	150	1.55
Control	0	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 this example, 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

Precipitation and temperature at Borderview Research Farm were recorded daily with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger (Table 4).

Table 4. Seasonal weather data collected in Alburgh, VT, 2017.

Alburgh, VT	June	July	August	September
Average temperature (°F)	65.4	68.7	67.7	64.4
Departure from normal	-0.39	-1.90	-1.07	3.76
Precipitation (inches)	5.6	4.9	5.5	1.8
Departure from normal	1.95	0.73	1.63	-1.80
Growing Degree Days (base 50°F)	468	580	553	447
Departure from normal	-7	-60	-28	129

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Alburgh precipitation data from August-October was provided by the NOAA data for Highgate, VT. Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

The months of June, July and August were cooler and wetter than average. September was unseasonably warm and dry, averaging 3.76°F warmer and accumulating 1.80 fewer inches of precipitation than normal. Overall, there were an accumulated 2293 Growing Degree Days (GDDs) over the growing season, approximately 81 more than the historical average; however, much of this heat gain came at the end of the season.

Table 5. Soil nitrate levels and sweet corn yield by frass application rate, Alburgh, VT, 2017.

Treatment	30-Jun NO_3^- ppm	14-Jul NO_3^- ppm	3-Aug NO_3^- ppm	27-Aug NO_3^- ppm	21-Sep NO_3^- Ppm	Yield tons ac^{-1}
Control	15.2*	12.6	8.6	**5.1**	3.3	2.61
125	12.5	17.6	11.5	4.8	**5.1**	3.39*
150	**16.8***	**18.6**	**17.9**	4.3	4.4	**4.07***
LSD (*p* = 0.10)	3.91	NS	NS	NS	NS	0.937
Trial Mean	14.8	16.3	12.7	4.7	4.3	3.35

*Treatments marked with an asterisk did not perform statistically similar than the top performing treatment (p=0.10) shown in **bold.**

NS – There was no statistical difference between treatments in a particular column (p=0.10).

Sweet corn yields ranged from 2.61 tons ac^{-1} to 4.07 tons ac^{-1}. The control, which received no cricket frass fertilizer, had significantly lower yield than the two cricket frass application treatments (Table 5). Cricket frass improved corn yields.

Soil nitrate-N differed among treatments at the first sampling period (Table 5). The first soil nitrate-N sampling period was 10 days following the amendment of the cricket frass. Hence, it was likely that that organic-N fraction of cricket frass had not started to fully mineralize. The subsequent sampling periods indicated higher levels of soil nitrate-N in the cricket frass treatments. The lack of significant differences was likely related to the low number of replicates for the trial (2 replicates per treatment). Replicate number was low due to limited availability of cricket frass. The level of soil nitrate-N in the soil dropped during the growing season, which signified N uptake by the plants. Soil nitrate-N decreased most rapidly between 3-Aug and 27-Aug, and stayed relatively unchanged after 27-Aug. The 150 lbs of N ac^{-1} treatment had the highest soil nitrate levels in the early part of the growing season before the sweet corn crop took up the additional nitrogen by 27-Aug, although the difference was only statistically significant for the first sampling date.

DISCUSSION

Sweet corn was used as a test crop since it requires significant amounts of N to produce high yields. In this study, cricket frass was applied at 125 and 150 lbs total N per acre. The majority of N in the cricket frass resides in the organic fraction (92.8 lbs per acre). The soil microorganisms must mineralize the organic fraction and hence, the release rate of N is largely dependent on the moisture, temperature, and soil conditions. It was clear from this study that the organic-N in the levels of cricket frass did not release enough plant available-N to meet the sweet corn needs. The soil nitrate-N levels need to reach a minimum of 25 ppm at the critical uptake period of corn to supply the needs of this crop. This indicates that higher rates of cricket frass will be needed if a farmer was to supply 100% of sweet corn nitrogen needs. It is important to remember that the organic-N will also be broken down and become available in subsequent years as well. Lastly, the cricket frass also has high levels of phosphorus and this will need to be considered when developing a nutrient management plan for a farm.

This demonstrates that cricket frass application can be an effective N amendment and did increase yield when compared to the control. However, more information is required to understand nutrient availability and other benefits from this amendment.

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