Impact of Organic Soil Amendments on Soil Quality and Crop Yield

(Sudbury SCIA Major Grant Project)

Purpose

With increasing costs of fertilizer and fuels for crop production, coupled with documented decreases in levels of soil carbon, there is an increasing requirement to examine alternate local nutrient sources which also serve to replace the depleted soil carbon levels. This preliminary project was designed to test the effectiveness of incorporation of locally produced organic materials, as well as regionally available carbonatite, in growing crops on local soil when compared to inorganic fertilizer.

Methods:

The field plots were set-up on an untiled silty clay loam in Chelmsford, Ontario. Soil properties are listed in Table 1. An area of 72.5 m X 20 m was divided into 5 m X 5 m plots, allowing a 2.5 m buffer strip between plots. The experiment was set-up in a randomized complete block design of 10 amendment treatments replicated 3 times. Amendments and rates are listed in Table 2. Amendments were applied June 28, 2008 and incorporated into the soil (Figure 1). Cool climate dwarf corn was mechanically planted July 1st, 2008.

Table 1: Soil properties

pH	5.87 (0.25)
Organic matter (%)	15.70 (1.71)
P (mg kg^{-1})	10.67 (1.53)
K (mg kg^{-1})	267.67 (43.78)
Mg (mg kg^{-1})	524.67 (69.51)
Ca (mg kg^{-1})	3689.67 (354.80)
Zn (mg kg^{-1})	33.83 (4.55)
Mn (mg kg^{-1})	10.37 (2.45)
Cu (mg kg^{-1})	33.30 (5.11)
Fe (mg kg^{-1})	194.20 (29.74)
B (mg kg^{-1})	0.49 (0.04)
NO_3 (mg kg^{-1})	8.96 (15.52)
Cation exchange capacity (MEQ/100g)	32.90 (5.46)
Base saturation	
K (%)	2.17 (0.74)
Mg (%)	13.73 (4.27)
Ca (%)	57.63 (14.54)
H (%)	26.50 (19.55)

One standard deviation to the mean is shown in parentheses.

Table 2: Amendment rates

Amendment	Rate
Fish compost 1	5 t ac^{-1}
Fish compost 2	5 t ac^{-1}
Meekers Mix	5 t ac^{-1}
Carbonatite	1 t ac^{-1}
Deer manure	1 t ac^{-1}
Fertilizer-12-32-16	100 lbs
46-0-0	75 lbs
Compost + carbonatite	2.5 t ac^{-1} (each)
Domatar Inc. paper biosolids	5 t ac^{-1}
No addition	-

Fish compost 1 and Fish compost 2 represent different batches of fish wastes and ratios of cellulosic amendments.

Variability in growth among treatments was monitored throughout the growing season. Treatments were visually rated based on vegetative growth September 30th, 2008 by local soil and crop experts. Plots were harvested October, 2008. Harvest involved collection of a series of composite soil samples from each subplot using a soil probe to a depth of 5-10 cm, after harvesting the above components of both crop and weedy species. All aboveground plant material within three circular areas of 1m diameter was removed within each subplot (Figure 2). Both aboveground and belowground samples were collected for the dwarf corn plants, Biomass yield per sub-plot was determined on a dry weight basis for all aboveground vegetative production. All samples were dried at 60C and ground prior to analysis.

The pH and electrical conductivity for all soil samples will be measured. Total carbon, nitrogen, and sulphur will be quantifed. Soil and plant samples will be digested with nitric acid and analysed for macro- and micro-nutrients using Inductively Coupled Argon Plasma Emission Spectroscopy (ICP-AES). Concentrations of bioavailable macro-, micro-nutrients, and metals in the soil will also be determined, as will the protein content of the vegetation samples.

Statistical analyses were done using Statistica© . Data were analysed using ANOVA and the Duncan multiple comparison test to identify significant differences ($p < 0.05$) between treatments.

Figure 1: Incorporation of amendments into the soil.

Figure 2: Aboveground biomass collection.

Results:

Variability among treatments was visually observed July 25th, 2008 (Figure 3). Through visual assessment (Figure 4) of all plots it was determined that the Fish compost 1, Fish compost 2, and Meeker's Magic Mix™ amendments resulted in greatest biomass production while the Fish compost mixed with carbonatite, carbonatite (5 t ac^{-1}), and paper sludge treatments were not different than the control treatment (no amendment). The amendments which visually appeared to result in the lowest biomass yield were the carbonatite applied at 1 t ac^{-1} and the deer manure amendments. The Deer Manure material had the highest weed infection of all amendments.

Biomass results are similar to those obtained by visual assessment. Vegetative biomass of the fertilizer treated plots and one of the fish compost treatment were significantly

greater than that of the control (Figure 5). Corn growth showed a similar trend, with biomass production being found to be greater in the fertilizer treatment, one fish compost treatment, and the Meeker's Magic Mix™ treatment when compared to the no addition control amendment (Figure 6).

Figure 3: Growth variability among treatments July 25th, 2008.

Figure 4: Visual assessment of effectiveness of amendments by local experts and academics.

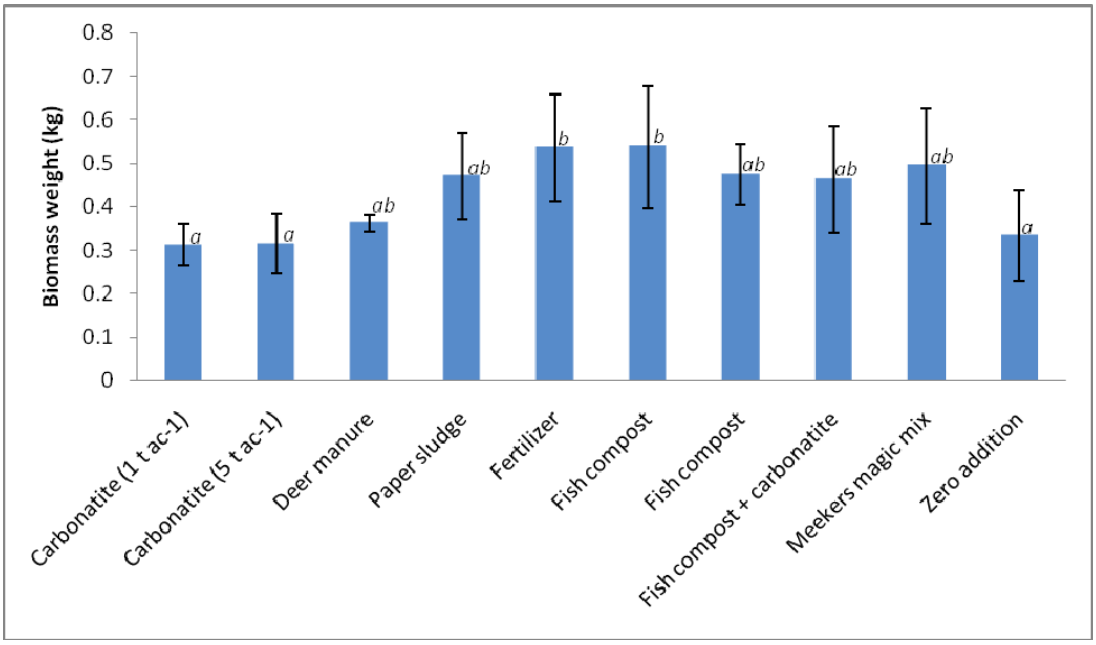

Figure 5: Average biomass of vegetative growth in plots given different nutrient amendments. One standard deviation is shown and columns headed by the same letter are not significantly different (N=3).

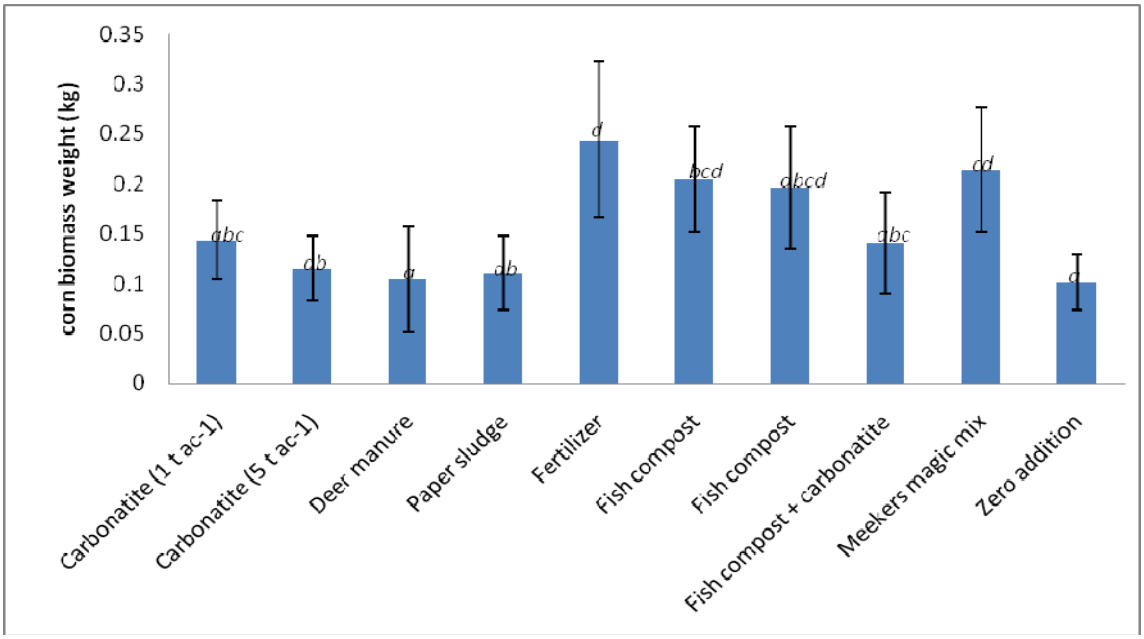

Figure 6: Average biomass of corn in plots given different nutrient amendments. One standard deviation is shown and columns headed by the same letter are not significantly different (N=3).

Summary:

Carbonatite applied at 1 t ac^{-1} and deer manure (5 t ac^{-1}) appeared to suppress biomass yield on all sub-plots. Examination of the Biomass data demonstrated that only the conventional chemical fertilizer application, together with one fish compost material at 5 t ac^{-1}, were superior amendments compared to the control with no additions.

Next Steps:

Soil and plant analyses are to be conducted within the first two months of 2009. These results will clarify the causes of poor plant growth in the carbonatite and deer manure treatments. An Honours B.Sc. at Laurentian University thesis will report the full results and interpretation, which will in turn provide a full final report to the Ontario Soil and Crop Improvement Association by June 2009.

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Location of Project Final Report:

Laurentian University library undergraduate thesis holdings.