Carbon Fractionation of Biosolids Amended Soils Impact on Carbon and Nitrogen Storage in Soils

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Introduction

Application of biosoids from municipal solid waste facilities to farmland in Washington State has been practiced since the 1980s. Research done at these sites has shown that applications of biosolids are able to provide necessary fertility for broad acre crops, and lead to an increase in soil carbon and nitrogen (Cogger et al., 2014).

The objective of our study was to identify the changes in acid resistant and light carbon and nitrogen fractions as a part of overall C and N gains in the system.

Materials and Methods

- Conventionally tilled WW-fallow rotation
- Biosolids applied every 4 years beginning in 1994
  - Rates of 4.8, 6.9, and 9.0 Mg/ha
- Two non-biosolids comparisons
  - 56 kg N/ha anhydrous ammonia, every 2 years
  - No nitrogen fertilizer
- 0-10 cm soil depth hand sampled postharvest
- Total C, N analysis
  - ~0.25 g air dried, ground soil weighed for Leco analysis.

Acid hydrolysis (resistant fraction)

- ~1.0 g 2 mm sieved, air dried, hand ground sample refluxed in 25 mL 6 M HCl at 115 °C for 16 hours.
- Post-hydrolysis soil recovered and rinsed with DI water using grade F glass fiber filter and vacuum filtration.
- ~0.2 g post-hydrolysis soil weighed for Leco analysis.
- %NHC, %NHN calculated using equation from Plante et. al. 2006.

$$\%NHC, \%NHN = \frac{\left(g\ of\ C,N/_{kg\ of\ sample}\right)_{after} * \left(mass_{after}/mass_{before}\right)}{\left(g\ of\ C,N/_{kg\ of\ sample}\right)_{before}}$$

Light fraction

- 25 g soil agitated in 50 mL of 1.7 g cm^{-3} NaI solution for 1 hour.
- Shaken sample transferred to Erlenmeyer flasks and covered for a settling period of 24 hours.
- Supernatant containing light fraction pipetted to vacuum filtration manifold (grade F glass fiber filter), rinsed 3x with 0.01 M $CaCl_2$ and 3x with DI H_2O.
- ~0.1 g post-LF air dried soil weighed for Leco analysis.

Results and Discussion

Carbon and nitrogen levels in the soil have been positively influenced by the application of biosolids. The greater the application rate, the greater the carbon and nitrogen storage.

When soil C is evaluated as a function of soil N, the relationship is linear, demonstrating that soil carbon pools cannot be augmented unless soil nitrogen pools increase (Figure 1).

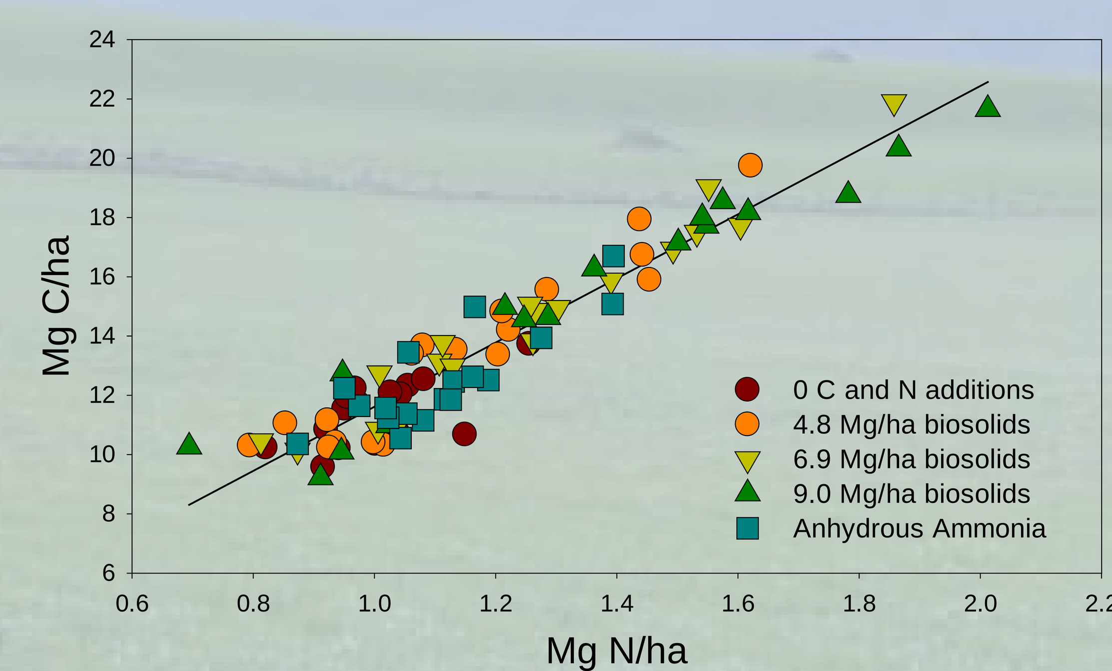

Figure 1: Soil carbon as a function of soil nitrogen. The regression line for all data points has a slope of 10.82 Mg C/Mg N, while individual slopes for 0 C and N additions, biosolids amended soils, and anhydrous ammonia are 6.80, 12.43, and 10.15 Mg C/Mg N, respectively.

Carbon Fractionation

Carbon fractionation allows us to better quantify the specific soil carbon pools that are being changed through the application of biosolids. As total carbon increases, carbon in the light and resistant fractions also increase (Figure 2). C accumulation can be evaluated as the slope of the total soil carbon line (Table 1).

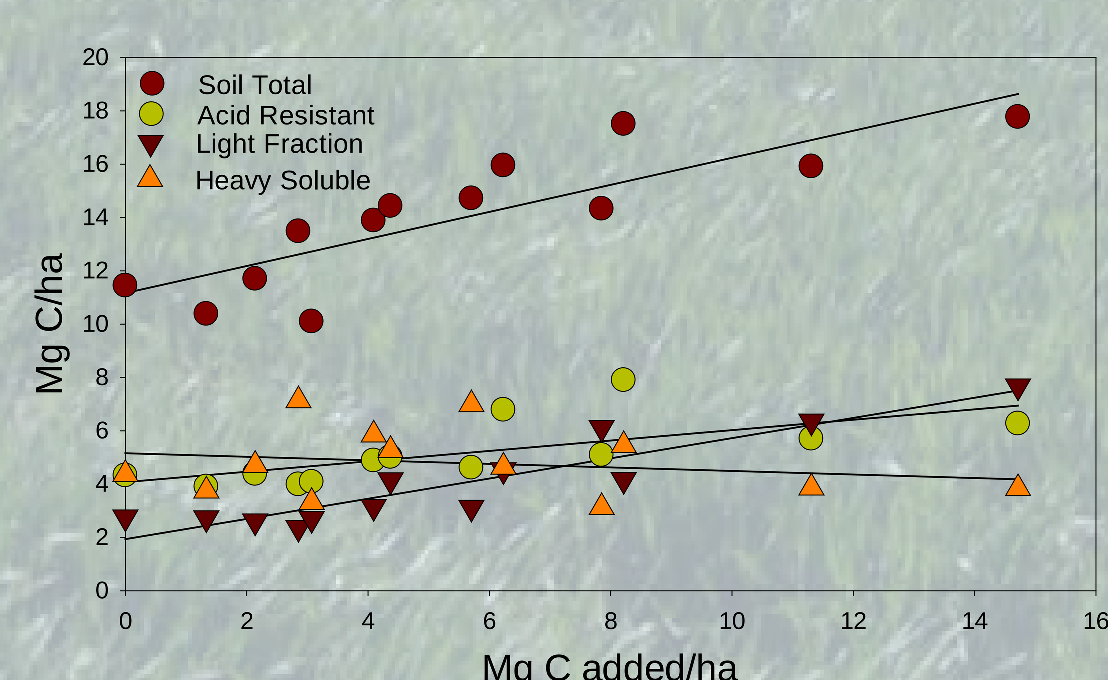

Figure 2: Soil carbon gains as a function of Mg C added in biosolids.

Nitrogen Fractionation

Soil nitrogen can be fractionated just as soil carbon is, and illustrates many of the same trends—significant increases in total soil N, and light fraction N, while the recalcitrant pool did not change significantly.

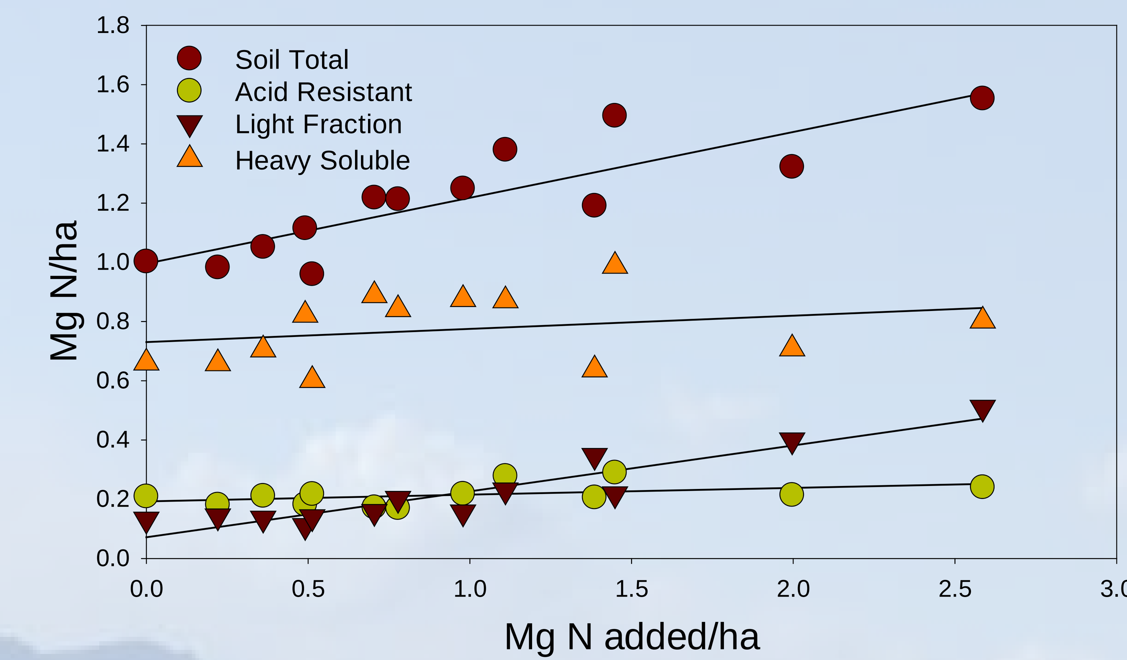

Figure 3: Soil nitrogen gains as a function of Mg N added in biosolids.

	C Accumulation		N Accumulation	
	Slope	r^2	Slope	r^2
Total	0.4938*	*0.61*	0.2203*	*0.63*
Acid Resistant	0.1830*	*0.34*	0.0183	*0.07*
Light Fraction	0.3394*	*0.56*	0.1388*	*0.64*
Heavy Soluble	-0.0286	*0.005*	0.0633*	*0.12*

Table 1: Slope and r^2 of least squares lines for carbon and nitrogen accumulation data. Slope can be interpreted as retention, as it represents Mg of C or N stored per Mg of C or N applied. *Denotes P value <0.05

Conclusion

Soil C and N accumulation due to application of biosolids in a wheat-fallow system is extremely high, approximately 50% of the C and 22% of N added. Lower soil accumulation of N than C is due to crop N uptake and grain N removal from the system. The light fraction more readily stores new C and N, while the acid resistant fraction is slower to change.

References

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