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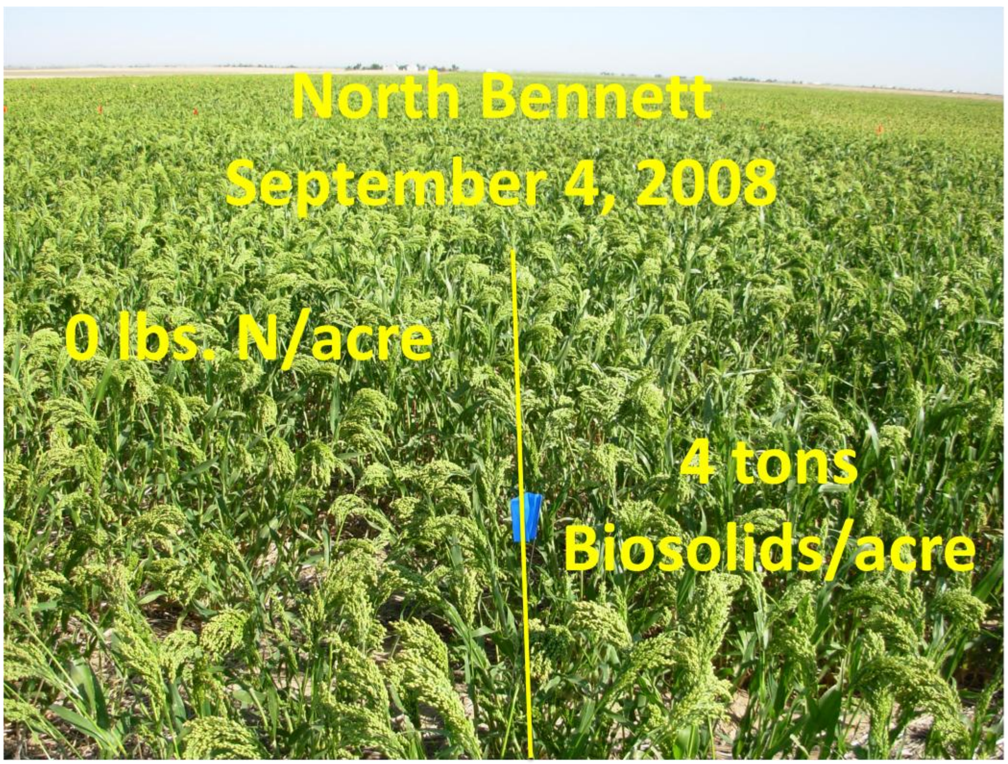
CARRYOVER EFFECTS OF ANAEROBICALLY DIGESTED BIOSOLIDS ON PROSO MILLET: 2008 RESULTS



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CARRYOVER EFFECTS OF ANAEROBICALLY DIGESTED BIOSOLIDS ON PROSO MILLET 2008 RESULTS

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INTRODUCTION

This technical report provides the millet (*Panicum miliaceum* L.) yield and elemental P, Cu, Ni, and Zn contents plus AB-DTPA extractable soil P, Cu, Ni, and Zn concentrations for the 2008 growing season. Our cooperating farmer, John Sauter, decided to grow millet in 2008 to help manage a potential jointed-goat grass (*Aegilops cylindrica* Host) weed problem.

We had reapplied biosolids (approximately 80% solids) at rates of 0, 1, 2, 3, 4, and 5 dry tons A^{-1} and N fertilizer (urea) at rates of 0, 20, 40, 60, 80, and 100 lbs. N A^{-1} in late July 2006. We harvested wheat (*Triticum aestivum*, L.) in July 2007 and we did not re-apply biosolids before planting millet in June 2008.

One advantage to this temporary change in crop management is that we were able to determine if the biosolids provided a carry-over effect of nutrients or trace elements on the subsequent millet crop.

The overall objective of the research in this report was to compare the carryover impacts of eight Littleton/Englewood (L/E) biosolids and commercial N fertilizer applications on: a) proso millet biomass production, b) biomass total P, Cu, Ni, and Zn contents, c) plant-available soil concentrations of P, Cu, Ni, and Zn, and (d) soil NO_3-N accumulation and movement.

MATERIALS AND METHODS

The North Bennett experimental plots used during the 2008 growing season were established in August 1992. The soil is classified as a Weld loam, Aridic Argiustoll. The land is farmed using minimum-tillage practices.

We applied N fertilizer (46-0-0; urea) at rates of 0, 20, 40, 60, 80, and 100 lbs N A^{-1} and biosolids at rates of 0, 1, 2, 3, 4, and 5 dry tons A^{-1} in July or August 1992, 1994, 1996, 1998, 2000, 2002, 2004, and 2006. Each treatment was replicated four times in a randomized complete-block arrangement in plots that were 6' by 56'. According to the 1996 Colorado Department of Public Health and Environment Biosolids Regulations, L/E biosolids are classified as Grade I and are suitable for application to agricultural and disturbed lands. We uniformly applied both biosolids and N fertilizer, and incorporated with a rototiller to a depth of 4 to 6 inches. This report provides data for the 2008 millet crop only.

We collected three random 3-foot row samples from each plots in mid-September 2008 to determine biomass yields. Plant P, Cu, Ni, and Zn concentrations were determined in nitric-acid digests (Ippolito and Barbarick, 2000) using an inductively coupled plasma-atomic emission spectrophotometer (ICP-AES; Soltanpour et al., 1996).

Two to three soil samples from 0 to 8 and 8 to 24 inches were taken from each plot and composited. We used ammonium bicarbonate diethylenetriaminepentaacetic acid (ABDTPA) to extract the soils and determine plant-available P, Cu, Ni, and Zn using the ICP-AES.

RESULTS AND DISCUSSION

Millet Biomass Yield and Elemental Content

Neither biosolids nor N fertilizer treatments affected millet biomass production. We found no N-fertilizer effects on the plant P, Cu, Ni, and Zn content; however, increasing biosolids rates increased plant concentrations of Cu (Table 1).

Soil Plant-Available and Nitrate-N Concentrations

We use AB-DTPA soil extractions to determine nutrient and trace metal availability to plants. Within the top 8 inches of soil, N fertilizer had no effect on extractable P, Cu, Ni, and Zn while increasing biosolids rates increased the AB-DTPA concentrations of P, Cu, and Zn. Overall, biosolids application resulted in higher AB-DTPA levels of P, Cu, and Zn compared to those with N fertilizer application (Table 2). For the 8-24 inch depth, neither biosolids nor N fertilizer affected AB-DTPA concentrations (Table 2). As shown in Figure 1, as the biosolids rate increased, the AB-DTPA soil extractable P, Cu, and Zn showed significant linear increases. This finding is especially important for soil Zn since the soil-test levels in the untreated, control plots were at deficient levels (Follett and Westfall, 2004).

Figure 2 presents the NO_3-N concentrations for selected treatments to an average depth of 75 inches. Only the surface soil showed differences in NO_3-N levels with the 2 and 5 tons biosolids/acre treatments exhibiting larger concentrations than the control (labeled as N0) and the 40 lbs. N fertilizer rate. Despite the differences in surface NO_3-N, millet-biomass yields were not affected.

SUMMARY

We found that eight previous additions of L/E biosolids compared to N fertilizer additions did not affect millet biomass or plant concentrations of P, Cu, Ni, and Zn. This occurred despite the fact that L/E biosolids increased soil-extractable levels of P, Cu, Ni, and Zn compared to N fertilizer. Growing millet as part of the management strategy to control jointed-goatgrass does not appear to be affected by biosolids carryover effects.

REFERENCE

Follett, R.H., and D.G. Westfall. 2004. Zinc and iron deficiencies. Fact Sheet no. 0.545. Colorado State University Extension. http://www.ext.colostate.edu/pubs/crops/00545.html (verified on 19 February 2010).

Ippolito, J.A., and K.A. Barbarick. 2000. Modified nitric acid plant tissue digest method. Commun. Soil Sci. Plant Anal. 31:2473-2482.

Solutanpour, P.N., G.W. Johnson, S.M. Workman, J.B. Jones, Jr., and R.O. Miller. 1996. Inductively coupled plasma emission spectrometry and inductively coupled plasma-mass spectrometery. P. 91-139. *In* D.L. Sparks (ed.) Methods of soil analysis: Part 3-Chemical Methods. SSSABook Ser. No. 5. SSSA and ASA, Madison, WI.

Table 1. Effects of N fertilizer and biosolids rates on elemental concentrations of proso millet biomass at North Bennett, 2008.

N fert. lbs N A^{-1}	Biosolids dry tons A^{-1}†	Biomass lbs $acre^{-1}$	P g kg^{-1}	Cu	Ni mg kg^{-1}	Zn
0		699	3.1	6.7	2.2	15
20		1030	3.2	7.5	0.8	14
40		670	3.0	7.9	2.0	15
60		869	3.0	8.1	2.3	15
80		1020	3.0	8.3	2.0	15
100		964	2.7	8.2	2.3	15
Mean§		911	3.0	8.0	2.1	15
Sign. N rates		NS	NS	NS	NS	NS
LSD						
	0	624	3.5	7.3	2.4	18
	1	725	2.8	6.5	1.9	15
	2	893	3.1	8.6	2.2	15
	3	1040	3.3	8.7	2.0	17
	4	1060	2.8	8.9	1.8	16
	5	870	3.5	8.9	2.2	17
	Mean	920	3.1	8.3	2.0	16
	Sign. biosolids rates	NS	NS	*	NS	NS
	LSD			2.3		
	N vs bio-solids	NS	NS	NS	NS	NS

† Identical biosolids applications were made in 1992, 1994, 1996, 1998, 2000, 2002, 2004, and 2006; therefore, the cumulative amount is 8 times that shown.

§ Means/LSDs/N vs biosolids do not include the controls (the zero rates).

¶ NS = not significant, * = significance at 5% probability level, ** = significance at 1% probability level, ND = non-detectable.

Table 2. Effects of N fertilizer and biosolids rates on elemental concentrations of proso millet biomass at North Bennett, 2008.

N fert.	Biosolids	P		Cu		Ni		Zn	
lbs N A^{-1}	dry tons A^{-1}†	0-8 inches	8-24 inches	0-8 inches	8-24 inches	0-8 inches	8-24 inches	0-8 inches	8-24 inches
		mg kg^{-1}							
0		7.8	2.0	2.9	2.2	0.9	0.4	0.8	0.1
20		11.1	2.0	3.9	2.5	0.9	0.5	1.5	0.2
40		7.3	2.1	2.8	2.4	0.9	0.6	0.7	0.2
60		7.1	1.8	3.0	2.3	0.9	0.4	0.7	0.1
80		11.7	1.7	3.6	2.3	1.1	0.5	1.3	0.2
100		7.8	1.9	3.1	2.4	1.0	0.5	0.8	0.1
Mean§		9.0	1.9	3.3	2.4	1.0	0.5	1.0	0.2
Sign. N rates		NS	NS	NS	NS	NS	NS	NS	NS
LSD									
	0	9.8	2.0	3.1	2.4	0.9	0.5	1.0	0.2
	1	11.2	1.7	4.0	2.4	0.8	0.4	1.6	0.2
	2	18.2	4.3	5.3	3.8	0.8	0.5	2.9	1.4
	3	16.0	1.8	5.0	2.3	1.1	0.4	2.3	0.2
	4	18.4	2.2	6.3	2.6	0.8	0.4	3.3	0.3
	5	24.8	2.1	6.1	2.3	1.0	0.5	3.3	0.2
	Mean	17.8	2.4	5.3	2.7	0.9	0.5	2.6	0.4
	Sign. biosolids rates	**	NS	*	NS	NS	NS	**	NS
	LSD	4.9		2.3				1.5	
	N vs bio-solids	*	NS	*	NS	NS	NS	*	NS

† Identical biosolids applications were made in 1992, 1994, 1996, 1998, 2000, 2002, 2004, and 2006; therefore, the cumulative amount is 8 times that shown.

§ Means/LSDs/N vs biosolids do not include the controls (the zero rates).

¶ NS = not significant, * = significance at 5% probability level, ** = significance at 1% probability level, ND = non-detectable.

Figure 1. North Bennett millet AB-DTPA surface-soil extractable P, Cu, and Zn, 2008.

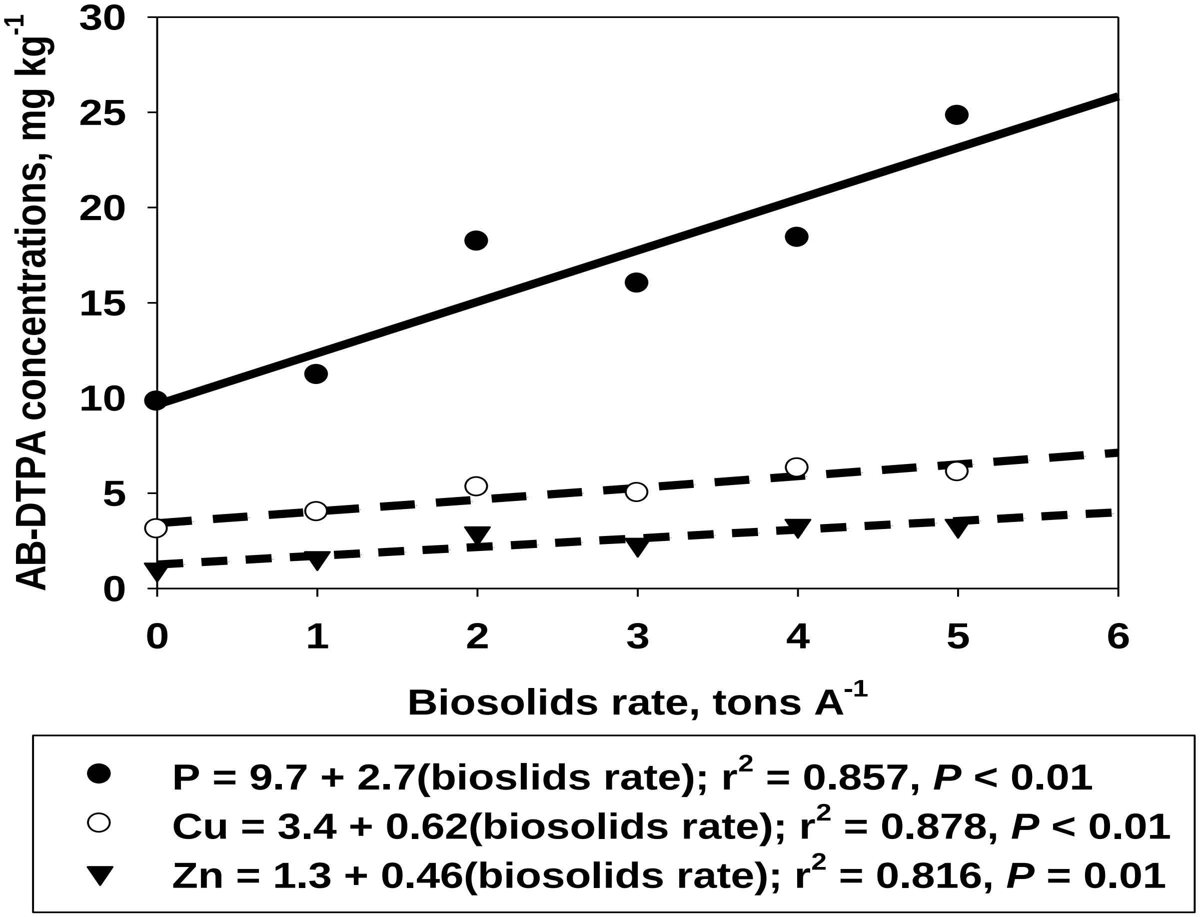
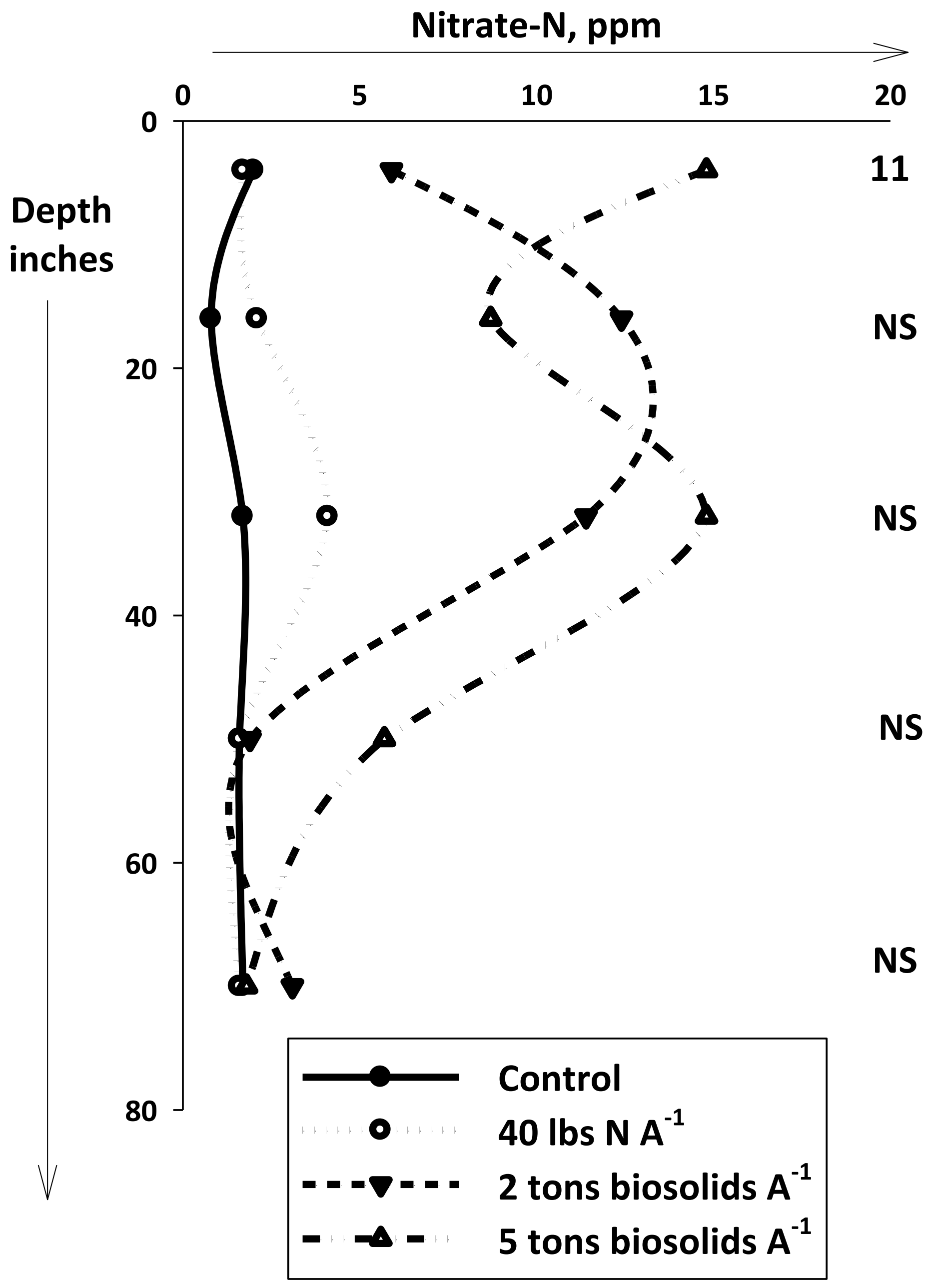


Figure 2. North Bennett millet harvest soil nitrate-N, 2008.



NS = non significant.