Biosolids and Biochar Application Effects on Bahiagrass Herbage Accumulation and Nutritive Value

Yanyan Lu, PhD Student and
Maria Lucia Silveira, Professor, Soil & Water Sciences, Range Cattle Research and Education Center, Ona, Florida

Published in *The Florida Cattleman and Livestock Journal*, February 2020

Pastures in Florida are typically low-input systems and have been historically under fertilized and often overgrazed. Biosolids can be a valuable resource to improve the sustainability of degraded pastures and to restore ecosystem functions such as availability of nutrients and food production. Perennial pastures are good candidates for receiving biosolids as a nutrient source because of their relatively high nutrient requirements and extended growing period. Land application of biosolids to pastures improves soil fertility and often results in greater forage production, nutritive value, and persistence. The extensive root system of perennial grasses efficiently captures nutrients in the biosolids and minimizes off-site nutrient transport. However, despite the multiple agronomic benefits associated with land application of biosolids to pastures, limited information is available documenting the agronomic benefits of biosolids recycling programs. One of the only documented field-scale research trials designed to evaluate forage responses to biosolids application consisted of the work done by Adjei and Rechcigl (2002). These authors examined bahiagrass responses to repeated application of various biosolids materials (applied at either 90 or 180 lb total N/acre/yr) and concluded that most biosolids sources were as effective as inorganic fertilizer for enhancing bahiagrass growth, with the exception of lime-stabilized materials (pH of 8.5 to 11) that resulted in decreased bahiagrass production. Since current recommended biosolids application rates often exceed 240 lb total N/acre/yr and biosolids materials currently being land applied consist mainly of conventional anaerobically- and aerobically-digested materials (no lime stabilization), additional large-scale field trials are essential to accurately assess the agronomic benefits of land application of biosolids to pastures in Florida. A field experiment was conducted on an established 'Pensacola' bahiagrass pasture at the University of Florida/IFAS Range Cattle Research and Education Center in Ona to evaluate bahiagrass responses to application of biosolids and inorganic fertilizer applied either alone or in combination with biochar. Our hypothesis was that biochar could alter N and P dynamics in soil, thus, affecting crop nutrient use efficiency. Treatments consisted of four fertilizer sources (inorganic fertilizer, thermally-dried Class AA biosolids, aerobically-digested Class B biosolids, and anaerobically-digested Class B biosolids; surface-applied at 160 lb plant available N /acre/yr with or without biochar (applied at 1% weight basis). Plant availability of N in the biosolids was estimated using a Florida-DEP factor of 1.5, therefore, annual N application rates for biosolids and inorganic fertilizer treatments were 240 and 160 lb total N/acre, respectively.

Results demonstrated that bahiagrass response to fertilization treatments was affected by fertilizer sources (inorganic fertilizer vs. biosolids) and environmental conditions (temperature, daylength, rainfall, and timing of fertilizer application). Bahiagrass total annual herbage accumulation was similar for biosolids and inorganic fertilizer treatments in 2017; however, inorganic fertilizer and aerobically-digested Class B biosolids increased total annual herbage accumulation by as much as 29% relative to other sources in 2018 (Table 1). The aerobically-digested Class B biosolids and inorganic fertilizer resulted in greater total annual herbage accumulation in 2018 than 2017. Excessive rainfall received in August and September, 2017 may have resulted in significant N loss (leaching) following application of inorganic fertilizer resulting in lower total annual herbage accumulation in 2017. Biochar application had negligible impacts on bahiagrass responses, which suggested no agronomic benefit and possibly no effect of biochar on N and P availability.

Biosolids and inorganic fertilizer increased bahiagrass crude protein concentration by as much as 22 and 39% in 2017 and 2018, respectively, compared to unfertilized bahiagrass. In general, no differences in CP concentration between biosolids and inorganic fertilizer treatments were observed (average CP concentration of 10 to 11%). Similarly, no treatment effects were observed on in vitro digestible organic matter (IVDOM) concentration in 2017; however, biosolids resulted in greater IVDOM than inorganic fertilizer in 2018. Bahiagrass tissue mineral concentrations in both biosolids and inorganic fertilizer treatments were generally within sufficient range for optimum plant growth.

Nitrogen recovered in above-ground biomass corresponded to 85 to 116% of applied plant available N (Table 2) suggesting that biosolids and inorganic fertilizer sources were effective at providing N to support bahiagrass growth. Phosphorus accumulation in above-ground biomass accounted for 18 to 48% of applied P. Despite the differences in annual P loads (70 to 165 lb P/acre/yr), herbage P accumulation remained relatively constant (29 to 36 lb P/acre/yr) during the experimental period. No clear differences in herbage P accumulation among biosolids and commercial fertilizer treatments were observed. Results indicated that biosolids can be a viable alternative for sustainable bahiagrass production while reducing the dependence on inorganic fertilizer.

This article was adapted from Lu, Silveira, Vendramini, Erickson, and Li. 2020. Biosolids and biochar application effects on bahiagrass herbage accumulation and nutritive value. Agronomy Journal (In Press). For additional information or access to the full peer-reviewed article, please contact Maria Silveira (mlas@ufl.edu).

Table 1. Bahiagrass total annual herbage accumulation as affected by fertilizer source and year.

Fertilizer source	Year	
	2017	2018
	---------------------lb Acre^{-1}--------------------	
Control	5360 b(A)†	4445 d(A)
Thermally-dried Class AA biosolids	9345 a(A)	9209 bc(A)
Aerobically-digested Class B biosolids	8526 a(B)	10088 ab(A)
Anaerobically-digested Class B biosolids	9295 a(A)	8402 c(A)
Inorganic fertilizer	8962 a(B)	10838 a(A)

†Total annual herbage accumulation corresponded to the sum of three harvest events per year. Data represent the average across biochar treatments (with or without biochar) and 4 replicates (n= 8). Same lowercase letters within columns and uppercase letters within rows are not different ($P > 0.05$).

Table 2. Annual plant available N (PAN) and total P loads and herbage N and P accumulation as affected by fertilizer source and year

Fertilizer source	Annual PAN load		Herbage N accumulation	
	2017	2018	2017	2018
	----------------------lb N Acre^{-1}--------------------			
Control	0	0	77 b(A)†	56 c(A)
Thermally-dried Class AA biosolids	160	160	160 a(A)	136 b(B)
Aerobically-digested Class B biosolids	160	160	151 a(B)	185 a(A)
Anaerobically-digested Class B biosolids	160	160	167 a(A)	136 b(B)
Inorganic fertilizer	160	160	163 a(A)	180 a(A)
Fertilizer source	**Annual total P load**		**Herbage P accumulation**	
	2017	2018	2017	2018
	---------------------- lb P Acre^{-1}-------------------			
Control	0	0	13 b(A)	8 d(B)
Thermally-dried Class AA biosolids	70	70	32 a(A)	31 bc(A)
Aerobically-digested Class B biosolids	165	74	30 a(B)	34 ab(A)
Anaerobically-digested Class B biosolids	82	107	32 a(A)	29 c(A)
Inorganic fertilizer	165	74	31 aB	36 a(A)

†Means represent the average across biochar treatments (with or without biochar) and 4 replicates (n= 8). Same lowercase letters within columns and uppercase letters within rows are not different ($P > 0.05$).