



**Forage Hay BMPs: Enhanced Efficiency Nitrogen and Other Options
FDACS Contract No. 21893, 2016 Interim Report**



**Florida Department of Agriculture and Consumer Services
Office of Agricultural Water Policy**

**FDACS Contract No. 21893, Deliverable 3
Year 2 Semi-Annual Report**

**Investigators: Dr. Cheryl Mackowiak (Lead PI); Dr. Jose Dubeux (Co-PI); Dr.
Ann Blount (Co-PI)**

UF-IFAS North Florida Research and Education Center, Quincy, FL 32351

**Doug Mayo (extension Co-PI)
Jackson County Extension, Marianna, FL**

**For further information, please contact:
Cheryl Mackowiak, Associate Professor, NFREC, Quincy (850) 544-7126;
echo13@ufl.edu**

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BACKGROUND

Pursuant to the Florida Watershed Restoration Act (FWRA), section 403.067(7)(c)3, F.S., the Florida Department of Agriculture and Consumer Services (FDACS), Office of Agricultural Water Policy (OAWP), develops, adopts, and assists with the implementation of agricultural Best Management Practices (BMPs) to protect and conserve water resources. This two-year project proposes to demonstrate the effectiveness of enhanced efficiency nitrogen fertilizers and mixed grass/perennial legume options for hay fields in North Florida as means to manage nutrient inputs more efficiently. This is the second of two interim reports, covering January through June, 2016.

METHODOLOGY

Locations: This project is represented by four different farms, located in the Jackson Blue Spring Basin BMAP (Table 1).

Table 1. On-farm study sites located in the Jackson Blue Spring Basin.

Producer	Latitude/longitude	Forage Effort
<u>Bill Conrad</u>	30.9960, -85.1088	EEF: bermudagrass 1 (BC)
	30.9961, -85.1087	N budget: bermudagrass 1
	30.9951, -85.1120	N budget: alfalfa 1
	30.9947, -85.1176	N budget: perennial peanut 1
	30.9946, -85.1175	Mixed grass/legume farm 1
<u>Ted Bruner</u>	30.8916, -85.0651	N budget: perennial peanut 2
	30.8916, -85.0650	Mixed grass/legume farm 2
<u>Jeff Pittman</u>	30.8827, -85.0626	EEF: bermudagrass 2 (JP)
	30.8827, -85.0627	N budget: bermudagrass 2
	30.8850, -85.0627	N budget: alfalfa 2
<u>Pat Pelt</u>		
House location	30.7501, -85.0631	EEF: bahiagrass 1 (PPH)
	30.7501, -85.0632	N budget: bahiagrass 1
Lowland location	30.7496, -85.0723	EEF: bahiagrass 2 (PPL)
	30.7497, -85.0724	N budget: bahiagrass 2

Enhanced Efficiency Fertilizer (EEF): The forage season ended in late October/early November, 2015. We continued to measure ammonia emissions weekly through

12/15/2015 for all but the Control and ESN treatments. Those were sampled weekly through 01/02/2016, as there appeared to be some continued low release occurring from some of the ESN plots. By January release values were below the detection limit ($0.03 \text{ kg N ha}^{-1}$) except for a couple of ESN plots at the PPH field. It is unclear why we continued measuring low (0.03 to $0.29 \text{ kg N ha}^{-1}$) weekly emission rates at those plots. In April, the plots at all locations were staged, fertilized, ammonia traps installed and weekly ammonia measurements reinstated.

Soil cores (0 to 48 inch depth) were collected in March 2016 from each EEF plot (prior to fertilization for Year 2). The 2-inch dia. cores were separated into 5 depth increments (0 to 6, 6 to 12, 12 to 24, 24 to 36, and 36 to 48 inches). The soils were air-dried, then extracted with 2 M KCl and analyzed for soluble inorganic N ($\text{NH}_4\text{-N}$ and $\text{NO}_3\text{-N}$).

The forage tissue collected in 2015 was ground to pass through a 2-mm screen in-house and then sent to a commercial laboratory (Waters Agricultural Laboratories, Camilla, GA) to be analyzed for plant essential elements (N, P, K, Ca, Mg, S, B, Fe, Mn, Zn, and Cu).

The EEF treatments in Year 2 were the same as for Year one and were as follows: CTL (control or no N fertilizer); UCU (uncoated urea at 80 lbs N ac^{-1}); ARB (Arborite coated urea at 80 lbs N ac^{-1}); ESN (ESN coated urea at 80 lbs N ac^{-1}), and BIO (pelleted biosolids, 6-4-0, at $240 \text{ lbs total N ac}^{-1}$). The BIO was applied only once for the season which equated to 2 tons biosolids per acre, while the prescription for the other N fertilizers was 80 lbs N after each harvest, except the last of the season (applied for 4 cuttings or 3 applications per season), per IFAS recommendations. All plots at all locations initially received $60 \text{ lbs K}_2\text{O ac}^{-1}$ as 0-0-60, and $20 \text{ lbs K}_2\text{O ac}^{-1}$ as 0-0-22, which provided $80 \text{ lbs K}_2\text{O}$, 20 lbs S , and 11 lbs Mg per acre. After each harvest (except the last of the season), all plots received an additional $40 \text{ lbs K}_2\text{O ac}^{-1}$ (30 lbs as 0-0-60 and 10 lbs as 0-0-22). No other fertilizers were applied. Two harvests were completed prior to 30 June, 2016.

Mixed grass/legume test: Weed pressures during Year 1 establishment were most challenging. Glyphosate was used to control winter weeds on bermudagrass plots and a combination of herbicides were used for plots with bahiagrass, perennial peanut, alfalfa or mixtures. Four harvests were completed prior to 30 June, 2016. An activity and herbicide log is provided in Appendix 1.

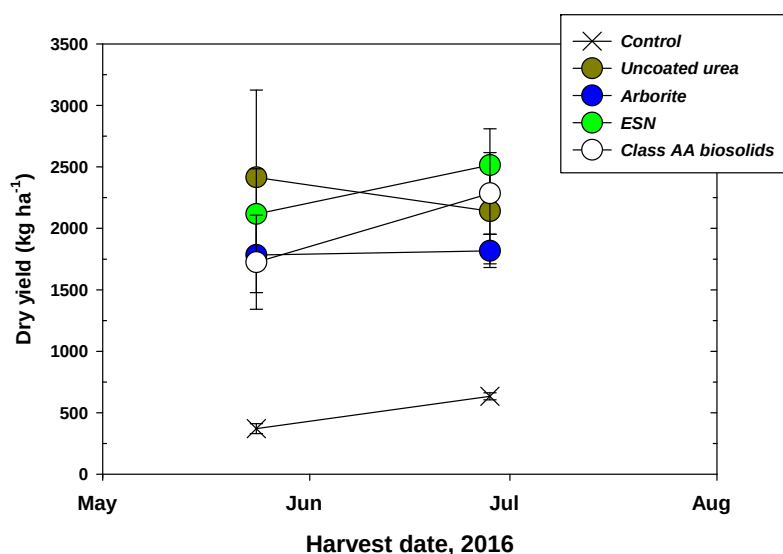
Nitrogen Budgets: Soil cores (three at 48 inch depth) were drilled per $40 \text{ ft} \times 40 \text{ ft}$ plot in March, 2016 (24 cores total). Soils were separated into five sections (0 to 6, 6 to 12, 12 to 24, and 24 to 36 and 36 to 48 inches). The soils were air-dried, sieved to pass through a 2-mm screen and stored until analysis for bromide (Br⁻). We did not detect Br⁻ in any of the samples although the ion-selective probe seemed to operate within the calibration range. We will purchase a new probe and run the analyses again, this fall. Further information is provided in the Results and Discussion section.

RESULTS AND DISCUSSION

Enhance Efficiency Fertilizers

Bahiagrass: Plots receiving N fertilizer, regardless of treatment, resulted in greater forage yields than the Control plots. Also, the June harvest resulted in more forage at the Pat Pelt Low Field (PPL) than the May harvest. Overall, the Low field trended towards greater yields than the House field (PPH). The Low field plots have access to greater soil moisture, which might be a benefit. Additionally, the House field bahiagrass may be more S deficient, as will be addressed later in the discussion.

Bahia (Pat Pelt house field)



Bahia (Pat Pelt low field)

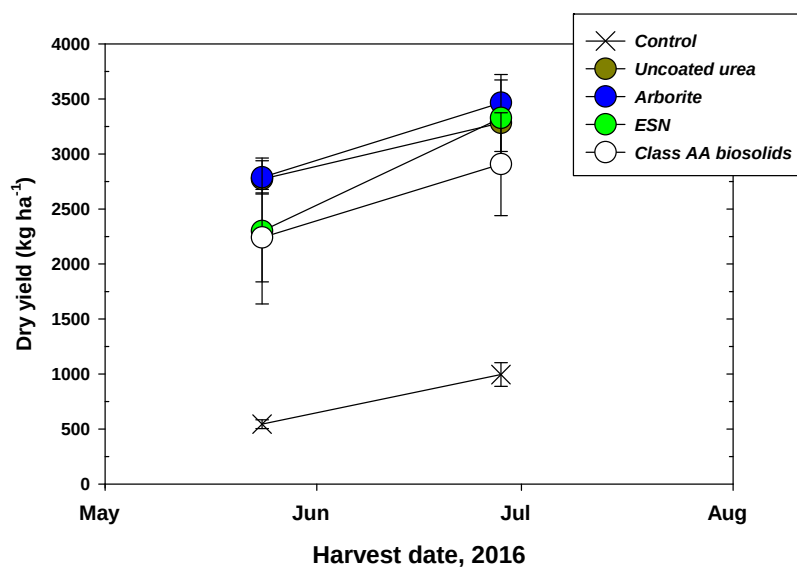


Fig. 1. Temporal yields at the House field (upper panel) and 9b, Low field (lower panel). Each symbol represents the mean $\pm$ standard error.

Ammonia emission losses peaked more, following the May harvest than after the initial application in late April at the PPH and PPL locations (Figs. 2a and 3a). This is likely due to increasing warmth and moisture in June.

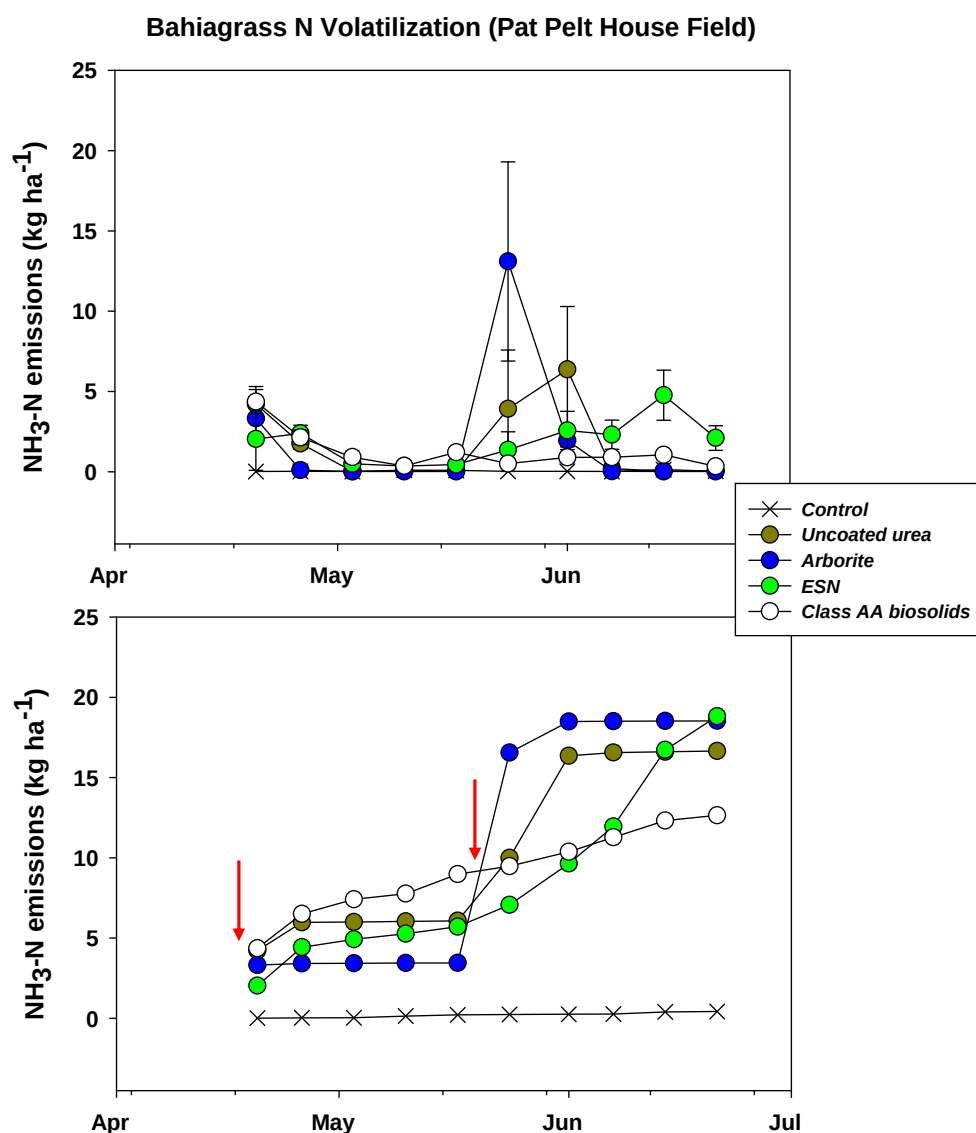


Fig. 2. Temporal NH₃-N emissions 2a, at the House field (upper panel) and cumulative emissions 2b, (lower panel) for the same location. Each symbol represents the mean $\pm$ standard error. The red arrows in 2b represent N fertilizer applications to the plots. The entire season of biosolids was applied only once.

Cumulative losses were also similar between locations, although UCU reached more than 20 kg ha⁻¹(Fig. 3). Although N emissions from UCU was greater at PPL, the other fertilizer

emissions were strikingly similar. By the end of June, the BIO treatment had greatly reduced N emissions nearly to background values at both locations (Figs 2a and 3a).

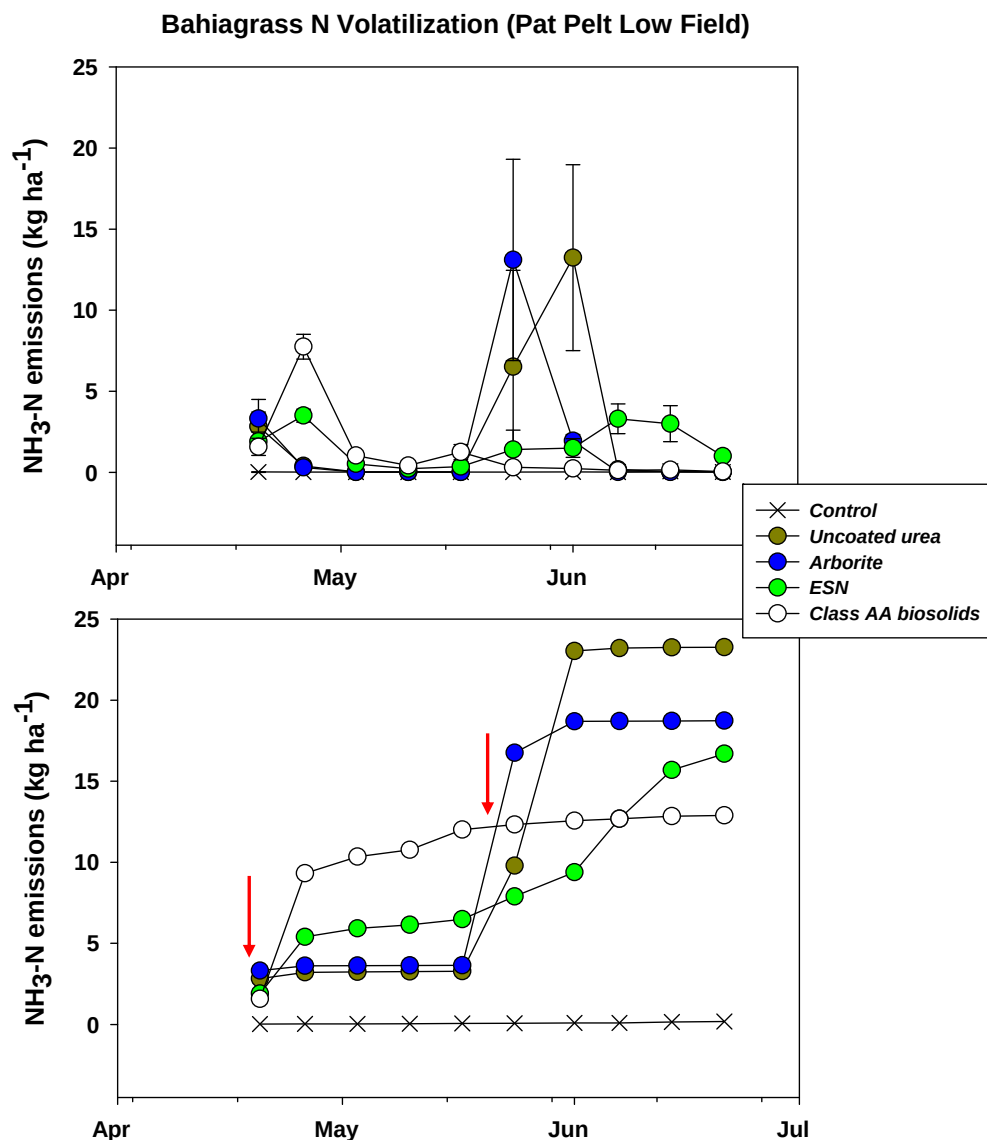
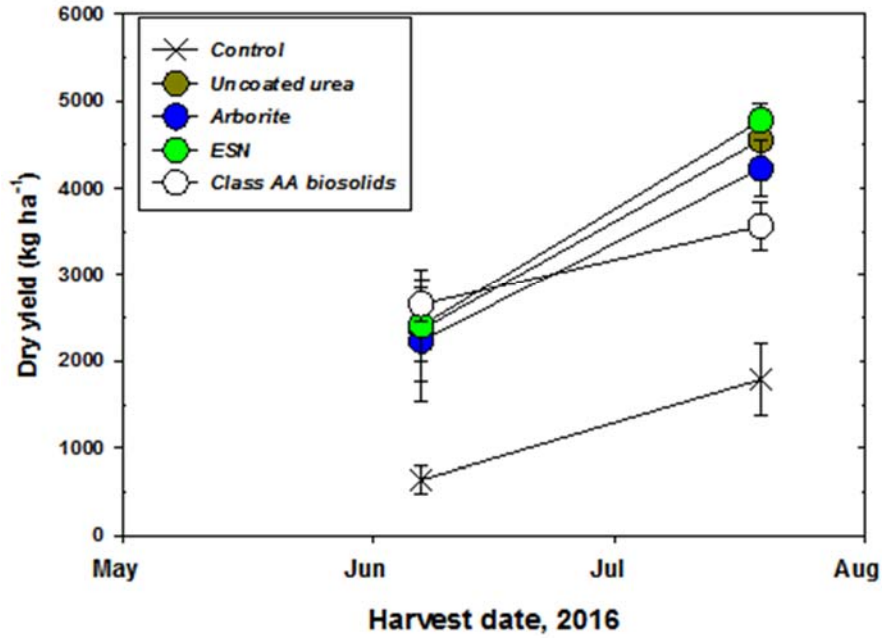


Fig. 3. Temporal $\text{NH}_3\text{-N}$ emissions 3a, at the Low field (upper panel) and cumulative emissions 3b, (lower panel) for the same location. Each symbol represents the mean $\pm$ standard error. The red arrows in 3b represent N fertilizer applications to the plots. The entire season of biosolids was applied only once.

Bermudagrass: As with bahiagrass, bermudagrass plots receiving N fertilizer, regardless of treatment, resulted in greater forage yields than Control plots (Fig. 4). Since there was only one harvest previous to 30 June, the July harvest was included for this report. Plots at BC had nearly twice the yield in June than the JP plots, although by the July harvest, the yield difference was much less. There were no other treatment differences at either location or sampling date.

Bermuda (Bill Conrad Farm)



Bermuda (Jeff Pittman Farm)

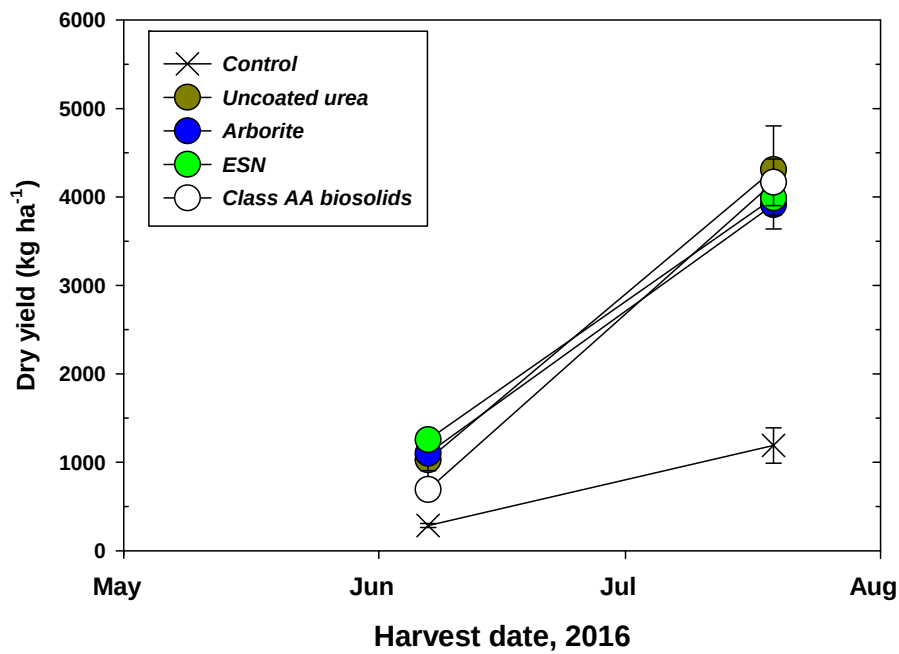


Fig. 4. Temporal yields at Bill Conrad (BC) field (upper panel) and 9b, Jeff Pittman (JP) field (lower panel). Each symbol represents the mean $\pm$ standard error.

The N emissions from the BC location were greater than from bahiagrass fields (Fig. 5), although biosolids emissions were similar to the bahiagrass fields. The JP location also had greater N emissions from UCU and ARB than from the bahiagrass fields but ESN emissions were lower (Fig. 6). In fact, the ESN emissions were no greater than emissions from BIO (biosolids).

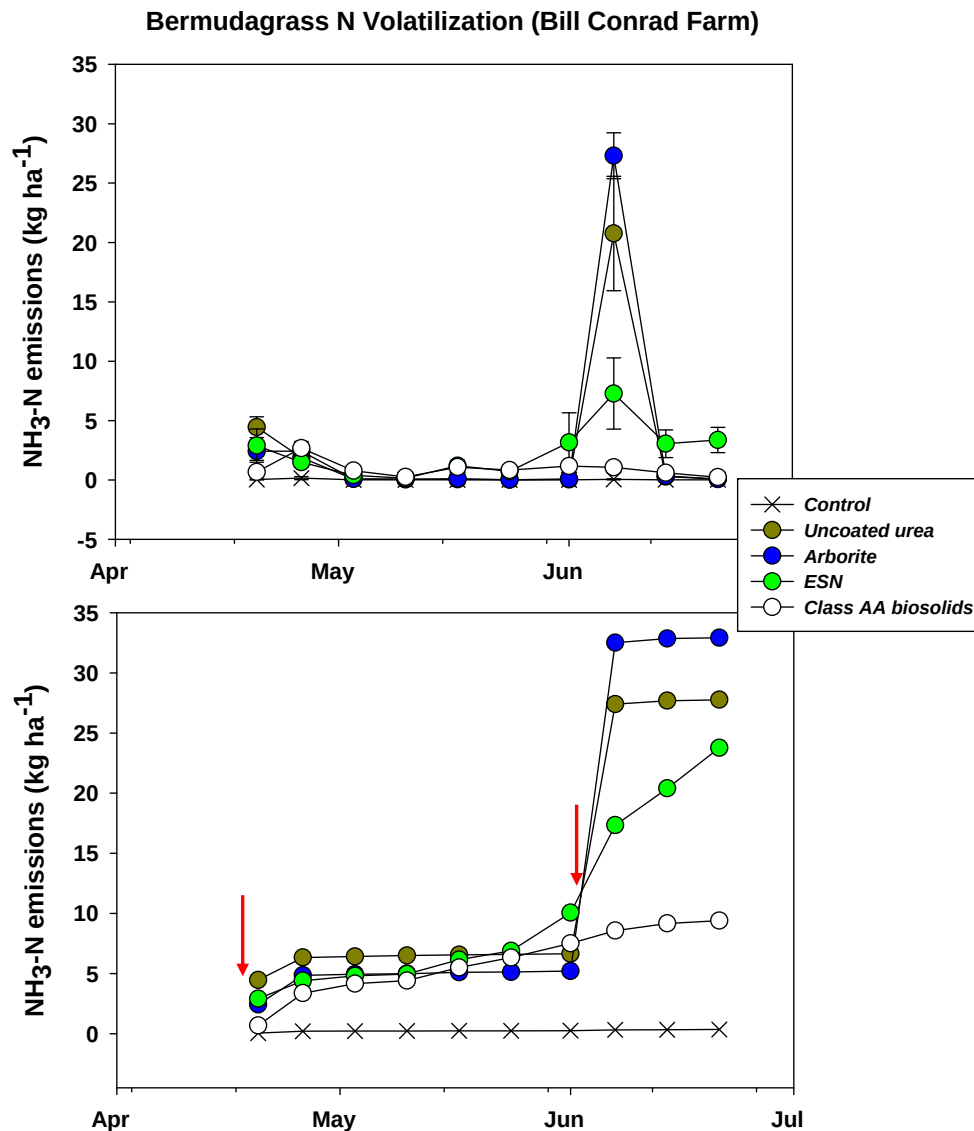


Fig. 5. Temporal NH₃-N emissions 5a, at the BC field (upper panel) and cumulative emissions 5b, (lower panel) for the same location. Each symbol represents the mean $\pm$ standard error. The red arrows in 3b represent N fertilizer applications to the plots. The entire season of biosolids was applied only once.

Over the past 1.5 years, the ESN short-term (1 to 2 weeks) emissions rates were much lower than rates from UCU and ARB. However, over the longer term, the continual low

release rate is further evidence that ESN is no more effective at limiting N gas emissions than the urease coating (ARB) or even uncoated urea. It is interesting to note that the biosolids treatments had similarly low emissions, regardless of location or forage application type.

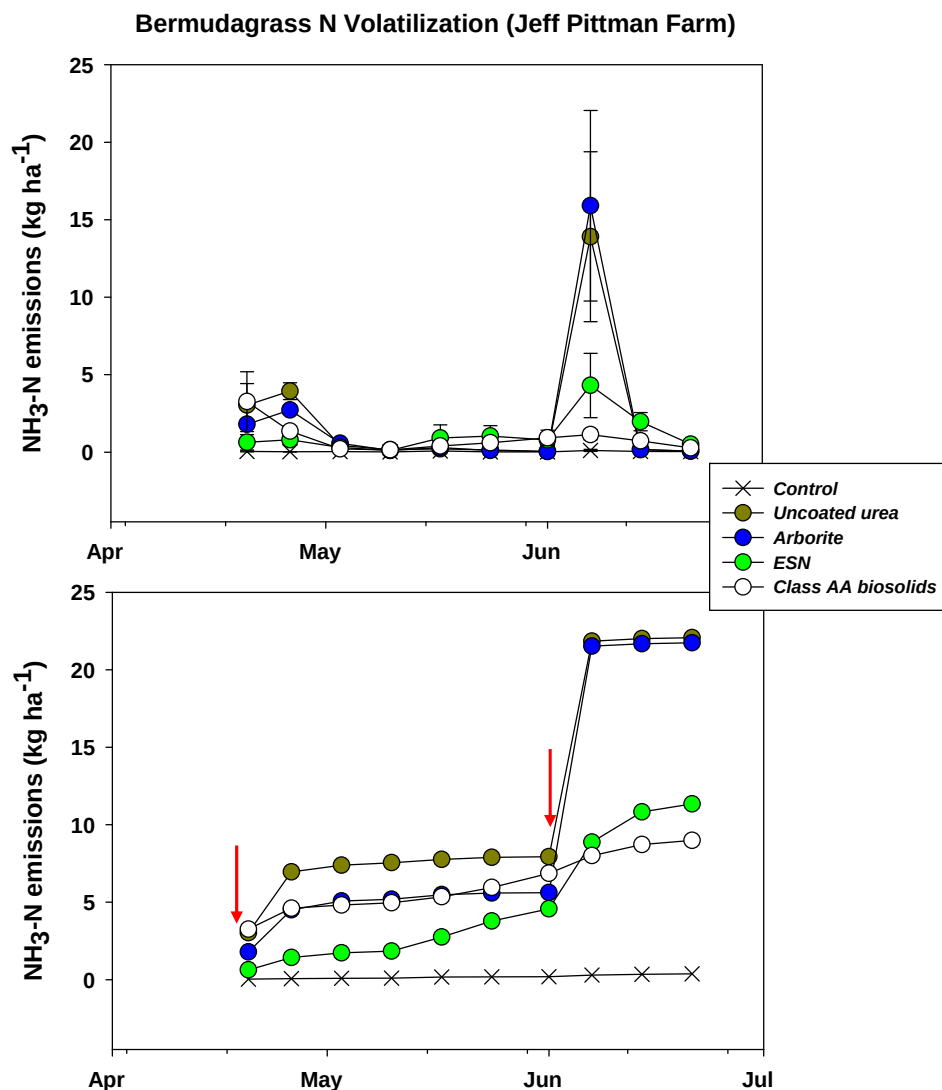


Fig. 6. Temporal $\text{NH}_3\text{-N}$ emissions 5a, at the JP field (upper panel) and cumulative emissions 6b, (lower panel) for the same location. Each symbol represents the mean $\pm$ standard error. The red arrows in 6b represent N fertilizer applications to the plots. The entire season of biosolids was applied only once.

Year 1 soil N: Even if the ESN polymer coating is not providing extra long-term protection from $\text{NH}_3\text{-N}$ emission losses, perhaps the coating is providing protection from leaching losses. Soils from deep cores collected in March, 2016 were analyzed for soluble inorganic N. Although there was not a significant treatment difference at $\alpha=0.05$, there

was some response at a lower level of significance ($\alpha=0.10$ and $P=0.068$) for total inorganic N, where the ABR treatment was greater than the control (1.44 vs 1.06 mg kg^{-1}). With no significance at $\alpha=0.05$, the treatments were combined to compare forage types and sampling depth. In this case, inorganic N varied with depth and bahiagrass plots had greater soil N than bermudagrass plots (Fig. 7). Both forages received the same rate of N but due to genetics, Tifton-85 bermudagrass typically out-yields Tifton 9 bahiagrass. Less N in the forage allows for more N to remain in the soil. Even so, the soil N concentrations were relatively low (<3 mg kg^{-1} near the surface). The pattern shows a potential for inorganic N to be accumulating deeper (below 4 ft) in the subsoil, particularly under the bahiagrass plots. Based on these values the bahiagrass plots averaged 26 lbs N ac^{-1} in the upper 4 feet of soil, while the bermudagrass plots averaged 16 lbs N ac^{-1} . The final soil cores will be collected in the fall, closer in time to the final harvest. If we cannot get the Br- tracking method to work, we may shift our coring efforts to these plots in order to characterize the subsoil N to at least 8 ft depth (2 to 3 m).

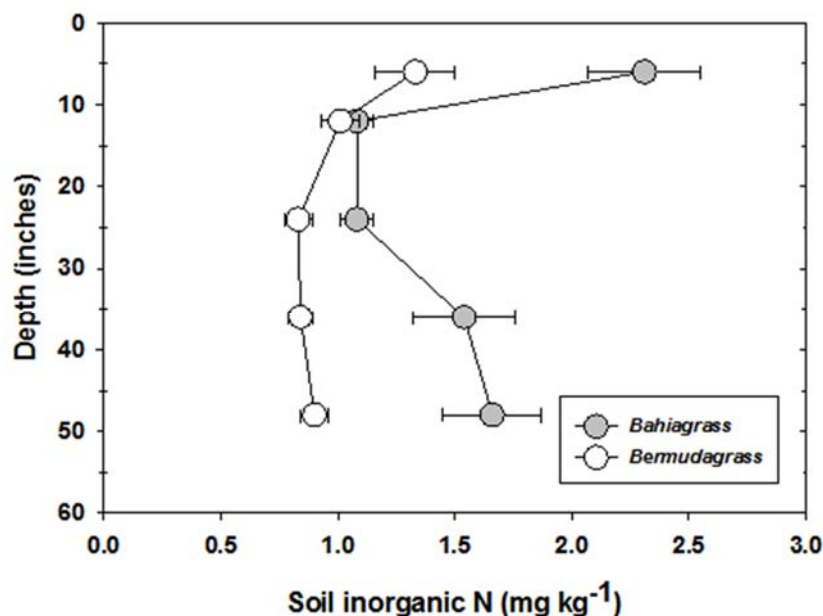


Fig. 7. Soil inorganic N ($\text{NH}_4\text{-N} + \text{NO}_3\text{-N}$) with soil depth from cores collected in March, 2016. Each symbol represents the mean $\pm$ standard error.

Year 1 tissue concentrations: Forage nutrient content was sampled with each harvest in 2015. There were significant interactions so treatments were compared separately at each location for the major nutrients, N, P, and K. Bahiagrass N at the PPH location was lowest with the Control treatment (Fig. 8). The BIO treatment began to decrease in tissue N after the August, 2015 harvest, which coincided with trends towards slightly lower yields later in the season. The same pattern occurred at the PPL location, as well (Fig. 9). Tissue

N at the final harvest was greater than many would try to achieve for bahiagrass and thus suggests excessive N application with the urea products.

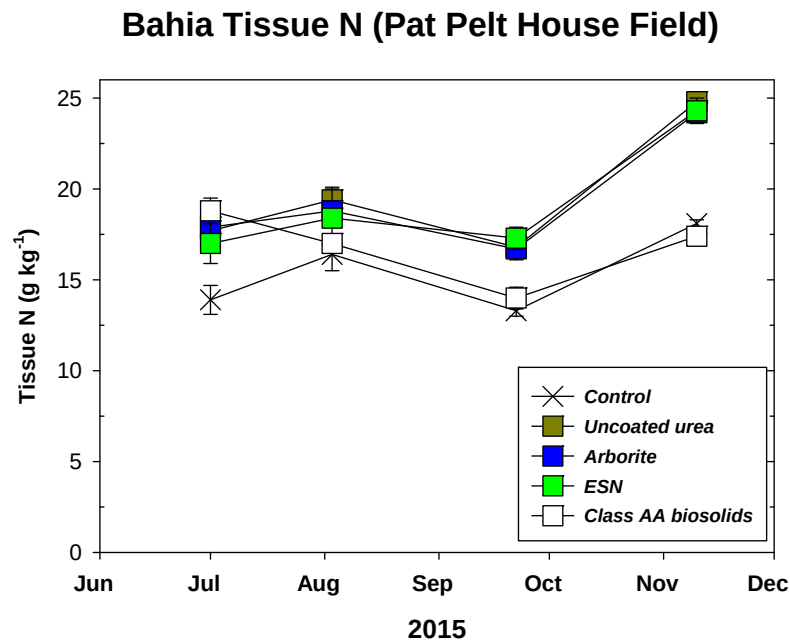


Fig. 8. Bahiagrass N at the House field over time. Each symbol represents the mean $\pm$ standard error.

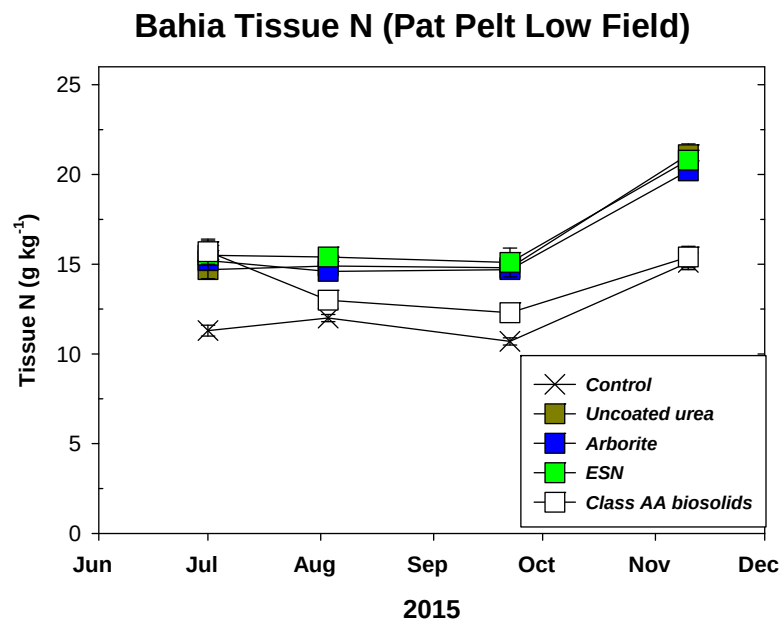


Fig. 9. Bahiagrass N at the Low field over time. Each symbol represents the mean $\pm$ standard error.

The tissue content from bermudagrass plots declined by the mid-summer harvest at the BC location, but remained almost unchanged at the JP location (Figs. 10 and 11). Only the Control was significantly lower than ESN at the BC location and it was significantly lower than all but ARB at the JP location. Unlike bahiagrass, growers aim for 20 g kg⁻¹ N or greater in bermudagrass. Even at IFAS recommendations (80 lbs ac⁻¹), tissue N at BC rarely exceeded this low value and bermudagrass at the JP location never achieved 20 g kg⁻¹). Other factors may have limited N uptake; some which will be discussed further.

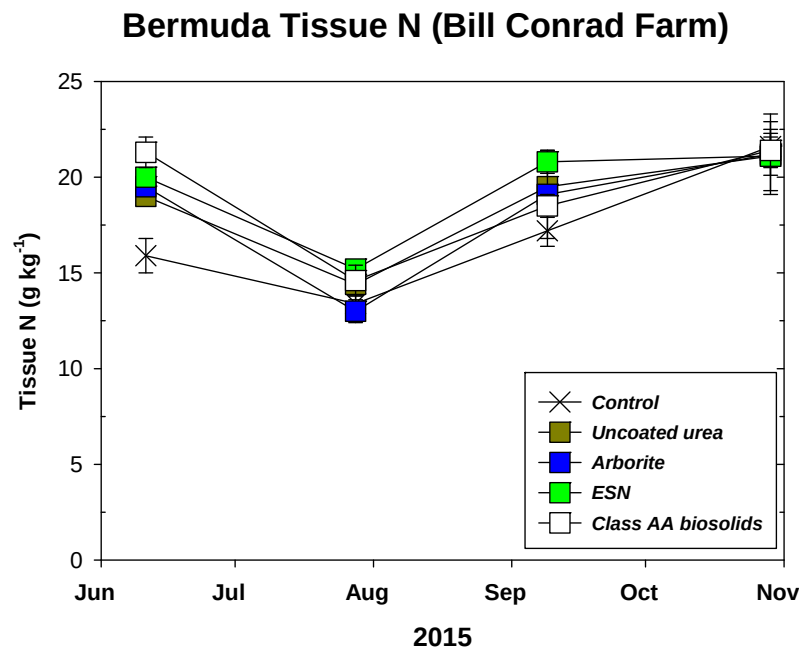


Fig. 10. Bahiagrass N at the BC location over time. Each symbol represents the mean $\pm$ standard error.

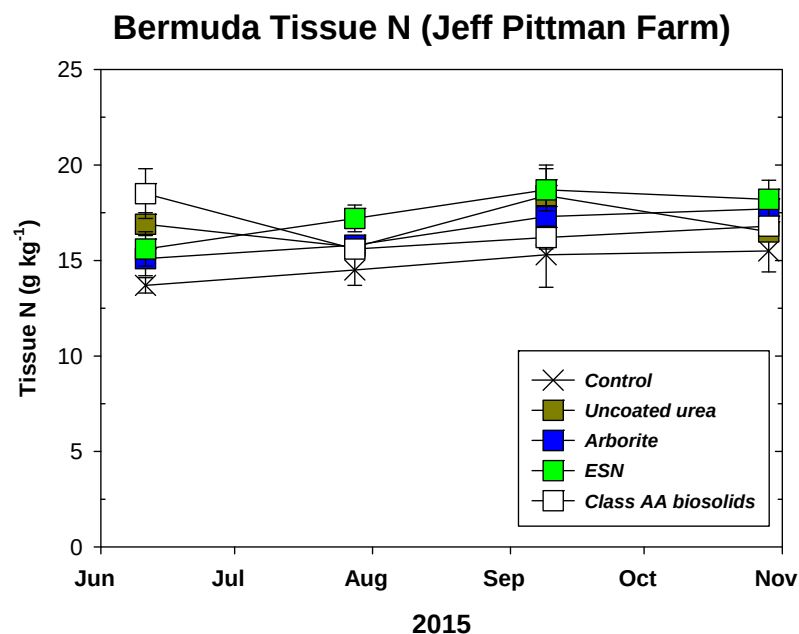


Fig. 11. Bahiagrass N at the JP location over time. Each symbol represents the mean $\pm$ standard error.

Tissue P was significantly lower with the BIO and Control treatments (Fig. 12). Low tissue P with the Control and BIO treatments was opposite of what was found at all the other locations where these treatments tended to have the greatest tissue P content (Figs 13, 14, 15). Regardless, tissue P was well above critical low limits 1.5 for bahiagrass and 2 for bermudagrass.

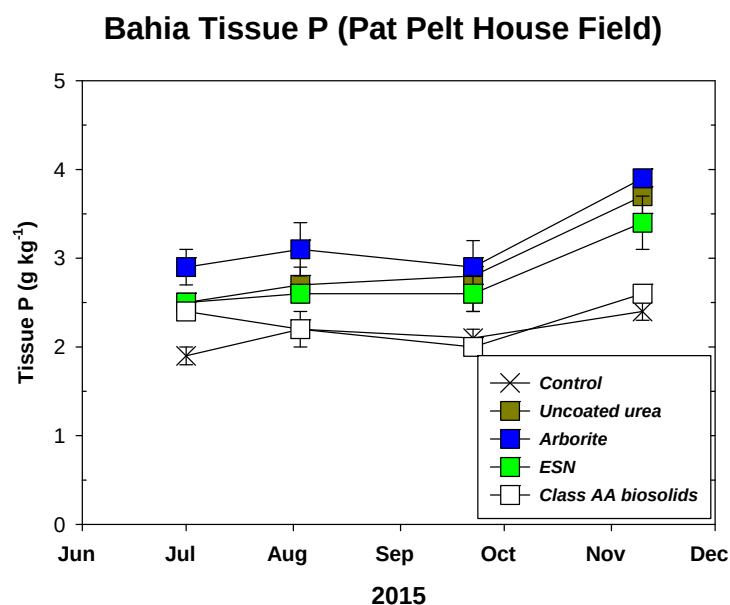


Fig. 12. Bahiagrass P at the PPH location over time. Each symbol represents the mean $\pm$ standard error.

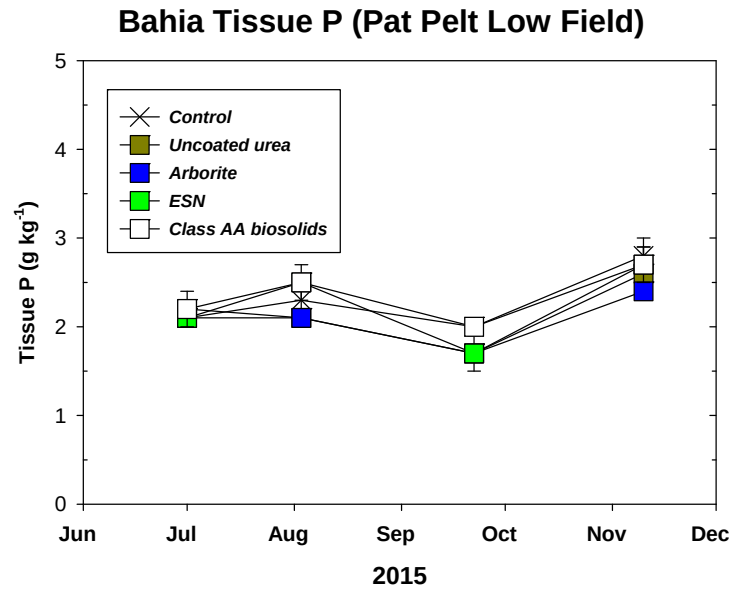


Fig. 13. Bahiagrass P at the PPL location over time. Each symbol represents the mean $\pm$ standard error.

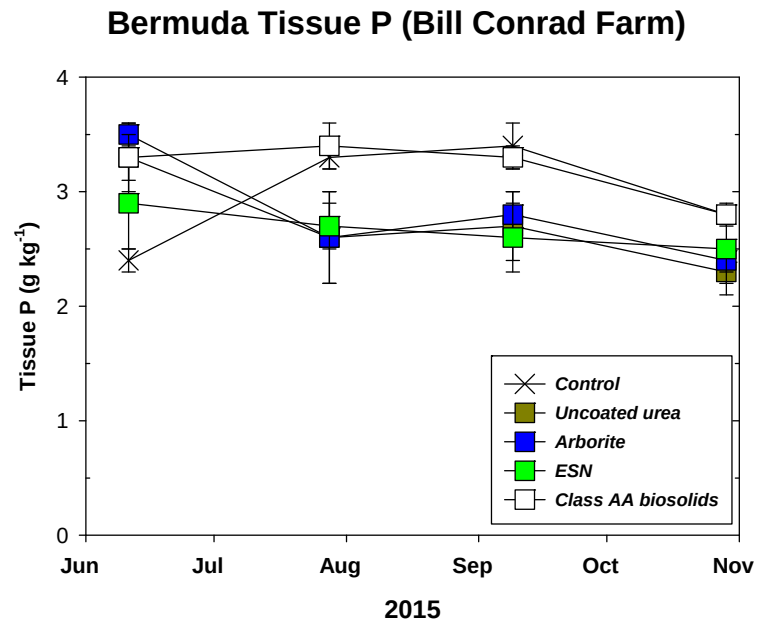


Fig. 14. Bermudagrass P at the BC location over time. Each symbol represents the mean $\pm$ standard error.

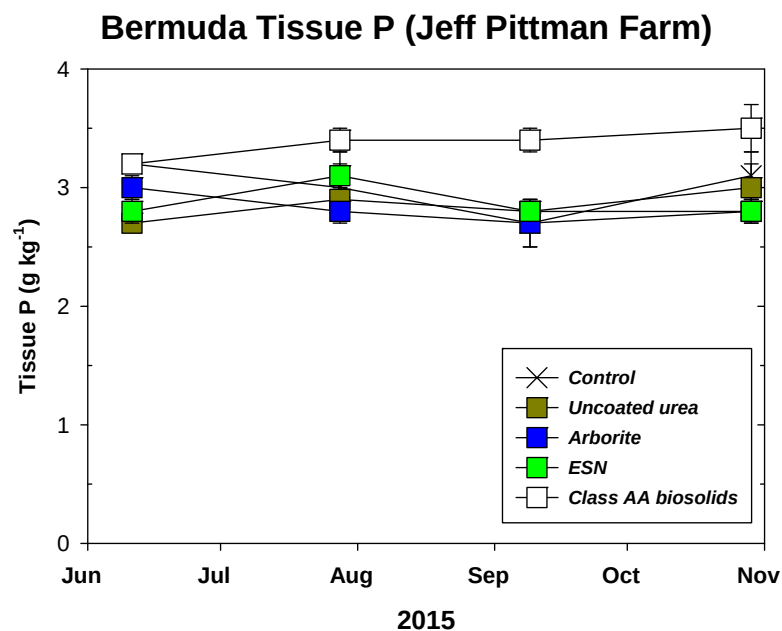


Fig. 15. Bermudagrass P at the JP location over time. Each symbol represents the mean $\pm$ standard error.

Bahiagrass tissue K was surprisingly low at the PPH and PPL locations (Figs. 16 and 17), where the sufficiency low is likely around 10 g kg^{-1} , or greater. The Control plots were at 6 mg kg^{-1} . This suggests that perhaps K fertilizer recommendations may need to be revisited.

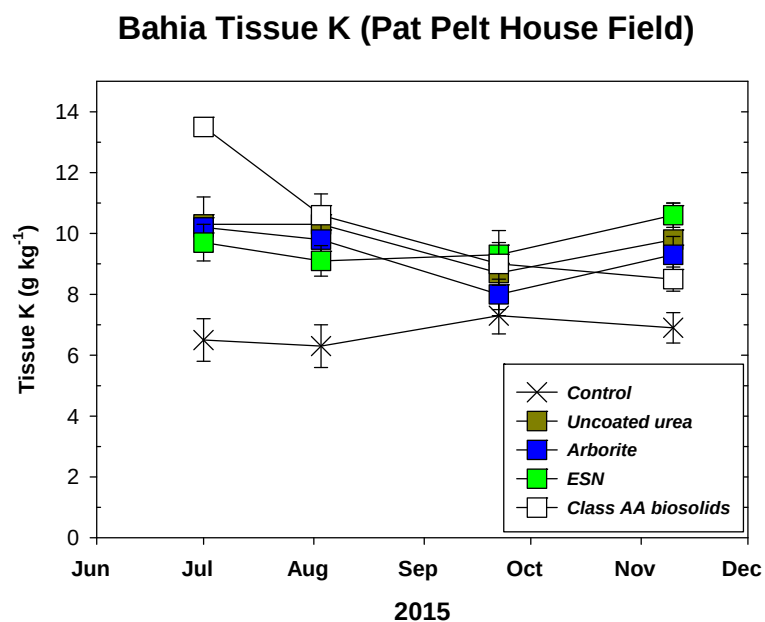


Fig. 16. Bahiagrass K at the PPH location over time. Each symbol represents the mean $\pm$ standard error.

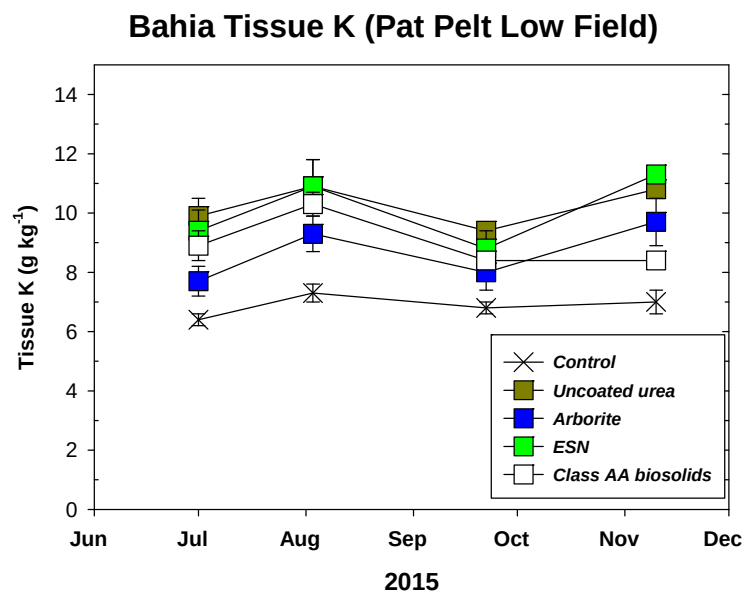


Fig. 17. Bahiagrass K at the PPL location over time. Each symbol represents the mean $\pm$ standard error.

The bermudagrass K content was also low but it has a higher sufficiency low of 15 g kg⁻¹. The Control treatment was significantly lower than the fertilized treatments with both forage types and at all locations. Maintaining adequate K fertilization is a universal challenge in Florida soils.

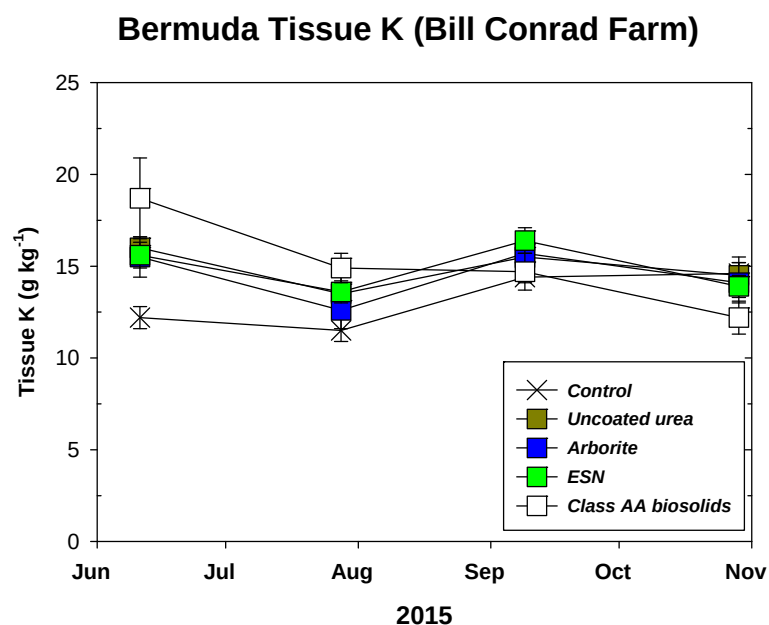


Fig. 18. Bahiagrass K at the BC location over time. Each symbol represents the mean $\pm$ standard error.

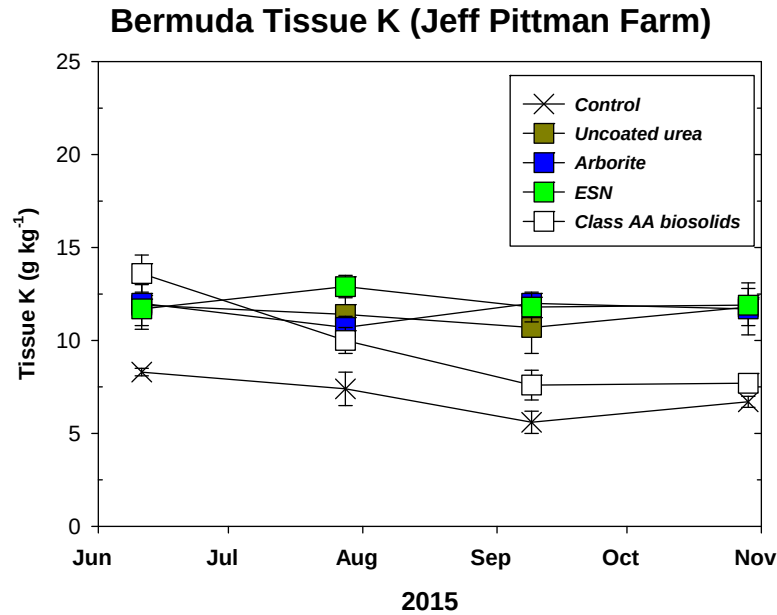


Fig. 19. Bahiagrass K at the JP location over time. Each symbol represents the mean $\pm$ standard error.

If it was not real clear with biosolids effects on forage P, it certainly had an effect on tissue S (Fig. 20). Biosolids greatly improved tissue S above the critical low value of 1.5 g kg^{-1} . Critically low S will affect N uptake and forage yield. Often deficiencies have a resemblance to N deficiency, so it is often overlooked. Discussions are planned with the landowners so that they are aware of the potential problem and how they might address it through S fertilization. Fortunately, S fertilizer is economical and the application of small amounts (10 lbs ac^{-1}) are often sufficient.

Other nutrients were also analyzed in the forage, but there were no clear trends or relationships among treatments, so these data are provided as box plots, based upon forage type (Appendix 2).

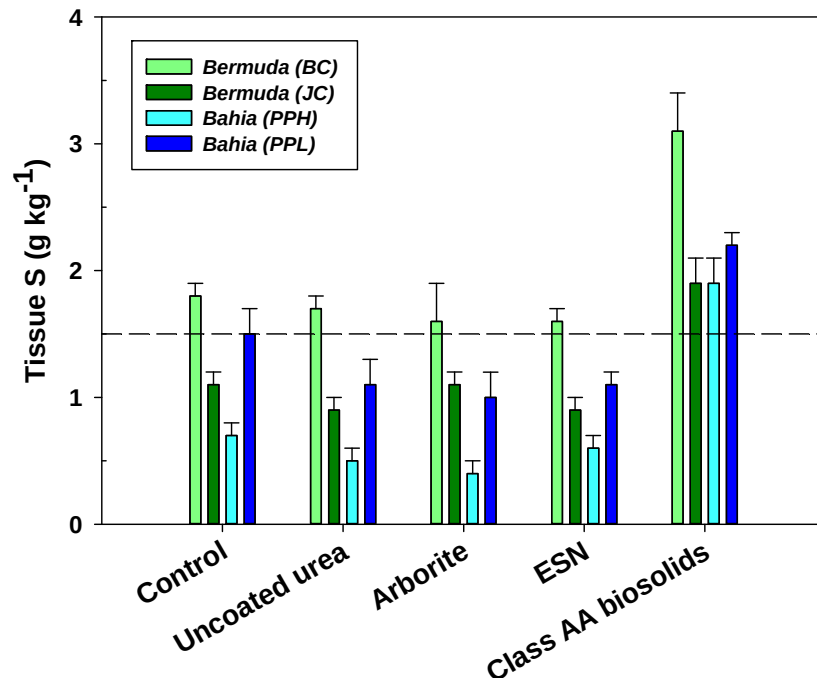


Fig. 20. Forage S at all locations over time. Each symbol represents the mean $\pm$ standard error.

Mixed grass/legume study

Farm 1 - Bahiagrass

A total of five harvests were accomplished. In Farm 1, results showed that when alfalfa or perennial peanut are mixed with Bahiagrass and receiving 40 lbs of N/ha their herbage mass is greater than all the monocultures, including the N fertilized bahiagrass (80 lbs ha⁻¹) (Fig. 21a). In May, the mixture of bahiagrass/alfalfa and bahiagrass/perennial peanut presented total herbage mass of 1980 and 1770 kg DM ha⁻¹, followed by the N fertilized bahiagrass with 1630 kg DM ha⁻¹. The non-N fertilized bahiagrass yielded 890 kg DM ha⁻¹, while the legumes monocultures had the least herbage mass yield, with 320 and 70 kg DM ha⁻¹ for alfalfa and perennial peanut, respectively. However, it is important to mention that early in the warm season the perennial peanut is still starting to grow after the dormancy period.

When growing in mixture with legumes the bahiagrass biomass was slightly greater (1970 and 1750 kg DM ha⁻¹, for bahiagrass/alfalfa and bahiagrass/perennial peanut, respectively) than the N fertilized bahiagrass (1630 kg DM ha⁻¹) and yielded twice as much as the non-N fertilized bahiagrass (890 kg DM ha⁻¹) for the May harvest (Figure 21b). The association with legumes plus some nitrogen fertilization might be able to reduce costs with nitrogen fertilizer and increase the nutritive value of the diet. However, these results are still preliminary and further harvests will be performed to find out whether

it compensates or not to replace 50% of the nitrogen recommendation by legume addition into the system.

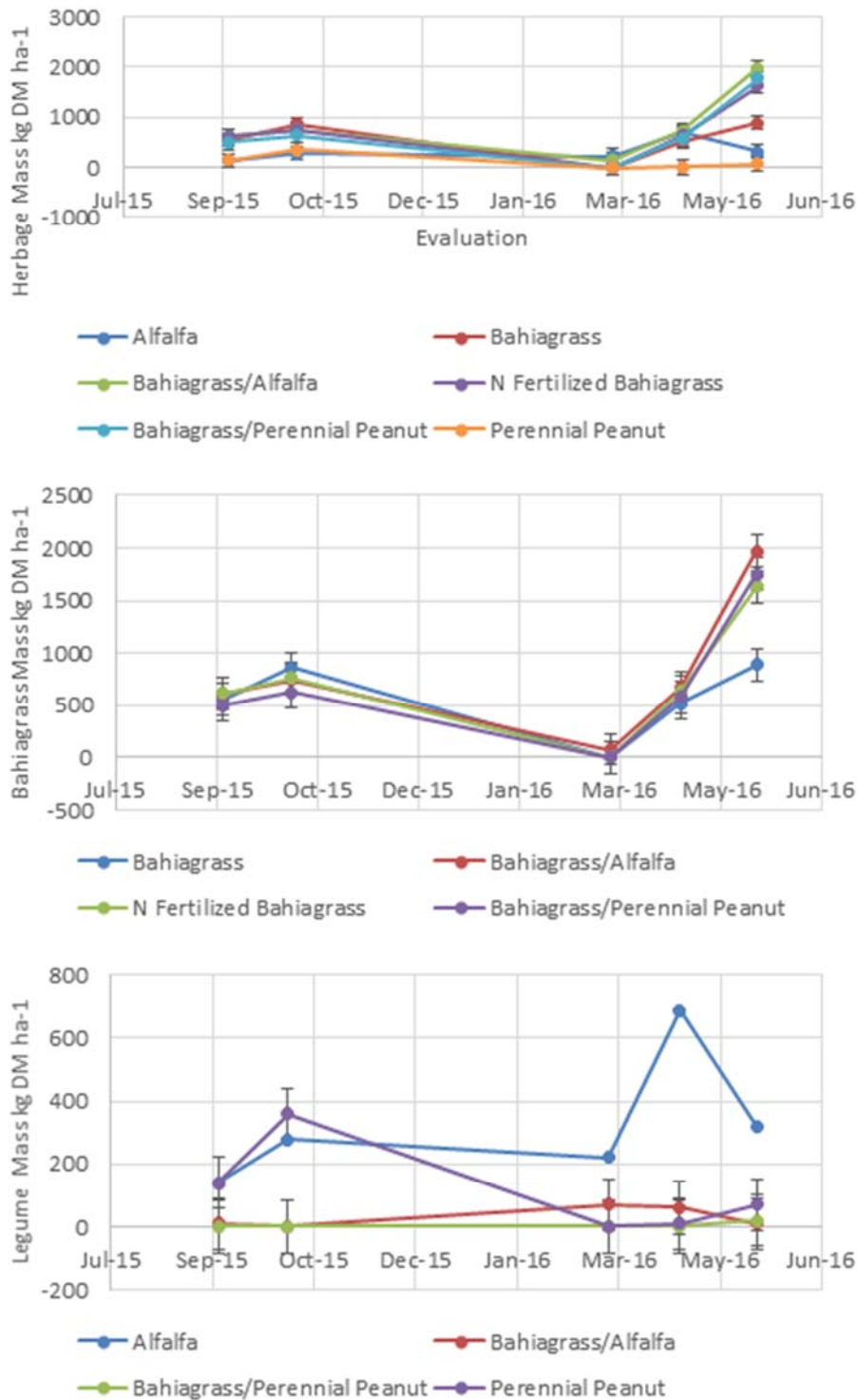


Fig. 21. a) Herbage mass, b) bahiagrass mass, and c) Legume mass in kg DM ha⁻¹ in Farm 1 for the experiment containing bahiagrass and legumes mixtures.

On the other hand, legume yield was affected when growing together with grasses (20 and 10 kg DM ha⁻¹, for the mixtures with perennial peanut and alfalfa, respectively) while the legume monocultures yielded 320 and 70 kg DM ha⁻¹ for alfalfa and perennial peanut, respectively (Fig. 21c).

Farm 1 – Bermudagrass

In May, when fertilized with 80 lbs of N ha⁻¹ the monoculture of bermudagrass had the greatest herbage mass, followed by the mixtures with perennial peanut and alfalfa, 4560, 3530, and 2450 kg DM ha⁻¹, respectively (Fig. 22a). Monocultures of alfalfa and perennial peanut presented the lowest biomass (1040 and 305 kg DM ha⁻¹, respectively). The bermudagrass portion of the total herbage mass was greater when comparing the mixture with perennial peanut and the mixture with alfalfa (3520 and 2260 kg DM ha⁻¹, respectively) (Fig. 22b). In addition, the legume portion was greater for bermudagrass/perennial peanut compared to bermudagrass/alfalfa (305 and 190 kg DM ha⁻¹, respectively) (Fig. 22c). When growing in monoculture, alfalfa herbage mass was 1040 kg DM ha⁻¹. The competition with bermudagrass has probably affected alfalfa performance.

Farm 2 – Bahiagrass: Total herbage mass for the N fertilized bahiagrass treatment was greater (2020 kg DM ha⁻¹) than the other treatments in May, followed by the mixtures with perennial peanut and alfalfa (1740 and 1520 kg DM ha⁻¹, respectively) (**Figure 3a**). The monoculture of alfalfa and non-N fertilized bahiagrass had similar yield, 1290 and 1170 kg DM ha⁻¹, respectively, and the perennial peanut monoculture had the least herbage mass (910 kg DM ha⁻¹).

The herbage mass of the bahiagrass was greater when compared to the mixture containing perennial peanut with the alfalfa mixture (1640 and 1290 kg DM ha⁻¹, respectively) (Fig. 23b). However, alfalfa was more present in the mixture than perennial peanut (230 and 100 kg DM ha⁻¹, respectively) (Fig. 23c). Moreover, legume performance was negatively affected for both. Monocultures of alfalfa and perennial peanut had an herbage mass of 1290 and 910 kg DM ha⁻¹ (Fig. 23c).

Farm 2 – Bermudagrass: When fertilized with N, the monoculture of bermudagrass herbage mass was 3620 kg DM ha⁻¹ for May (Fig. 24a). The mixtures of bermudagrass/perennial peanut and bermudagrass/alfalfa had an herbage mass about half of the N fertilized treatment (1930 and 1750 kg DM ha⁻¹). Non-N fertilized bermudagrass and alfalfa had similar herbage mass in May (1240 and 1330 kg DM ha⁻¹).

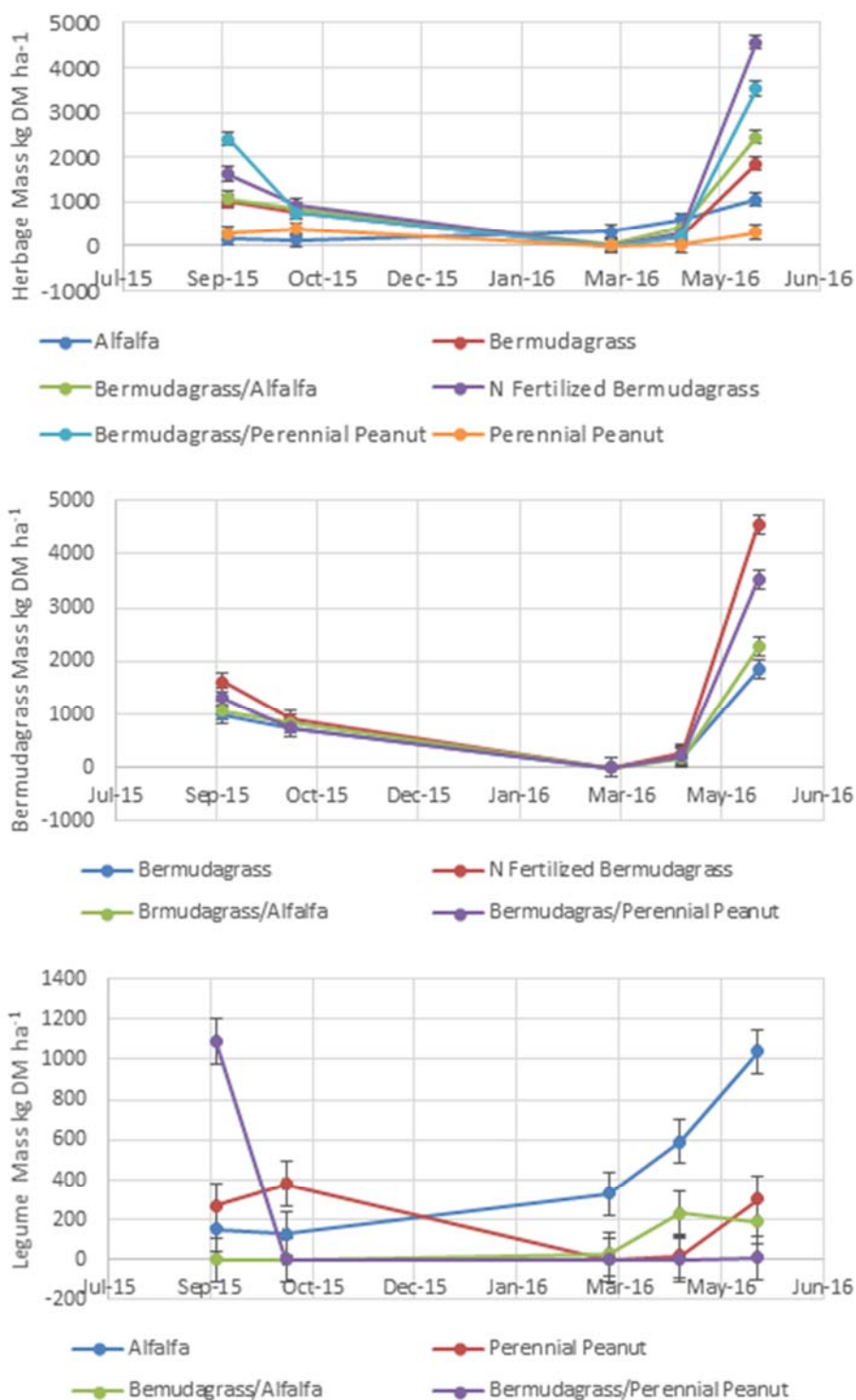


Fig. 22. a) Herbage mass, b) Bermudagrass mass, and c) Legume mass in kg DM ha⁻¹ in Farm 1 for the experiment containing bermudagrass and legumes mixtures.

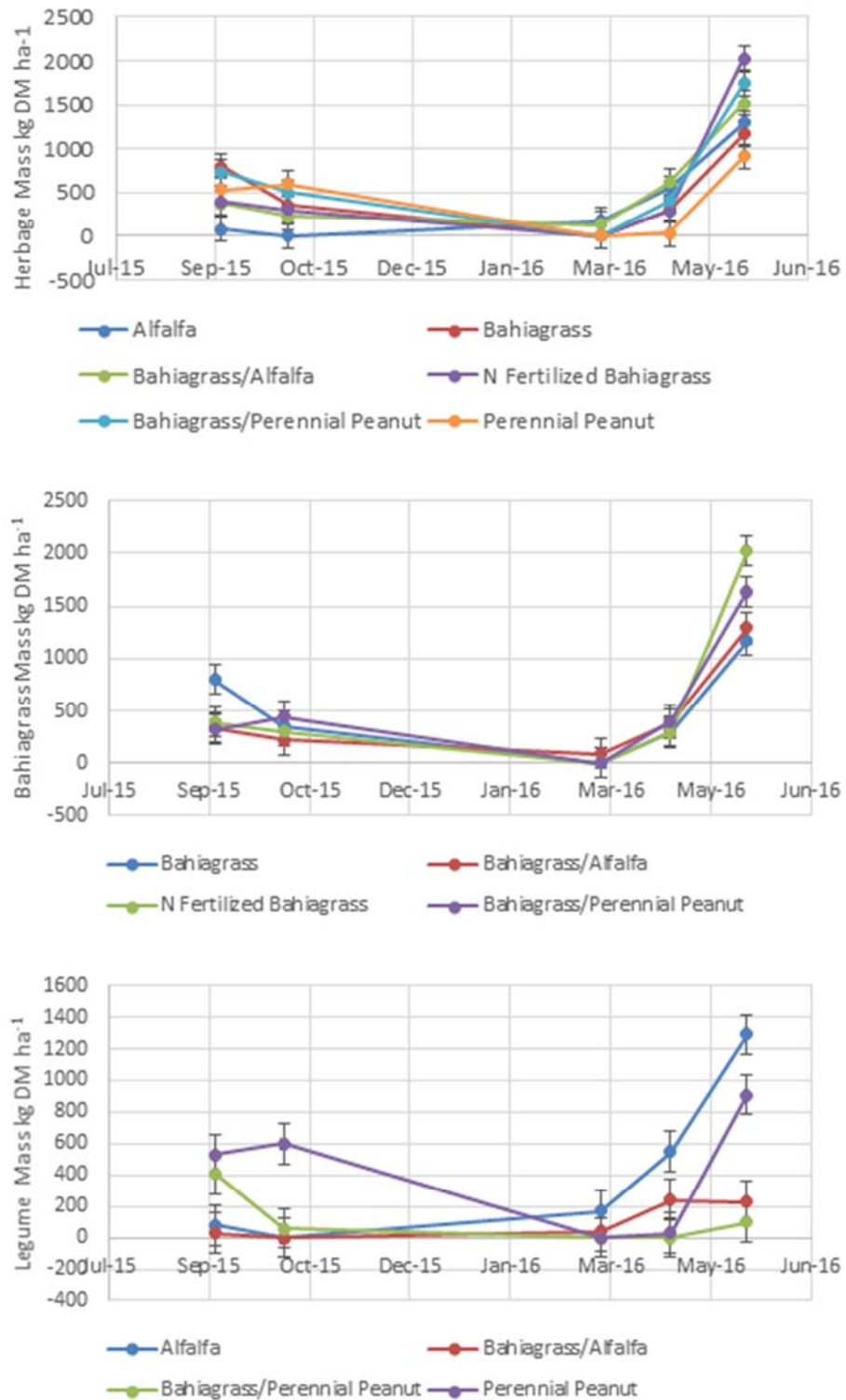


Fig. 23. a) Herbage mass, b) bahiagrass mass, and c) Legume mass in kg DM ha⁻¹ in Farm 2 for the experiment containing bahiagrass and legumes mixtures.

The contribution of bermudagrass for total herbage mass in the mixture with perennial peanut was greater than the mixture with alfalfa, representing 1870 and 1060 kg DM ha⁻¹ (Fig. 24b). On the other hand, the legume presence for alfalfa was greater than for perennial peanut when growing together with bermudagrass in May (690 and 60 kg DM ha⁻¹, respectively) (Fig. 24c). Nonetheless, it is important to notice that both legumes were affected by the presence of bermudagrass. The herbage mass of alfalfa dropped from 1240 to 690 kg DM ha⁻¹ and the perennial peanut herbage mass dropped from 680 to 60 kg DM ha⁻¹ when growing together with bermudagrass (Fig. 4c).

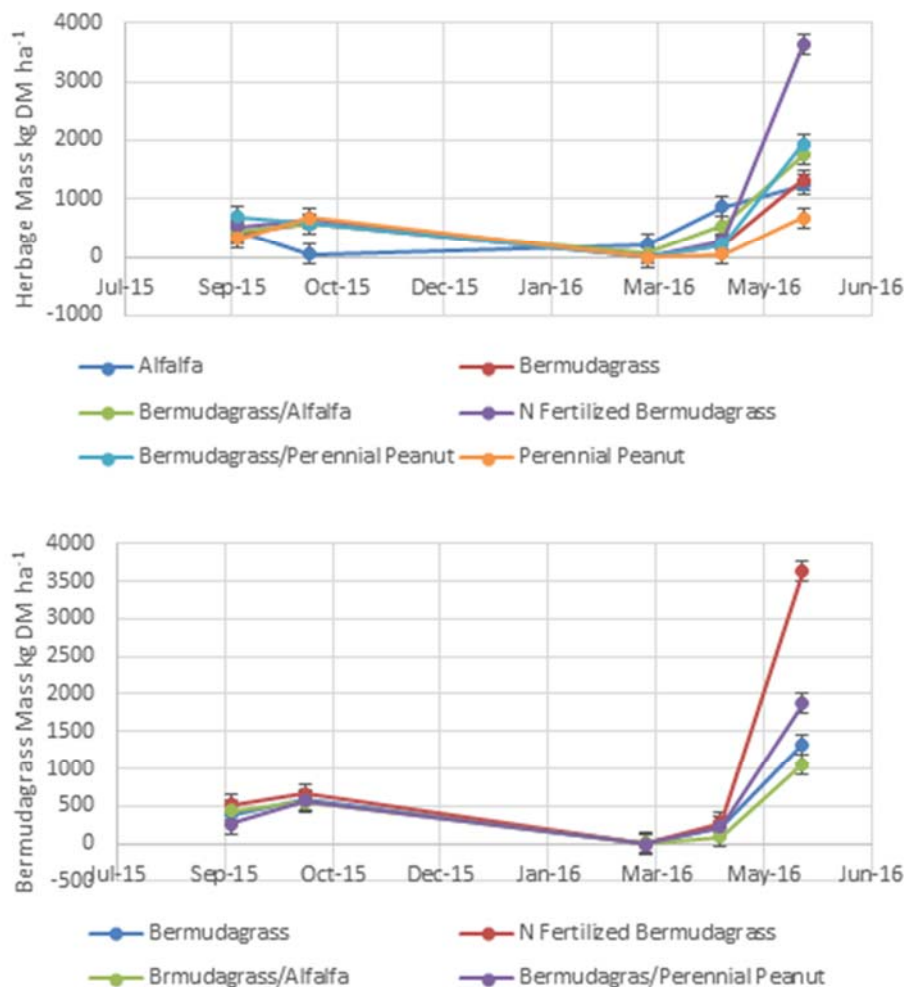


Fig. 24. a) Herbage mass, b) Bermudagrass mass in kg DM ha⁻¹ in Farm 1 for the experiment containing bermudagrass and legumes mixtures.

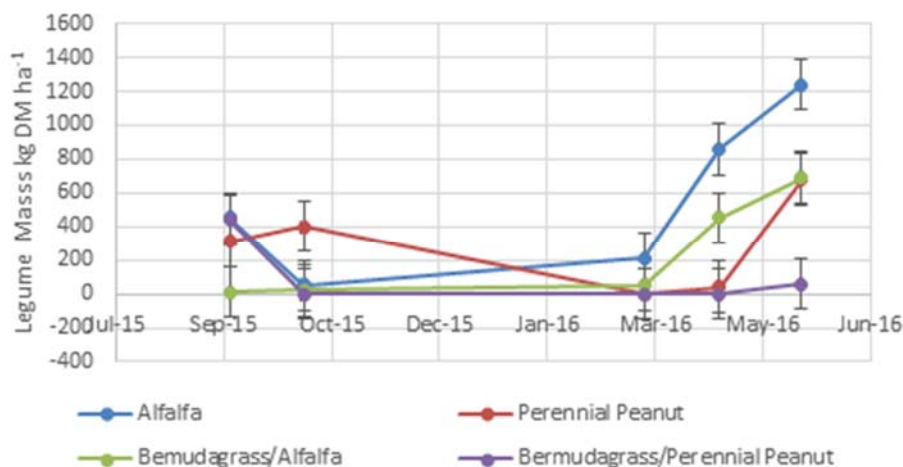


Fig. 24c. Legume mass in kg DM ha⁻¹ in Farm 1 for the experiment containing bermudagrass and legumes mixtures.

Nitrogen budgets

Forages and soils were sampled for Br⁻ (via KBr tracer) but the data suggest no Br⁻ in the tissue or soils, which are highly unlikely results. We aim to purchase another Br ion selective probe and re-analyze all the forages and soils. Also in the final quarter, we will complete our soils characterizations and use HYDRUS1D model to help assess the risk for nitrate leaching in these hay fields. The information we are gathering and “lessons learned” will help contribute needed information to the BMP development process.

OUTREACH

Several students, technical staff and faculty have been involved with the management of these research and demonstration plots. Each week there is representation from our group at one or more of the farm locations. Additionally, we are actively involved in the adoption of BMPs related to these deliverables. The Forage Program at the NFREC promotes best management practices for all forage-related operations, including hay production, stressing proper variety selection, land preparation, soil testing, and fertilization practices be followed as promoted by our UF extension publications and FDACS BMP manual guidelines. Some of our activities included:

1. Blount, A. 2016. Management of triticale and other forage crops. 71st Annual Meeting Alabama Crop Improvement Association and the 21st Annual Meeting Southern Seed Certification Association. 28-29 Feb., 2016. Auburn, AL.

2. Blount, A., Mackowiak, C.L., and Dubeux, J.C 2016. Forage and soil fertility updates from all authors. Agronomic in-service training. 19 Jan. Quincy FL.
3. Blount, A. 2016. Breeding forages for Florida. Florida Cattlemen's Association Leadership Academy. 21 Jan. Marianna, FL.
4. Blount, A., Dubeux, J.C., and C.L. Mackowiak 2016. Forages and BMPs for Florida. Beef-Forage Field Day. Presentations/demonstrations from all authors. 15 April. Marianna, FL.

A complete listing of related publications and presentations will be included in the final report 31 December, 2016.

DELIVERABLES

Table 2. Deliverables summary from January 2016 through June 30, 2016.

Deliverable	Status
Year 2 interim report	Submitted September 13, 2016.
Nitrogen data	All forage tissue and soil cores from 2015 were analyzed for N species. The tracer analyses was completed for all forage and soils samples through 2015, but samples will be analyzed again to verify highly suspect results.
Outreach/Field Days	We highlighted this work at one Center field day and one in-service training (see Appendix 3). A publication was created for the Beef Forage Field day aimed specifically at perennial grasses to protect water resources (see Appendix 4). We plan to hold an additional field day on-farm in October, 2016.

Appendix 1. Enhance Efficiency Fertilizer (EFF) plot maps.

Activities Update: Harvests on 3/16/2016, 4/20/2016, 5/28/2016, and 6/29/2016.

Herbicide Update Farm 1

February 29th, 2016 – Round up was applied (1qt of round up and 32 oz of something else) in the bermudagrass trial.

March 22nd, 2016 – Herbicides were applied at the bahiagrass trial:

- Bahiagrass monoculture plots: GrazonNext HL (1.5 pt/ac + 80/20 nonionic surfactant at 2 pt/100 gal)
- Alfalfa monoculture plots: Roundup Weathermax 4.5S (1 qt/ac + AMS at 3 gal/100 gal)
- Alfalfa-Bahia mix: 2,4-DB amine (Butyrac 200): (4 pt/ac + crop oil surfactant at 1 gal/100 gal)
- Perennial peanut monoculture plots: Imazapic (Impose) (4 oz/ac + crop oil surfactant at 1 gal/100 gal).
- Perennial peanut-Bahia mix: 2,4-D amine: (1 pt/ac + crop oil surfactant at 1 gal/100 gal).

April 7th, 2016 – Prow H2O was applied in all plots at a rate of 2 qt/ac.

April 8th, 2016 – Perennial peanut monoculture plots: Clethodim (Select) (12 oz/ac + AMS at 3 gal/100 gal + crop oil surfactant at 1 gal/100 gal).

Herbicide Update Farm 2

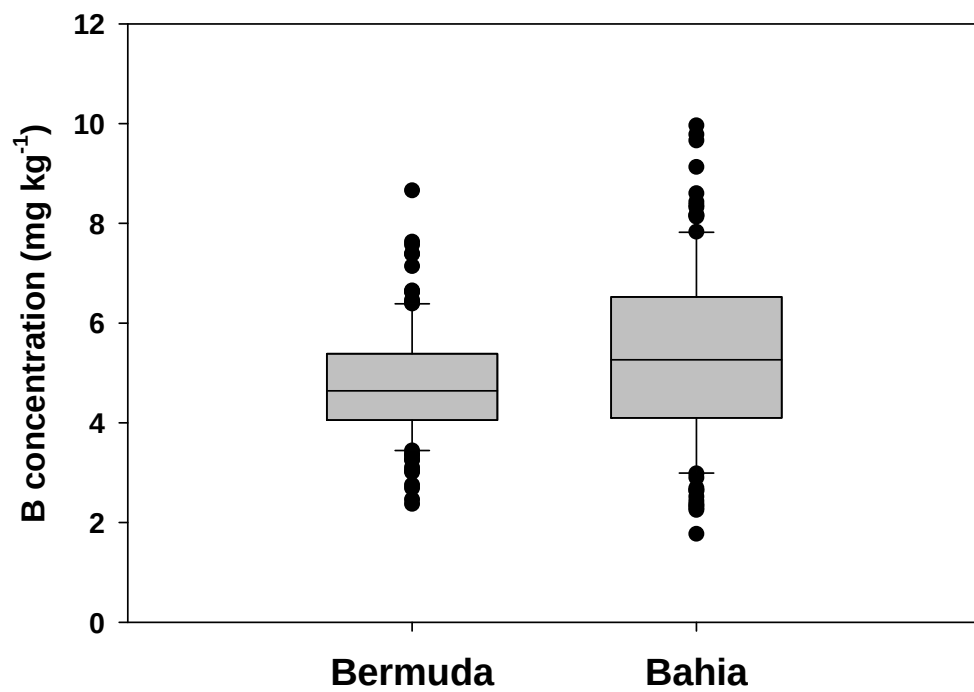
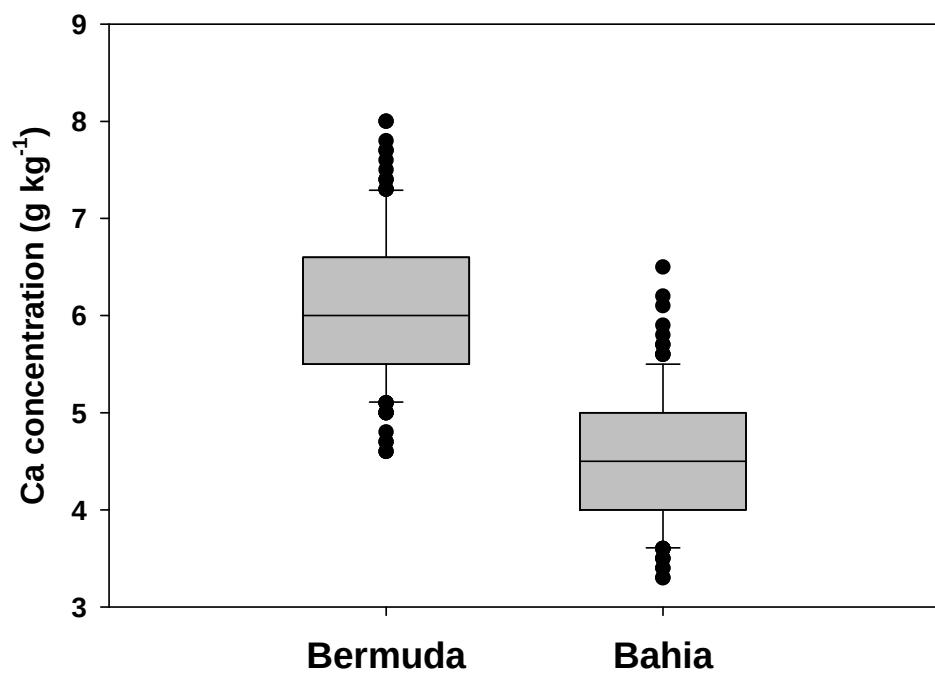
March 22nd, 2016 – Herbicides were applied on both trials: Bahiagrass monoculture plots: GrazonNext HL (1.5 pt/ac + 80/20 nonionic surfactant at 2 pt/100 gal)

- Bermudagrass monoculture plots: GrazonNext (1.5 pt/ac + 80/20 nonionic surfactant at 2 pt/100 gal)
- Alfalfa monoculture plots: Roundup Weathermax 4.5S (1 qt/ac + AMS at 3 gal/100 gal)
- Alfalfa-Bahia mix: 2,4-DB amine (Butyrac 200): (4 pt/ac + crop oil surfactant at 1 gal/100 gal)
- Alfalfa-Bermuda mix: 2,4-DB amine (Butyrac 200): (4 pt/ac + crop oil surfactant at 1 gal/100 gal)
- Perennial peanut monoculture plots: Imazapic (Impose) (4 oz/ac + crop oil surfactant at 1 gal/100 gal).
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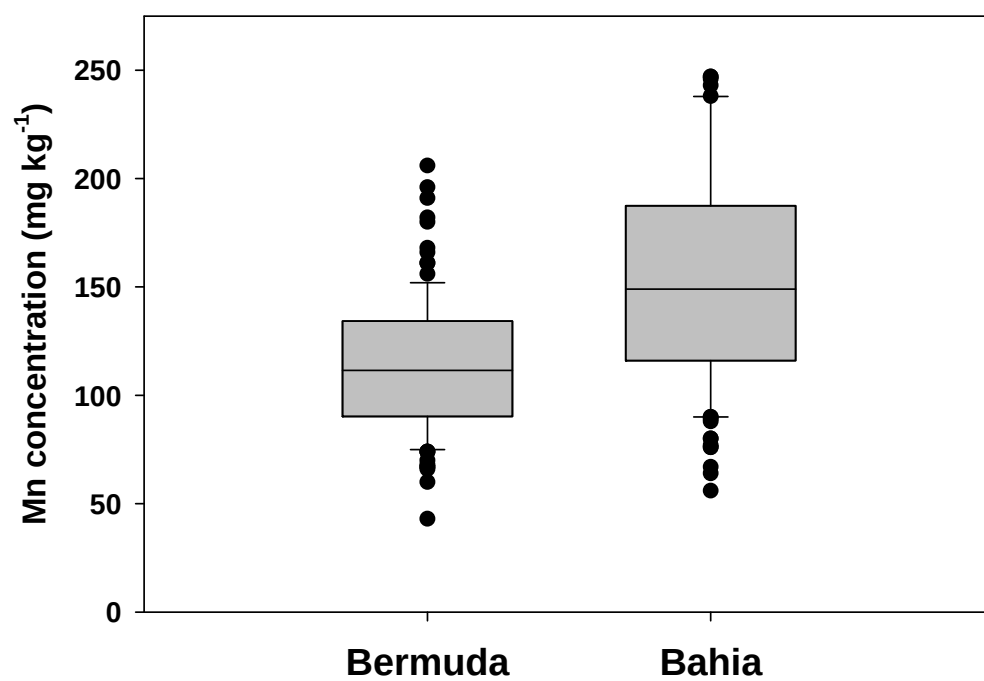
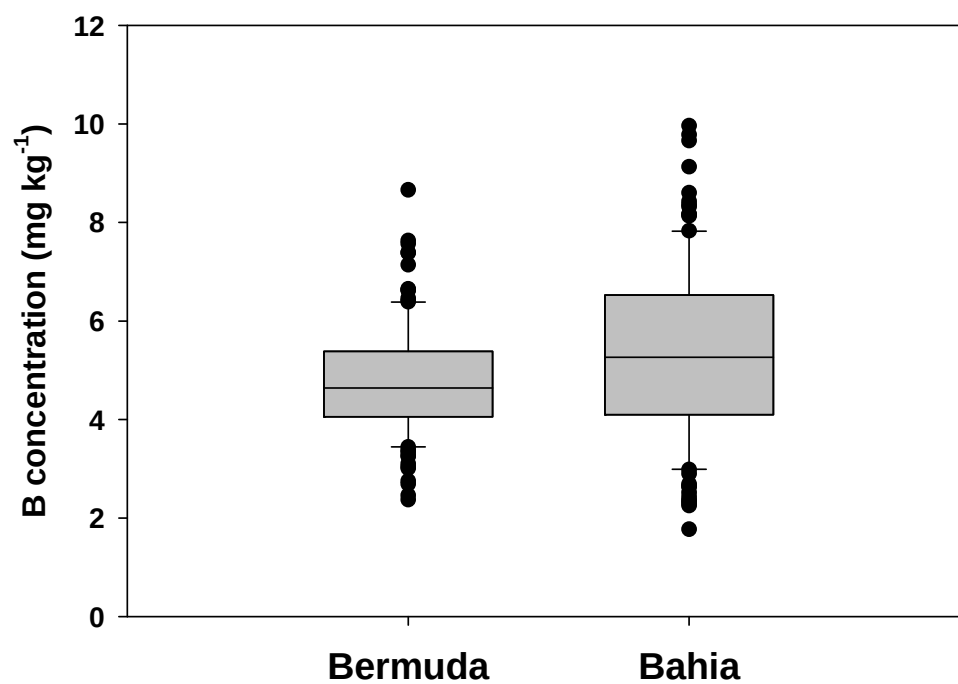
April 7th, 2016 – Prow H2O was applied in all plots at a rate of 2 qt/ac.

April 8th, 2016 – Perennial peanut monoculture plots: Clethodim (Select) (12 oz/ac + AMS at 3 gal/100 gal + crop oil surfactant at 1 gal/100 gal).

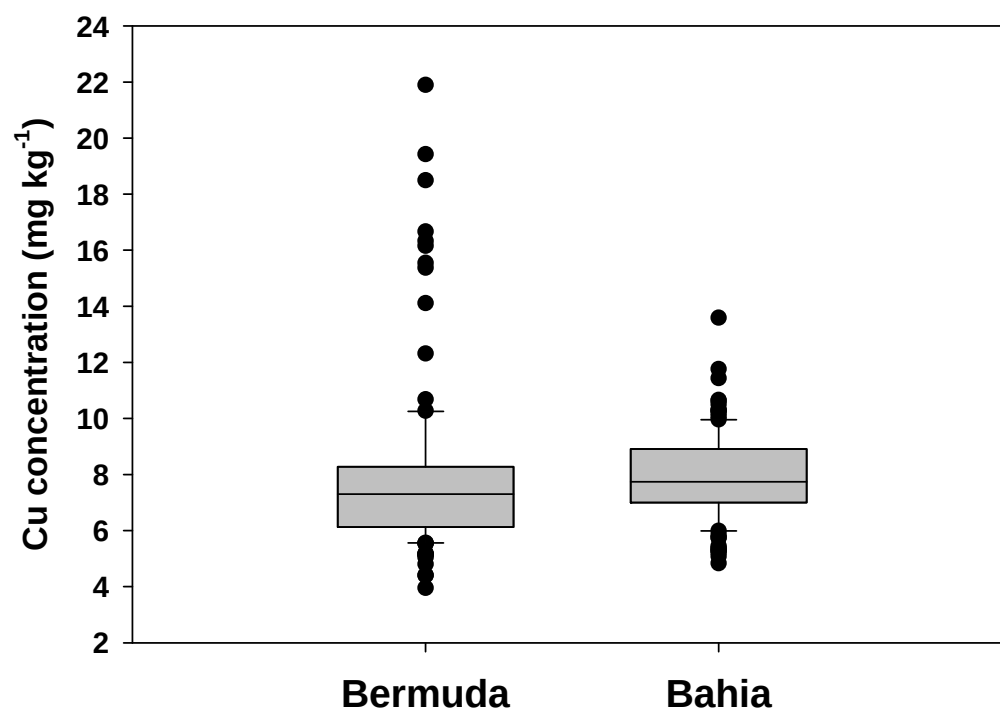
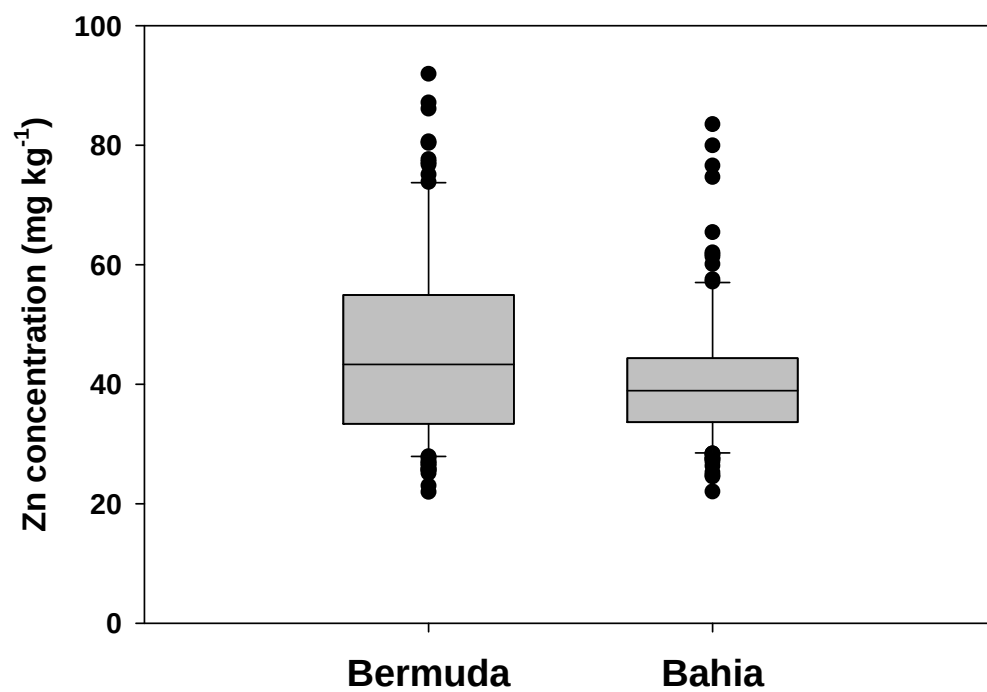
Appendix 2. Tissue concentration of forages harvested in 2015. Harvest dates and treatments were combined.



Appendix 2 continued.



Appendix 2 continued.



Appendix 3. Agronomy In-service Training program and agenda.

Agronomic In-Service Training – Locally and Distance Technology Format

Title: 2016 Agronomic In-Service Training, NFREC, Quincy

Date of In-Service: Tuesday, Jan. 19, 2016

Purpose and Objectives: Update County extension faculty on latest production techniques and issues related to agronomic crops.

Description of In-Service: An all-day course offered in person at NFREC Quincy or multi-polycom sites

Intended Audience (Goal Area/Focus Team): County extension faculty

Expected Outcomes: County faculty will increase their knowledge of emerging and new issues related to agronomic crops

Evaluation Methods to be Used: Course evaluation of each of the speakers at the end of the course.

Number of Hours of In-Service:

What is the total number of hours: 8 hours

What will be the point of origin of the In-Service: NFREC/Quincy with some speakers at remote locations with use of polycom.

Do you want this training taped for future use: If any of the faculty who are signed up want a copy we will provide that or Power Point presentations as we have done in the past.

If it is to be taped, you will need the signature of each presenter

Proposing Goal/Focus Team: Goal-Enhance and maintain agricultural, natural resource, and food systems/Focus area 1Agricultural and natural resource, industry profitability, and the sustainable use of environmental resources – agronomic row crops

Contact person: David Wright or Cheryl Mackowiak

Telephone: 850-875-7119, 850-875-7126

E-mail: wright@ufl.edu echo13@ufl.edu

Appendix 3. Continued.

Agenda:

Tuesday, Jan. 19th, 2016

9:00- 9:15 Welcome - Dr. Comerford/Wright

9:15-10:00 Peanut varieties for 2016 - Dr. Barry Tillman, UF

10-10:45 Forage updates - Dr. Ann Blount, UF

10:45-11:15 Disease management of row crops - Dr. Nick Dufault, Ext. Plant Pathologist, UF

11-11:30 Best Management Practices and conservation efforts in North Florida- Joel Love - BMP Specialist UF

11:30 -12:15 Next Generation BMPs: Soil mapping and equipment demonstration - Dr. Cheryl Mackowiak, UF

12:15-1:00 Lunch

1:00-1:45 Weed control and crop safety considerations for new 2,4-D and dicamba tolerant crops - Dr. Ramon Leon, UF

1:45- 2:15 Agronomic crop markets and outlook for 2016- Amanda Smith UGA

2:15-2:45 Making a profit with key management practices on corn, cotton and peanut - Dr. David Wright, UF

2:45-3:15 Crop insurance updates. Ms. Davina Lee, RMA, Valdosta, GA

3:15-4:00 What are ecosystem services and how can current farming system provide them - Dr. Jose Dubeux

4:00-4: 45 Climate forecast for the spring of 2016, what to expect - David Zierden, State Climatologist

4:45- 5:00 Discussion and evaluation

Appendix 4. Beef Forage Field Day Flyer and associated publication.

2016 NFREC Beef/Forage Day

Friday, April 15, 2016

UF/IFAS NFREC Beef Research Unit
(One mile west of Greenwood, FL on Hwy 162)

Schedule of events (CDT):

8:30 AM **Registration (Registration fee - \$10) and interact with exhibitors**

9:00 AM **Start morning program**

- **Reducing Nitrogen Inputs in Livestock Systems** – Jose Dubeux, UF Forage Specialist
- **Planning for Summer Forages** – Ann Blount, UF Forage Breeder
- **Bahia grass Effects on Soil Health** – Cheryl Mackowiak, UF Soils Specialist
- **Focus on Preweaning Calf Management** – Philippe Moriel, UF Beef Specialist
- **Impact of Record Keeping and Culling on Herd Profitability** – Nicolas DiLorenzo and Cliff Lamb, UF Beef Specialists

12:30 PM **Lunch and speaker**

- **Panhandle Heifer Development Program** – Kalyn Waters, UF Holmes County Extension Director and Cliff Lamb, UF Beef Specialist

1:30 PM **Start afternoon program (Choose one)**

- **Winter forage demonstration** – Ann Blount, UF Forage Breeder and Jose Dubeux, UF Forage Specialist, Cheryl Mackowiak, UF Soils Specialist and Mark Mauldin, Livestock Agent, Washington County
- **Feed Efficiency Tour and Experiment Overview**– Nicolas DiLorenzo and Cliff Lamb, UF Beef Specialists

2:30 PM **Adjourn**



For further information call 850-526-1613 or visit the NFREC website (<http://nfrec.ifas.ufl.edu/>).

University of Florida Extension/IFAS educational programs are made available to any individual without regards to race, color, sex, age, handicap or national origin. Participants with disabilities requiring special accommodations please contact Marianna NFREC at least 5 working days prior to the event.

Appendix 4 continued.

PERENNIAL FORAGES PROTECT WATER QUALITY

C.L. Mackowiak¹, J.C. Dubeux², A.R. Blount², and J. Shirley¹

¹UF-IFAS NFREC, Quincy, FL and ²Marianna, FL

Production System Effects on Nitrate Losses

Agriculture accounts for over 40% of current land-use in Jackson County, Florida, and it is its second largest industry, behind government. Jackson County also is home to one of the largest 1st-magnitude springs in the state, Jackson Blue Spring. Contaminants, including fertilizer and manure-derived nitrates, may rapidly enter groundwater leading to the spring, resulting in water quality impairment. Estimates suggest that over half of the nitrate contribution originates from agricultural production practices. The state has recently responded and is drafting a basin management action plan (BMAP) that may require large N fertilizer use reductions by neighboring farms.

The good news for Florida cattle producers is that livestock and forage production operations tend to have a lower impact on water quality than other types of agricultural production, such as row crops or production systems requiring overhead irrigation. These differences can be more than skin deep. Unlike annual crops, including cover crops, perennial forages under good management can develop incredibly deep and massive root systems. It is not uncommon to discover bahiagrass or bermudagrass roots at depths of 8 ft or more. Part of their ability to achieve greater depth is the longer period of time (years instead of months) to develop deep roots. Deeper roots translate into a greater ability to mine soil nutrients, especially nitrogen, in the form of ammonium and nitrate nitrogen (NH₄-N and NO₃-N), respectively.

We have the unique ability to core soils to depths of twenty feet or greater, in order to determine the long-term impact of different production systems on nutrient movement and leaching risks. We have sampled locations where the same production systems have been in operation for a decade or more. We have also sampled a minimally disturbed, natural area to represent what soil conditions may have been prior to agriculture in the area. In spring 2014, soil cores (2 cm diameter and approximately 6 m depth) were collected from nine agricultural sites (mostly forage-based agriculture) and one natural site in Jackson County. These sandy and loamy sand Ultisols were sampled at each location, represented by two soil cores. Cores were air-dried, and passed through a 2 mm sieve. Inorganic nitrogen (NH₄-N and NO₃-N) were extracted with 2 M KCl. Only the NO₃-N data will be discussed. As a point of reference, NO₃-N $\geq$ 10 ppm (mg L⁻¹) in water may be of concern to long-term, public health.

In Figure 1, there are two graphs representing different production systems. The upper panel includes a natural system (dominated by pine and a native vegetation understory), with low (< 2 mg kg⁻¹ or ppm) NO₃-N throughout the 6 m (20 ft) profile depth. The other non-irrigated systems in the upper panel consist of a bahiagrass pasture and different perennial forage hay systems. The bermudagrass hay field registered soil NO₃-N values below 4 ppm, while the perennial peanut (*Arachis*) field had soil NO₃-N below 10 ppm. In comparison, the bahiagrass hay field and

improved pasture were associated with subsoil $\text{NO}_3\text{-N}$ values that peaked at 12 and 20 ppm, respectively. It is noted that the bermudagrass hay field was managed with relatively low N inputs (< 200 lbs N/A per season) and only one or two cuttings per season. As these data represent a snapshot of current soil conditions, additional research is being conducted to determine if the deep soil $\text{NO}_3\text{-N}$ represents fertilizer and cattle contributions within a single production season (short-term effects) or if it is representing a longer progression, over many years. Answering these and related questions requires dedicated, long-term research and financial support.

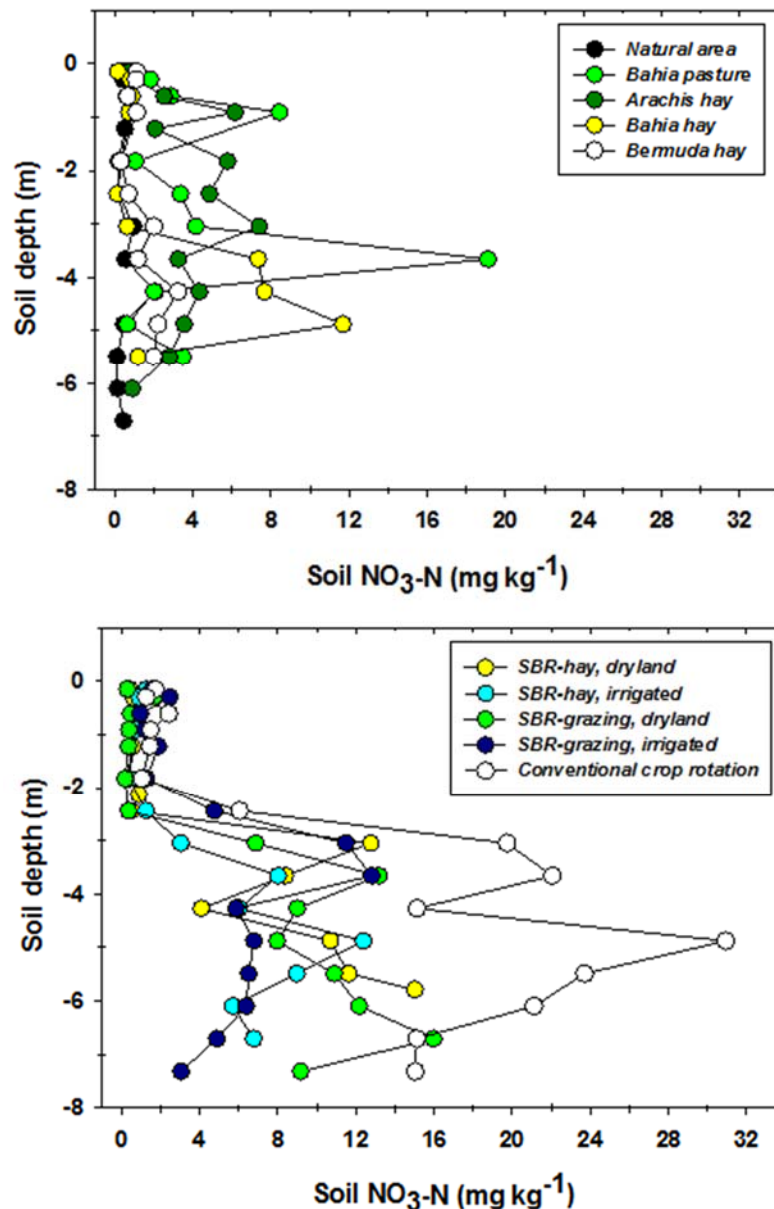


Figure 1. Soil nitrates (each symbol is an average of two samples collected in spring, 2014) under different management schemes at farms within the Jackson Blue spring watershed, Jackson County, FL. Locations in the upper panel were under dryland (non-irrigated) management. SBR = sod-based rotation (bahia grass-bahia grass-peanut-cotton rotation).

If 20 ppm soil NO₃-N sounds like a high value, consider the NO₃-N contributions from a conventional, irrigated, row crop (cotton-peanut rotation) production system. In the lower panel, the conventional system not only peaked over 30 ppm NO₃-N, the values remained at or above 20 ppm NO₃-N at several sampling depths. In comparison, under a sod-based crop rotation (SBR) system (bahiagrass is included as a 2-year rotation within the row crop rotation schedule); subsoil NO₃-N was less than 50% of the conventional row crop system. The bahiagrass in the SBR can be managed as a hay crop or grazed and managed as pasture. Figure 1 (lower panel) represents bahiagrass under both management schemes.

Agriculture helps to maintain greenspace and provides additional ecosystem services that other land uses do not. These data demonstrate that beef and forage production systems are likely more protective of water quality than row crop production. However, by managing row crops as a SBR system (utilizing sod-forming, perennial grasses), we can mitigate some of the water quality problems that are attributed to row crop agriculture, without imparting economic hardship on the grower.

Conserving Nitrogen with Enhanced Efficiency Fertilizers (EEFs)

We can reduce nitrate losses further in forage systems by controlling N fertilizer inputs. Enhanced efficiency fertilizers (EEFs) are gaining interest, particularly where agriculture is adjacent to environmentally sensitive areas. Urea is one of the most readily available dry N fertilizer sources in North Florida. However, urea is prone to NH₃ volatilization as it converts to ammonium, by urease enzymes. Additional N leaching losses can occur as soil ammonium oxidizes to nitrate. Urease and nitrification inhibitors slow the aforementioned processes, thereby reducing gaseous and leaching losses, respectively. There are many different EEFs available nationally, but individual fertilizer distributors typically carry only one product. Additionally, there are many claims but sometimes there are also conflicting reports on effectiveness of specific products.

Organic fertilizers, such as municipal wastewater biosolids, are considered EEFs, because nutrients are released slowly, over time. Class AA biosolids (previously known as municipal sludge) are registered as fertilizer-grade in Florida, and therefore can be used on-farm as a fertilizer without the need for a nutrient management plan (NMP), whereas lower grade biosolids (Class B) will require a NMP. Pelleted class AA biosolids flow similarly to mineral fertilizer and can be applied by spreader truck. A small proportion of plant-available N is released soon after application, while the majority of biosolids N is released slowly, during the growing season. In addition to N, biosolids supply ample amounts of phosphorus and other macronutrients, except for potassium (potash). They also supply micronutrients (trace elements) that are often deficient in Florida soils. A yearly (or every few years) application of biosolids may benefit worn out (nutrient depleted) soils.

Two locally available EEF fertilizers and Class AA biosolids (GreenEdge[®]) were compared against uncoated urea and a control (received no nitrogen) plots on-farm in existing bermudagrass and bahiagrass hay fields. The first coated urea product was Environmentally Smart Nitrogen[®] (ESN), a polymer coated urea (Agrium U.S. Inc., Denver, CO) that is purported to provide slow N release. Arborite[®], a urease inhibiting N-(n-butyl) thiophosphoric triamide or NBPT (Weyerhaeuser Co., Federal Way, WA) that acts as a urease inhibitor, was the other coated urea product tested. The entire season of biosolids was applied initially (2 tons/A), while 80 lbs N as urea products, was applied initially and following each cutting (except the last cutting). There were

5 hay cuttings in 2014. Ammonia losses were measured, using traps constructed from plastic soda bottles containing an acid solution to absorb ammonia gas. Once in the acid, the ammonia (NH_3) converts to ammonium ($\text{NH}_4\text{-N}$), which can be analyzed for N. Forage and soil N data from 2015 are being processed. This report provides comparisons of forage production and estimated $\text{NH}_3\text{-N}$ losses across treatments for one of the bahiagrass fields and one of the bermudagrass fields in 2015.

The Arborite (NBPT-based urease inhibitor) fertilizer trended towards lower bahiagrass yields at this field (Figure 2), but not at the other bahiagrass field. As expected, the yields peaked in July and early August, with declining yields in fall, regardless of treatment. In this case, uncoated urea was as effective as the coated products and the seasonal yield from a single biosolids application was as good as using mineral N fertilizers.

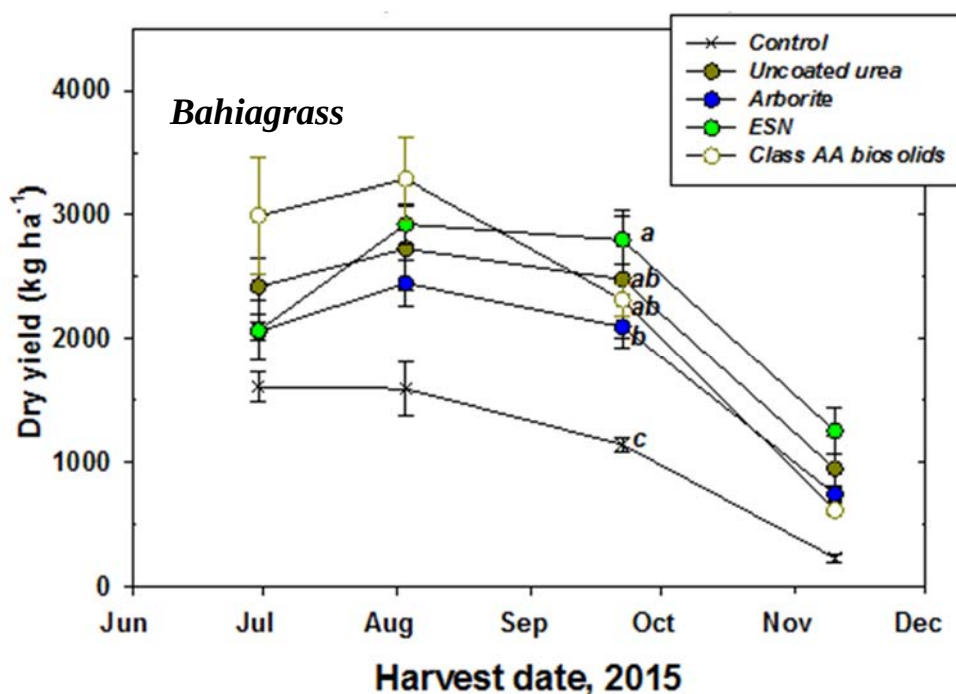


Figure 2. Bahiagrass forage production over time. Lower case letters that are different represent different yield responses over the course of the entire season. Each symbol represents 3 replications. Vertical bars = standard error of the mean.

As expected, bermudagrass (Tifton-85) yields were greater than bahiagrass yields, but again, the Arborite trended slightly lower in this bermudagrass field, at least initially. The biosolids treatment resulted in significantly less grass than the urea products, particularly after August (Figure 3). This suggests that a single 2 tons/A biosolids application does not provide enough mineralized N to support high forage yields through an entire season.

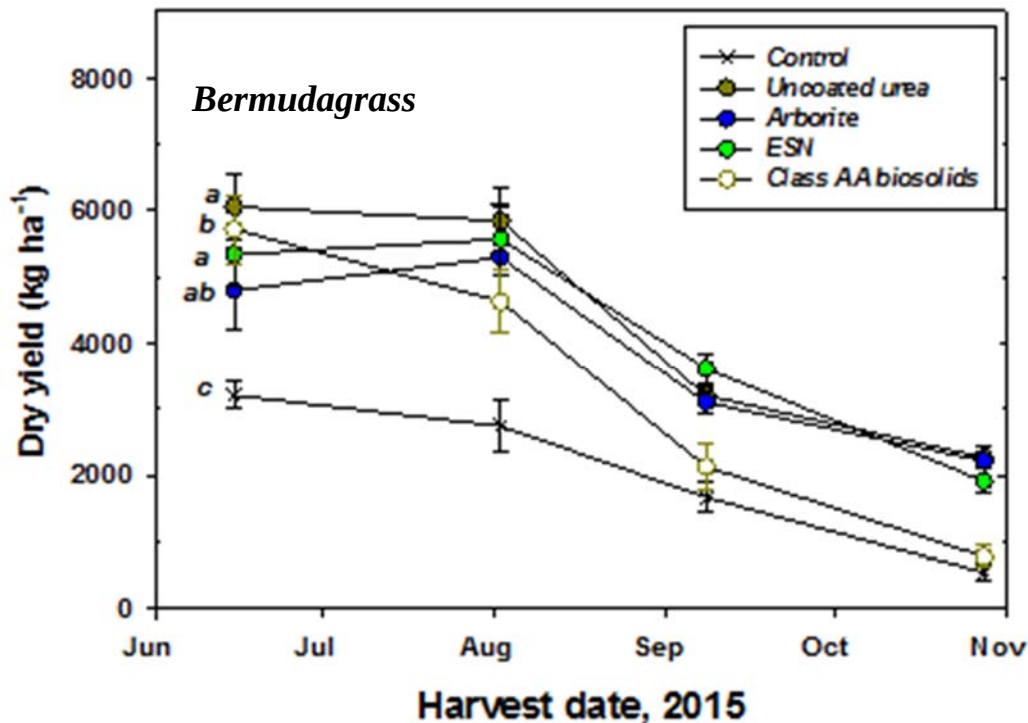


Figure 3. Bermudagrass forage production over time. Lower case letters that are different represent different yield responses over the course of the entire season. Each symbol represents 3 replications. Vertical bars = standard error of the mean.

Total seasonal $\text{NH}_3\text{-N}$ losses were similar among urea products, but greater short-term losses were measured after each N application with the uncoated urea and Arborite products, as noted by the small jumps in cumulative rates at each red arrow, representing mineral N additions (Figures 4 and 5). The biosolids were applied only once and NH_3 volatilization ended in August, near the time when forage became less responsive to this treatment. The ESN (polymer coated urea) often trended highest in cumulative NH_3 loss. This was an unexpected finding. The polymer coating allows for slow N release, so once out of the coating, it likely remains susceptible to volatilization.

At worst total N loss due to volatilization from urea products were between 40 and 50 kg ha^{-1} , or 13 to 16% of total N applied in 2015. At \$0.62 N per pound, about \$28 per acre in fertilizer losses may be realized. That cost might cover one or more herbicide applications. Most $\text{NH}_3\text{-N}$ losses occurred with the July application, when conditions were more conducive to urea volatilization. Conversely, even greater N losses may occur through leaching with uncoated urea. The coatings may reduce N leaching losses by reducing the amount of $\text{NO}_3\text{-N}$ in the soil at any given time. The soil and tissue N content data are being processed. It will be interesting to learn if coatings help lessen N leaching losses. Stay tuned to for updates on this project. It will continue through 2016.

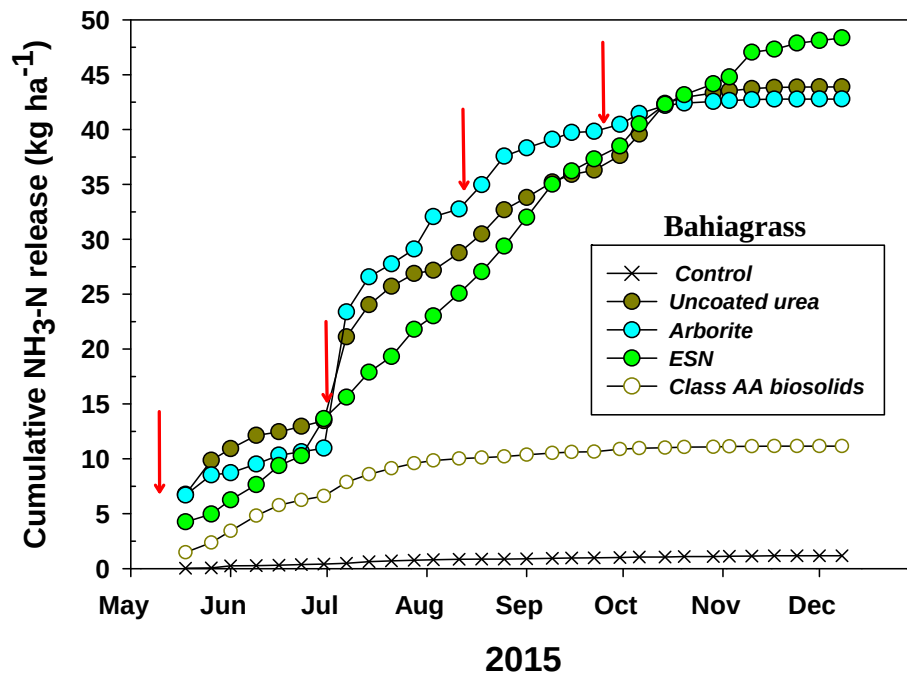


Figure 4. Cumulative bahiagrass NH_3 volatilization losses over time. Each symbol represents 3 replications. Arrows represent N fertilizer application dates.

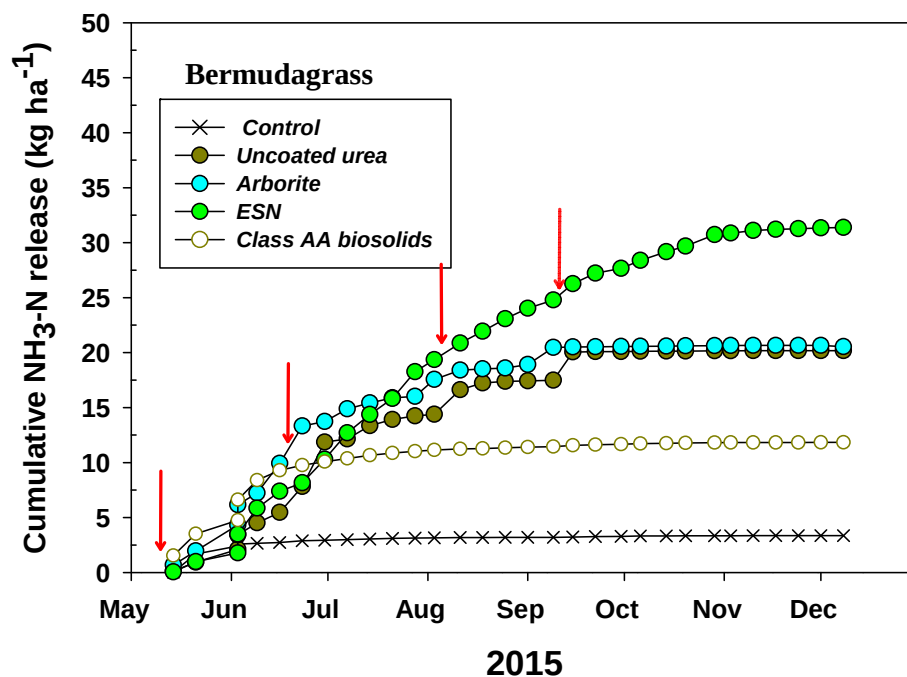


Figure 5. Cumulative bahiagrass NH_3 volatilization losses over time. Each symbol represents 3 replications. Arrows represent N fertilizer application dates.