Technical Note

USDA –Natural Resources Conservation Service
Booneville Plant Materials Center

Plant Materials Technical Note March 2007

CP 512 – Pasture & Hay Planting

Dry-Matter Production of Eight Grass Species With Three Levels of Poultry Litter

SUMMARY

A three-year study was conducted at the USDA-Natural Resources Conservation Service, Booneville Plant Materials Center in Booneville, AR. The study purpose was to evaluate the effects of three poultry litter rates (0-, 4-, and 8-ton/A) on dry-matter production of perennial warm- and cool-season native and introduced grass species and a cool- and warm-season annual combination.

CONCLUSIONS

~ Land application of poultry litter increased dry-matter production of native and introduced grass species.
~ Generally, the warm-season perennial grasses produced more dry-matter than the cool-season perennial species.
~ The majority of dry-matter, regardless of species, was produced during the first one-half of the growing season.
~ Differences in dry-matter production were more pronounced and greater between 0- and 4-ton/A than mean differences observed between 4- and 8-ton/A poultry litter rates.
~ The cool- and warm-season annual combination of rye, ryegrass, and forage sorghum produced 2.82 ton/A more dry-matter than eastern gamagrass and 3.31 ton/A more dry-matter than bermudagrass at the 4- and 8-ton/A litter rates, respectively.
~ Annual grass or grain crops may be used in the production of livestock forage. This is predicated on suitable soils which are not subject to extensive soil erosion and also rainfall patterns which are conducive to seed germination and crop growth and sustainment.

INTRODUCTION

Studies have been conducted using poultry litter on cool- and warm-season grass species however, limited information exists using variable rates of land-applied litter for both cool- and warm-season native grass species.

Land-applied poultry litter may be used as a crop fertilizer, which tends to limit the problems associated with litter accumulation. Poultry litter has a beneficial impact on yield of tall fescue (*Festuca arundinacea* Schreb.) (Hunneycutt et al., 1988), orchardgrass (*Dactylis golmerata*) (Hilman, 1973), bermudagrass [*Cynodon dactylon* (L.) Pers.] (Hunneycutt et al., 1988; Read et al., 2006; Brink et al., 2004). Swine effluent was applied to eastern gamagrass, switchgrass, and Indiangrass (McLaughlin et al., 2004) and dairy manure linearly increased production of 'Alamo' switchgrass (Sanderson et al., 2001).

This three-year study was conducted to determine the effects of three rates poultry litter applied to four warm-season, three cool-season grass species and a combination of a warm- and cool-season annual on total seasonal dry-matter production.

METHODS and MATERIALS

The study was located at the NRCS Plant Materials Center, Booneville, AR. The study was conducted on a Taft silt loam (fine-silty, ciliceous, Thermic Glossaquic Fradiuoults) soil. Three poultry treatments consisted of a control (0), 4, and 8 tons of litter/acre on a dry weight basis. The 4 ton/A poultry litter rate was broadcast-applied as a single application in April and October for the warm- and cool-season grass species, respectively. The 8-ton litter rate was applied as two 4-ton/A split applications in April and June for the warm-season species and October and April for the cool-season species. Nutrient analysis of the poultry litter was approximately 80.1, 68.8, and 54.3 lb/ton for nitrogen, phosphorus, and potassium, respectively.

Individual grass and fallow randomized subplot sizes were 10 by 20 feet. Warm-season perennial grass species included 'Alamo' switchgrass (*Panicum virgatum* L.), 'T-587' Old World bluestem(*Bothriochloa caucasica)* C. E. Hubb.), 'Pete' eastern gamagrass [*Tripsacum dactyloides* (L.) L.], and 'Midland' bermudagrass. Cool-season perennial species consisted of 'Palaton' reed canarygrass (*Phalaris arundinacea* L.), 'Martin' tall fescue, and 'Boone' orchardgrass.

A cool- and warm-season annual subplot included a combination of 'Marshall' ryegrass (*Lolium multiflorum* Lam.)and 'Elbom' rye (*Secale cereale* L.) planted in the early fall and a forage sorghum [*Sorghum bicolor* (L.) Moench] planted in early summer. Establishment seeding rates for subplots were based on NRCS and University of Arkansas Extension Service recommendations. A 4.5-inch row spacing was used for seeded species. Bermudagrass was vegetatively established and sprigged on 1-foot centers. Eastern gamagrass seed was germinated in a greenhouse and transferred to subplots with a 1.5-foot row spacing and a 1-foot spacing between plants within the row. Cool-season perennials were seeded in March and warm-season perennials were established in June of the establishment year.

Litter was applied on the cool- and warm-season fallow subplots at the same rate and on similar dates as the grass subplots. The fallow plots were maintained free of plant material throughout the study.

Harvest regimes for seasonal distribution and total dry-matter production were based on best management practices for maximizing production and/or hay production for individual grass species. Clipping height for grass species were: 6 inches for switchgrass, 4 inches for Old World bluestem and sorghum, 8 inches for eastern gamagrass, 2 inches for bermudagrass, and 3 inches for tall fescue, orchardgrass, reed canarygrass, and rye, ryegrass combination.

Grab samples were obtained from subplots after each harvest for dry-matter determination. Results are reported on an oven dry-weight basis.

RESULTS and DISCUSSION

Seasonal dry-matter (DM) means (Table 4) for the observed grass species ranged from 0.82 to 3.41 ton/A for the control (0 litter); 3.57 to 9.35 ton/A for the 4-ton/A litter application; and 5.76 to 12.23 ton/A for the 8-ton/A rate. Yield response was observed for individual grass species with each additional 4-ton/A increment of litter. Greater responses were observed between the 0- and 4-ton/A rates than between the 4- and 8-ton/A rates. Averaged over species, increases between the 0 and 4-ton/A rate were 66.7% compared to increases between the 4- and 8-ton/A rates of 24.6%.

Greater responses were observed between the 0- and 4-ton/A rate for tall fescue (77.8%) and Old World bluestem (77.0%) than for other species. Dry-matter yield increase for eastern gamagrass was lower (49.7%) than for increases in production of other species with the addition of 4-ton/A of litter.

Generally, dry-matter increased from Year 1 through Year 3 for the perennial species. This observation is due to the plant material from which the samples were taken becoming better established and developing more extensive root systems. This fact would not hold true for the cool- and warm-season annual since these were established as a new crop at the beginning of each growing season.

At the 0 litter rate (3 year average), reed canarygrass produced more dry-matter than other cool-season species. Yields for tall fescue (5.04 ton/A) and orchardgrass (5.01 ton/A) were similar and higher than for reed canarygrass (4.22 ton/A) at the 4-ton/A rate. The 8-ton/A litter rate produced similar yields for tall fescue, reed canarygrass, and orchardgrass 6.54, 6.88, and 6.16 ton/A, respectively. Cool-season perennial species, tall fescue, reed canarygrass, and orchardgrass produced lower dry-matter yields than bermudagrass, eastern gamagrass, and switchgrass at the 4- and 8-ton/A litter rates.

The cool- and warm-season annual combination produced higher dry-matter yields at the 0-, 4-, and 8-ton/A litter rates, 3.41, 9.35, and 12.23 ton/A, respectively, than other grass species. This was primarily due to the utilization of 2 growing seasons for this combination. There was a dry-matter increase of 6.21 and 2.88 ton/A between the 0- and 4- and 4- and 8-ton/A litter rates, respectively. The warm-season annual (3-year average) contributed over 67.2% of the total dry-matter yield. Annual grass or grain crops may be used in the production of livestock forage. This is predicated on suitable soils which are not subject to extensive soil erosion and also rainfall patterns which are conducive to seed germination and crop growth and sustainment.

The warm-season grass species, bermudagrass, eastern gamagrass, and switchgrass, produced more dry-matter than the cool-season grasses at 4- and 8-ton/A of poultry litter. Eastern gamagrass produced 3.29 ton/A dry-matter which was 46.8% higher than bermudagrass or switchgrass at 1.75 ton/A. The warm-season species at the 4- and 8-ton/A litter rate produced an average of 1.6 and 1.64 ton/A, respectively, more dry-matter than the cool-season grasses. Increases in dry-matter production for warm-season species were greater between the 0- and 4-ton/A (64.1%) than between the 4- and 8-ton/A (22.6%) litter rates. Dry-matter production at the 4-ton/A litter rate was similar for bermudagrass, eastern gamagrass, and switchgrass with 6.21, 6.53, and 6.27 ton/A, respectively, and similar at the 8-ton/A litter rate for bermudagrass and switchgrass with 8.92 and 8.11 ton/A, respectively.

Table 1. Seasonal dry-matter yields of grass species as influenced by 0-, 4-, and 8-tons of applied poultry litter. Year 1.

	Litter application rate (tons/ac)		
Species	0	4	8
	----------DM tons/acre----------		
Cool and warm-season annual	5.38	11.47	13.45
Bermudagrass	2.01	6.47	9.26
Tall Fescue	1.05	4.11	5.59
Reed Canarygrass	1.77	3.82	5.78
Old World Bluestem	0.83	3.43	3.69
Eastern Gamagrass	3.02	4.41	5.04
Orchardgrass	1.19	3.45	5.95
Switchgrass	2.37	5.63	6.85

Table 2. Seasonal dry-matter yields of grass species as influenced by 0-, 4-, and 8-tons of applied poultry litter. Year 2.

	Litter application rate (tons/ac)		
Species	0	4	8
	----------DM tons/acre----------		
Cool and warm-season annual	2.71	8.02	10.25
Bermudagrass	1.64	7.41	9.21
Tall Fescue	2.22	5.98	7.07
Reed Canarygrass	2.41	5.68	6.24
Old World Bluestem	0.51	4.98	6.68
Eastern Gamagrass	4.18	7.93	9.19
Orchardgrass	1.82	5.69	6.52
Switchgrass	1.45	5.86	7.83

Table 3. Seasonal dry-matter yields of grass species as influenced by 0-, 4-, and 8-tons of applied poultry litter. Year 3.

Species	Litter application rate (tons/ac) 0	4	8
	----------DM ton/acre----------		
Cool and warm-season annual	2.16	8.55	12.99
Bermudagrass	1.61	4.74	8.13
Tall Fescue	0.84	5.03	6.95
Reed Canarygrass	1.39	6.97	8.62
Old World Bluestem	1.14	5.72	6.91
Eastern Gamagrass	2.66	7.25	7.95
Orchardgrass	1.21	5.86	6.34
Switchgrass	1.44	7.31	9.66

Table 4. Three year means for dry-matter yields of grass species as influenced by 0-, 4-, and 8-tons of applied poultry litter.

Species	Litter application rate (tons/ac) 0	4	8
	----------DM tons/acre----------		
Cool and warm-season annual	3.41	9.35	12.23
Bermudagrass	1.75	6.21	8.92
Tall Fescue	1.12	5.04	6.54
Reed Canarygrass	1.86	4.22	6.88
Old World Bluestem	0.82	3.57	5.76
Eastern Gamagrass	3.29	6.53	7.39
Orchardgrass	1.41	5.01	6.15
Switchgrass	1.75	6.27	8.11

LITERATURE CITED

Brink, G.B., K.R. Sistani, and D.E. Rowe. 2004. Nutrient uptake of hybrid and common bermudagrass fertilized with broiler litter. Agron. J. 96:1509-1515.

Hileman, L.H. 1973. Response of orchardgrass to broiler litter and commercial fertilizer. Rpe. Ser. 207, Arkansas Agricultural Experiment Station, University of Arkansas, Fayetteville, AR.

Hunneycutt, H.G., C.P. West, and J.M. Phillips. 1988. Responses of bermudagrass, tall fescue and tall fescue-clover to broiler litter and commercial fertilizer. Bull. 913,

Arkansas Agricultural Experiment Station, University of Arkansas.

McLaughlin, M.R., T.E. Fairbrother, and D.E. Rowe. 2004. Nutrient uptake by warn-season perennial grasses in a swine effluent spray field. Agron. J. 96:484-493.

Read, J.J., G.E. Brink, J.L. Kingery, and K.R. Sistani. 2006. Effects of broiler litter and nitrogen fertilization on uptake of major nutrients by ‘Coastal’ bermudagrass. Agron. J. 98:1065-1072.

Sanderson, M.A., R.M. Jones, M.J. McFarland, J. Stroup, R.L. Reed, and J.P. Muir. 2004. Nutrient movement and removal in a switchgrass biomass-filter strip system treated with dairy manure. J. Environ. Qual.30:210-216.