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Six Year Results from a Longleaf and Slash Pine At-Planting Poultry Litter and Diammonium Phosphate Application Trial in Two Old-Field Sites

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INTRODUCTION

The private non-industrial forest landowner (NIPFL) sector has become increasingly interested in using commercial and other fertilizer materials such as poultry litter to fertilize pine stands. There is an abundance of forestland in Georgia (approximately 2/3 of Georgia is forested). Pine plantations often respond to fertilization with commercial and other organic fertilizer materials. Principle limitations to poultry litter applications in pine plantations include ground access, turn-around areas, hauling distance, and spreader/tractor availability. Landowners who are interested in poultry litter applications in their pine plantations may plan for pine spacings (6'x10' or 8'x8' with 14' between the rows every 4th or row, 6'x12', and other variations) to allow a tractor/spreader to be driven through the woods periodically prior to a first thinning.

OBJECTIVES

To determine (1) slash and longleaf pine survival and early growth effects of poultry litter applied prior to planting compared to no fertilizer material and diammonium phosphate (DAP @ 250 lbs/acre) and (2) the growth rate of longleaf versus slash pine poultry litter or DAP versus no fertilizer material at planting.

PROJECT DESCRIPTION

The demonstration sites are located in Tattnall County, Georgia on former corn and soybean fields (old-fields). The Fuquay soil series (loamy Arenic Plinthic Kandiudults) dominates the Durrence old-field site and the Blanton soil series (loamy Grossarenic Paleudults) dominates the Tootle old-field site. The sites are located (west) off GA Highway 169 approximately 3 miles south of Mendes. The experimental design is randomized complete block. The treatments on the Tootle property are: (1) control; no fertilizer treatment, (2) poultry litter @ 1.4 tons/acre (broadcast without incorporation, Table 1 and 2), and (3) DAP @ 200 lbs/acre (36 lbs/ac N and 40 lbs/ac elemental-P or 92 lbs P_2O_5/ac) with three replications per treatment. The treatments on the Durrence property are the same as the Tootle site but with a 2.8 ton/acre poultry litter application level. The Tootle old-field site had 9 plots that were followed through six years (110' wide by 99' long; 0.25 acres) installed on 21 August 2000. The Durrence old-field site had 16 plots (8 plots in planted bareroot slash and 8 plots in planted containerized longleaf pine) that were followed for six years (155.5' wide by 70' long; 0.25 acres) installed on 21 August 2000. Baseline soil (0-6", ten composite samples/plot) samples were taken in each plot on 21 August 2000 and analyzed @ UGA for extractable P, K, Ca, Mg, Zn, Mn and soil pH (Table 3). Site fertility was good on both study areas as would be expected with growing annual crops (Table 3).

Poultry litter from Mr. Durrence's broiler houses was applied on 22 August 2000 in randomly assigned plots on both sites. The litter was applied with a Barron and Brothers, Inc (manufactured in Gainesville, Georgia) rear port spreader (dual axle, dual spinners, 6" port door height) pulled by a John Deere 4240 tractor (5^{th} gear, 1800 RPMs, PTO @ 540 RPMs). A total of 42 calibration tubs were placed on the Tootle field in the poultry litter applied plots. The average application level was 1.4 tons/acre. The effective swath width was also determined with the calibration tubs. All tubs placed greater than 9' from the rear port door dropped to 4-10 grams/ft^2. It was determined that the effective swath width was 18' (9' either side of center). We therefore ran the tractor/spreader down the litter plots every 18' but starting 9' inside the plot=s length. A total of 50 calibration tubs were placed in the poultry litter applied plots on the Durrence site. Litter was collected and analyzed from the calibration tubs in the plots and were analyzed at UGA for total-N, P_2O_5, K_2O, Ca, Mg, S, Mn, B, Cu, and Zn (Table 1). The mean application level for one pass was 1.4 tons/acre and the 2 pass dose was 2.8 tons/acre (Table 2). Herbaceous weed control was performed on the Tootle property (all plots @ 3 qts Roundup/acre) prior to poultry litter application. Herbaceous weed control was performed on the Durrence site (all plots @ 3 qts Roundup Ultra + 1 qt surfactant/acre) approximately one month after the poultry litter was applied. DAP @ 200 lbs/ac was broadcast applied in 11 May 2001 to the Tootle and Durrence plots. The remaining plots were controls where no fertilizer material was applied. Subsoiling was performed in November 2000 at both sites. Containerized longleaf seedlings from International Forest Company were planted in December 2000 on 8 plots on the Durrence site by hand with tube dibbles. Slash pine seedlings were machine planted in December 2000 on the remainder of the plots. A banded application (6' wide) of 2 oz Oust/ac and 20 oz Velpar L/acre to control spring/summer herbaceous weeds in all plots was performed on both sites in April 2001. One-tenth acre internal permanent measurement plots were installed in each gross treated plot after the seedlings were planted.

Table 1. Poultry litter macro- and micro-nutrient characteristic means (range) for the one-time, pre-plant application on the Durrence and Tootle old-field sites in Tattnall County, Georgia.

Total-N	P_2O_5	K_2O	Ca	Mg	S	Mn	B	Cu	Zn
---------- lbs per ton ----------									
70 (60-76)	65 (55-76)	58 (46-64)	41 (33-48)	8.4 (6.7-10.3)	10.5 (9-12)	0.51 (.41-.63)	0.068 (.06-.08)	0.57 (.44-.66)	0.42 (.33-.52)

Table 2. Poultry litter macro- and micro-nutrient levels for the two poultry litter treatments for the one-time, pre-plant application on the Durrence and Tootle old-field sites in Tattnall County, Georgia broadcast, surface applied on 21 August 2000.

Poultry litter treatment	Total-N	P_2O_5	K_2O	Ca	Mg	S	Mn	B	Cu	Zn
---------- lbs per acre ----------										
PL 1.4	98	91	81	57	12	15	0.71	0.095	0.80	0.59
PL 2.8	196	182	162	104	24	29	1.4	0.19	1.6	1.2
Treatments: PL 1.4 = poultry litter @ 1.4 tons/ac and PL 2.8 = poultry litter @ 2.8 tons/ac.										

Table 3. Background (August 2000) surface mean (range) soil pH and available (Mehlich I) nutrient status prior to poultry litter and DAP applications and six years after treatments (March 2007) on the two old-field sites in Tattnall County, Georgia

Time (mo-yr)	Species	Property - treatment	pH	P	K	Ca	Mg	Zn	Mn	% OM
				---------- lbs/acre----------						
August 2000	na	Durrence Fuquay soil	5.7 (5.4-6.0)	100 (42-157)	76 (49-98)	509 (421-696)	64 (30-67)	5.8 (4-7)	9.1 (5-13)	1.1 (.90-1.6)
	na	Tootle Blanton soil	5.7 (5.5-6.0)	29 (24-32)	45 (37-58)	391 (324-498)	43 (24-48)	1.5 (1-2)	13 (12-14)	0.80 (.67-1.0)
March 2007	longleaf	Durrence								
		C	5.4	104	43	446	40	7	10	
		DAP	5.4	94	51	443	46	7	14	
		PL 1.4	5.4	117	70	400	47	6	13	
		PL 2.8	5.5	173	50	600	46	9	11	
	slash	Durrence								
		C	5.4	98	53	492	49	7	16	
		DAP	5.3	79	38	473	43	7	16	
		PL 1.4	5.3	109	42	419	36	6	17	
		PL 2.8	5.4	99	48	466	42	8	19	
	slash	Tootle								
		C	5.3	32	25	222	20	3	27	
		DAP	5.4	47	21	228	20	3	34	
		PL 1.4	5.6	53	27	380	29	4	39	

C = control, no treatment, DAP = 200 lbs diammonium phosphate/ac applied 6 months post-plant, PL1 = poultry litter @ 1.4 tons/ac and PL 2.8 = poultry litter @ 2.8 tons/ac broadcast and surface applied 4 months pre-plant.

SIX YEAR RESULTS

Longleaf pine

Mean d.b.h. and total height for the control and DAP treatments were not significantly different after six growing seasons (Table 4) and were significantly greater than the poultry litter @ 1.4 tons/ac treatment. The DAP treated longleaf plots on the Durrence site had significantly greater volume per tree (0.637 ft^3) than the control (0.537 ft^3) and the control had significantly greater volume per tree than the low (0.242 ft^3) and the high (0.437 ft^3) poultry litter treatments trees (Table 4). There were no significant mortality differences between treatments; ranging from 4.8 (poultry litter @ 2.8 tons/ac) to 7.4 percent (poultry litter @ 1.4 tons/ac, Table 4). Stem canker incidence was not significantly affected by treatment for the longleaf and was low (0 for the poultry litter @ 1.4 tons/ac, 2 for the DAP, and poultry litter @ 2.8 tons/ac, and 3 percent for the control).

Slash pine

There were no significant differences between treatments on both the Durrence and Tootle sites for d.b.h., total height, volume per tree, and mortality after six growing seasons (Table 4). Mean tree d.b.h., (4.4 inches) total height (22.2 feet), and volume per tree (1.30 ft^3) through age 6-years on the Durrence site were 13, 7, and 35 percent greater than on the Tootle site, respectively. This may be due to a number of factors including; (1) better soils (in particular depth to argillic; the Fuquay is 25-35" and the Blanton is 50-65"), (2) slightly better baseline soil fertility, and (3) possibly better competition control post-planting (not documented). Mortality ranged from 5.9 (poultry litter @ 1.4 tons/ac) to 19.5 percent (poultry litter @ 2.8 tons/ac) on the Durrence property and 4.8 (DAP) to 8.6 percent (poultry litter @ 1.4 tons/ac) on the Tootle site (Table 4). Stem canker incidence did increase by treatment with 6 percent for the control, 8 percent of the poultry litter @ 1.4 tons/ac, 9 percent for the poultry litter @ 2.8 tons/ac, and 10 percent for the DAP on the Durrence site. Stem canker incidence on the Tootle property was approximately one-half of that on the Durrence site (3 percent for the DAP and 4 percent for the control and poultry litter @ 1.4 tons/ac) as well as mortality (6.3 versus 13.7 percent, Table 4).

Table 4. Six year slash and longleaf growth results (December 2000 – March 2007) from the pre-plant poultry litter and post-plant DAP applications on the Durrence and Tootle old-field sites in Tattnall County, Georgia

Site – Soil series	**Species**	**treatment**	**Dbh (in)**	**Height (ft)**	**Volume per tree ($ft3^{\dagger}$)**	**Mortality (%)**
Durrence - Fuquay	longleaf	Control	3.2 ab*	16.1 a	0.537 b	6.5
		DAP	3.4 a	17.1 a	0.637 a	4.7
		PL 1.4	2.4 c	12.2 c	0.242 d	7.4
		PL 2.8	3.0 b	14.6 b	0.437 c	4.8
	slash	Control	4.4	22.0	1.31	12.6
		DAP	4.3	22.2	1.25	16.8
		PL 1.4	4.5	22.4	1.39	5.9
		PL 2.8	4.3	22.1	1.25	19.5
Tootle - Blanton	slash	Control	4.0	21.1	1.04	5.4
		DAP	3.7	20.7	0.87	4.8
		PL 1.4	3.9	20.6	0.97	8.6

Treatments: Control = no treatment, DAP= diammonium phosphate @ 200 lbs/ac, PL 1.4 = poultry litter @ 1.4 tons/ac, PL 2.8 = poultry litter @ 2.8 tons/ac

† Volume/tree for longleaf and slash estimated using equation (for slash pine); $TV = 0.00616 \times D^{2.0568} \times Ht^{0.7468}$

*Growth parameter means followed by a different letter are significantly different using Duncan's Multiple Range test at the 5 percent alpha level by species and site.

Longleaf versus slash pine growth through six years

Longleaf pine mean (across the four treatments) d.b.h. (3.0 inches), total height (15.0 feet), and volume per tree (0.446 ft^3) were 46, 48, and 191 percent less than the slash pine d.b.h. (4.4 inches), total height (22.2 feet), and volume per tree (1.30 ft^3), respectively (Table 4) on the Durrence site. Longleaf pine mortality (longleaf pines were re-planted after the first growing season in any spots where there was mortality, whereas there was no slash pine re-planting) averaged 6.3 percent while slash pine mortality averaged 13.7 percent on the Durrence site.

SUMMARY

Based on stand conditions for both the longleaf and slash pine on these relatively fertile old-field sites through six years, pine straw could be raked at the end of the 7th of 8th year for slash pine and at the end of the 10th year for the longleaf pine. For longleaf, post-plant DAP seems to be the best fertilizer choice, where fertilization is warranted, as it had a significantly greater volume per tree than the poultry litter and control treatments (but not significantly greater d.b.h. and total height than the control). There were no fertilizer treatment (DAP or the poultry litter) that significantly improved slash pine growth though six years on both sites. Slash pine survival was reduced with the DAP and poultry litter @ 2.8 tons/ac on the Durrence site and the poultry litter @ 1.4 tons/ac on the Tootle site.

RECOMMENDATIONS

On fertile old-field sites, fertilization is usually not recommended at planting for slash and longleaf pine. If soil test available P is greater than 12 lbs/ac (6 parts per million), which is almost always the case, and the N and K fertilization history has been consistent, then N, P, and K are not warranted until the stand has reached first thinning age or older. Using well established fertilization diagnostic tools: soil and foliage sampling, leaf area estimation, growth rate estimates, and soils knowledge can aid in determining if the stand will respond to fertilization once the stand has occupied the site. Herbaceous weed control prior to and the first year after planting are more critical in maximizing survival and early growth on these sites by improving soil moisture and nutrient resources to the planted seedlings.

Photos 1, 2, and 3. Tootle site (Blanton soil); slash pine control plot (upper left), DAP plot (upper right), and poultry litter @ 1.4 tons/ac (lower left) starting seventh year. Poultry litter applied August 2000, subsoiled November 2000, site planted December 2000, banded herbicide applied April 2001, and DAP applied May 2001.

Photos 4, 5, 6, and 7. Durrence site (Fuquay soil) slash pine control (upper left), DAP treatment (upper right), poultry litter @ 1.4 tons/ac (lower left), and poultry litter @ 2.8 tons/ac (lower right) starting seventh year (March 2007). Poultry litter applied August 2000, subsoiled November 2000, site planted December 2000, banded herbicide applied April 2001, and DAP applied May 2001.




Photos 8, 9, 10, and 11. Durrence site (Fuquay soil) longleaf pine control (upper left), DAP treatment (upper right), poultry litter @ 1.4 tons/ac (lower left), and poultry litter @ 2.8 tons/ac (lower right) starting seventh year (March 2007). Poultry litter applied August 2000, subsoiled November 2000, site planted December 2000, banded herbicide applied April 2001, and DAP applied May 2001.

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CITATION

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