

Impact of a Broiler Litter and DAP+Ammonium Nitrate Application in an Old-field Thinned Slash Pine Stand in Mitchell County, Georgia – Four Year Growth Results

E. David Dickens - Forest Productivity Associate Professor, David J. Moorhead - Silviculture Professor, Bryan C. McElvany – Treutlen County Extension Coordinator, Brad Mitchell – Mitchell County Extension Coordinator, and W. Ed Harrison – Mitchell County Extension Agent - UGA Warnell School of Forestry and Natural Resources and College of Agriculture and Environmental Sciences
E-mail: ddickens@uga.edu

Introduction

This study examined old-field slash pine growth responses in a recently thinned stand to treatments of broiler litter and diammonium phosphate (DAP) plus ammonium nitrate. Comparisons were made between single applications of broiler litter, a single application of DAP+ammonium nitrate, annual applications of broiler litter, and a non-treated control. All treatment materials were broadcast across in randomly assigned plots. Broiler litter applications were tested using two delivery methods; a side-delivery manure spread broadcast the litter into the selectively thinned rows of the residual trees while application using the rear-delivery spreader broadcast the litter into the removed (“take”) row between the selectively thinned rows on residual trees.

Study area and experimental design

The Mitchell County, Georgia site was a former old-field site of slash pine planted in 1980 on Bonneau (well or somewhat excessively drained, loamy, Arenic Paleudults), Wagram (well drained, loamy, Arenic Kandudults), and Troup (somewhat excessively drained, loamy Grossarenic Kandudults) soils, and thinned in 1999 (5th row with select). There were three replications of four treatments in a randomized complete block experimental design. The treatments (Table 1) were:

- (1) no treatment (Control),
- (2) DAP+ammonium nitrate (NP),
- (3) one-time broiler litter rear port (One-time R),
- (4) one-time broiler litter side port, (One-time S) and
- (5) annual broiler litter (Annual litter)

Each gross treated plot was ½ acre with a 1/3 acre internal permanent measurement plot (IPMP) centered within each gross plot. There were 40 feet of untreated buffer between each plot. All living slash pine trees in each IPMP were aluminum tree tagged, numbered, and measured for dbh, total height, and live crown ratio in December 2001 (prior to the first application date in February 2002), in December 2003 (2-years post application), and in December 2005 (4-years after application). Slash pine growth, soil, and foliage parameter means were tested for significant differences using Duncan's Multiple Range Procedure at the 5% alpha level. Soil and foliage were collected prior to the February 2002 initial application date and annually through February 2005.

Soil and Foliage Results

There were no significant differences between treatments for surface (0-6") soil pH, available P, K, Ca, Mg, Mn, B, Cu, and Zn and total N prior to initial treatments, and two years post treatment (Table 2). There were two significant differences in nutrients four years after initial treatments. Surface soil available P in 2005 was significantly greater in the annual litter plots (62.3 lbs/ac) than the one-time rear port application (32.3 lbs/ac) and the NP plots (32.6 lbs/ac). Soil available P was greater in all fertilizer treatments than the control (10 lbs/ac). Surface soil available Mg in 2005 was significantly greater in all litter plots (79.2 to 80.4 lbs/ac) than in the NP (52.9) and the control (54.9 lbs/ac) (Table 2).

Mean surface soil pH on October 2001 (pre-application collection date) ranged from 5.7 to 5.8. Mean surface soil pH declined for all treatments during the 4-year study period. The control plots surface soil pH declined by 0.5 units (5.7 to 5.2), the annual litter by 0.4 units (5.7 to 5.3), one time rear by 0.4 units (5.8 to 5.4), one-time side by 0.3 unit (5.8 to 5.5), and the NP by 0.7 unit (5.7 to 5.0). Mean pre-treatment surface soil available-P were below to slightly above sufficiency (a range of 7.5 to 19 lbs/ac) for all treatment plots (Table 2). Mean control plot surface soil available P remained below sufficiency in the 2- and 4-year post initial treatment sample dates (6.8 and 10.0 lbs/ac, respectively, Table 2). Surface soil total-N ranged from 0.021% control to 0.037% (annual litter) prior to initial treatments and 0.023% (one-time rear) to 0.042% (NP) 2-years post initial treatments (Table 2).

There were no significant foliar N, P, K, Ca, Mg, B, Cu or Zn differences by treatment during the 4-year study period (Table 3). Mean foliar N concentrations were above sufficiency for slash pine for all treatments prior to initial treatments (Table 3). Mean foliar P was slightly above sufficiency for the one-time rear, one-time side and control plot trees (0.10%) and at sufficiency (0.09%) from the annual litter and NP trees prior to initial treatments. Mean foliar P was above sufficiency for all treatments in the January 2003 and February 2006 sampling dates (Table 3). In January 2004, mean foliar P was at sufficiency (0.09%) for the control, below sufficiency (0.08%) in the NP trees and above sufficiency (0.11 to 0.12%) for the poultry litter treated trees. Mean foliar P was above sufficiency across all treatments in February 2006 (Table 3). Mean foliar K concentrations were above the minimum sufficiency (0.25%) for all treatments prior to initial treatments (Table 3) and above sufficiency across all treatments for the remainder of the study period. Foliar Ca and Mg concentrations were above to well above sufficiency (0.08 to 0.12% for Ca and 0.06% for Mg) throughout the study period for all treatments. Foliar micro-nutrients (Mn, B, Cu, and Zn) were also above to well above the minimum guidelines (20-40 ppm for Mn, 4-8 ppm for B, 1.5 to 3 ppm for Cu and 10-20 ppm for Zn) during the study period for all treatments (Table 3).

Four Year Growth Response Results

Pre application growth parameters

Mean trees per acre ranged from 144 (NP) to 162 (one-time side and one-time rear litter, Table 4). Mean dbh ranged from 9.4 inches (one-time side) to 10.1 inches (control). Basal area prior to the start of the ninth growing season ranged from 74 (NP) which was significantly less than the control (85 ft²/ac) and one-time rear litter treatment to 88 ft²/ac (one-time rear litter). Live crown ratios (LCR's) were above the minimum guidelines for slash pine (>33 to 40 percent) ranging from 43 (one-time side poultry litter) to 45 percent (control) as of January 2001. Total heights ranged from 59.1 feet (NP) to 61.3 feet (control), or an average of 3 feet of height growth per year as of January 2001. Volume per tree ranged from 14.1 ft³ (one-time side) to 16.3 ft³ (control). Volume per acre ranged from 2127 ft³ (annual litter) which was significantly less than the one-time litter rear treatment (2452 ft³) and the control (2423 ft³) to 2452 ft³ (Table 4).

Post two- and four- year application growth parameters

Mean trees per acre declined by 2 for the NP, 8 for the control and one-time litter rear, and 12

for the annual litter and one-time side litter treatments during the four year study period (Table 4). Dbh's ranged from 10.1 (one-time side and annual litter) to 10.6 inches (control) two years after initial treatments and 10.8 (one-time side and annual litter) to 11.3 inches (control) four years after initial treatments (Table 4). The basal area range was; 84 (NP and annual litter) to 95 ft²/ac (one-time side litter) two years after initial treatments. Four year post initial application basal areas ranged from 89 (annual litter) to 105 ft²/ac (one-time rear litter, Table 4). Live crown ratios changed little during the four-year study period with a range of 43 (NP, annual litter, one-time rear, and one-time side poultry litter) to 44 percent (control, Table 4). Total heights ranged from 64.6 feet (NP) to 67.0 feet (control) two years post treatment and 68.4 (NP) to 41.8 feet (control) four years post treatments. Volume per tree ranged from 17.1 ft³ (annual litter) to 19.4 ft³ (control) two years after initial application and 20.7 ft³ (annual litter) to 23.1 ft³ (control) four years after initial application (Table 4). Volume per acre ranged from 2495 ft³ (NP and annual litter) to 2896 ft³ (control) two years after initial application and 2816 ft³ (annual litter) to 3314 ft³ (one-time rear) four years after initial application (Table 4).

Incremental mortality and growth response to treatments

Tree mortality ranged from 0% (control, NP) to 3.7% (one-time side litter) during the December 2001 through December 2003 period (Table 5). Tree mortality during the second measurement period (2003-2005) ranged from 1.4% (NP) to 6.8% (annual litter). Tree mortality over the four year study period ranged from 1.4% (NP) to 8.1% (annual litter, Table 5). The relatively low levels of mortality from the fertilized plots; overall mean of 5.5% compared to the control plot mean mortality of 5.3% illustrates that once a slash pine stand is thinned, mortality losses due to fertilization may not be different than losses in non-fertilized thinned stands. There were no significant dbh, BA/ac, live crown ratio, total height, volume/tree, or volume/ac growth increment gains with any of the fertilizer treatments over the control during the first or second measurement periods (2001-2003, 2003-2005) or over the 4-year study period (Table 5). Mean annual volume per acre growth increment for the control plot trees was 210 ft³/ac/yr (2.44 cords/ac/yr or 6.6 tons/ac/yr). The fertilizer treatment with the highest mean annual volume/ac increment gain; the one-time litter side (@ 500 lbs total-N, P₂O₅ and K₂O per acre) was 250 ft³/ac/yr (2.91 cords/ac/yr or 7.9 tons/ac/yr) or a 40 ft³/ac/yr (0.47 cds/ac/yr or 1.3 tons/ac/yr) gain versus not fertilizing.

Wood value per acre prior to initial treatments, four years post-initial treatments, and value per acre growth

Wood value per acre estimates ranged from \$1426.57 (one-time litter side treatment) to \$1788.88 (control) in December 2001 prior to initial treatments (Table 8). Wood value per acre estimates ranged from \$2546.21 (annual litter) to \$3060.34 (control) in December 2005, 4-years post initial treatments (Table 8). Four year value per acre increment for this thinned slash pine stand (from age 21- through age 24-years) was \$1069; annual litter, \$1152; NP, \$1194; one-time rear litter, \$1271; control, and \$1591; one-time side litter (Table 8). The one-time side litter treatment had the largest dose of nutrients (500 total-N, 630 P₂O₅, 450 K₂O per acre) grew \$320/acre more wood (all in the sawtimber classes) than the unfertilized control. Annual wood value during the 4-year study period ranged from \$267/ac/yr (annual litter), \$318 /ac/yr (control), to \$398/ac/yr (one time side litter, Table 8).

Summary and Conclusions

This site had a moderate residual fertility level. This moderate fertility prior to any fertilizer or litter application was evident by (1) surface soil available-P slightly below to slightly above the minimum guideline of 12 lbs/ac, and (2) foliar N, P, and K concentrations above sufficiency for slash pine (1.11% N, 0.16% P, and 0.50% K). This site having a prior land use history of old-field had essentially no hardwood competition. Minimal competition allowed the planted slash pines to capture much of the site's resources (sunlight, water, and nutrients). The rate of growth for slash pine in the untreated plots of 0.33"/yr for dbh, 2.5 feet/yr for height, and 2.44 cords/ac/yr for volume (6.6 tons/ac/yr) from ages 21- through 24-years-old can be considered much better than average for

these soils (Bonneau, Wagram, and Troup). The live crown ratio means for the slash pine across all treatments as of January 2001 were above the minimum guidelines (>33 to 40 percent) for slash pine and remained so throughout the study period; ranging from 43 to 46 percent. On this site, fertilization using DAP+ammonium nitrate (NP), the one-time broiler litter, and the annual broiler litter applications did not significantly improve slash pine growth and yield. In this case, if broiler litter can be applied at a relatively low to moderate cost (@ \$12/ton using 2005 prices and \$25/ton for 6 tons/ac using 2010 prices), then a one-time application may be attractive in (1) sound utilization of the litter and (2) possible value per acre gains with increased higher valued product (chip and saw or sawtimber) growth. The side delivery litter application did improve slash pine value by \$320/ac over the control (\$1271 vs \$1591/ac) using third quarter 2005 Timber Mart South GA stumpage prices (Table 8). This may be due to the much larger application level of nutrients and tonnage than the other treatments (Table 1). We were not able to directly compare the two poultry litter delivery systems, side versus rear one-time application, due to large differences in N, P, K, and other nutrient levels (Table 1).

Recommendations

Forest landowners should continue to use established fertilization diagnostic tools: (1) leaf area index (LAI) estimates, (2) soil sampling for available P, and (3) foliar sampling as well as soil series and land use history knowledge for cost-effective fertilization prescriptions. Fertilization, in this case, did not significantly improve any of the growth parameters during the 4-year study period. Boiler litter can be applied to thinned slash stands as a way to utilize the organic matter and nutrients without undue mortality in most cases (an exception was the Brantley County study where tropical depressions in 2004 increased four year mortality in poultry litter and NP fertilizer slash pine plots to 13% to 16% compared to 2% mortality from the unfertilized slash pine plots; see url for the Brantley Co. study). If fertility was more marginal, the probability of response to fertilization should have increased. For more information on the diagnostic tool use and results interpretations go to these web sites: www.bugwood.org or www.forestproductivity.net and look under the *fertilization* heading.

Table 1. Application dates, amounts, and nutrient levels (on an “as sampled” basis) for the fertilizer treatments used in the old-field 1980 planted, 1999 thinned slash pine stand in Mitchell County, Georgia (Bonneau, Troup and Wagram soils).

Fertilizer Treatment	Application date(s)	Amount	Total-N	P ₂ O ₅	K ₂ O	Ca	Mg	S
				(lbs/ac)				
Control		0	0	0	0	0	0	0
DAP+NH ₄ NO ₃ (NP)	Feb 2002	250+465	200	115	--	--	--	--
[†] One-time litter-rear	Feb 2002	9,600	295	375	265	140	35	35
[†] One-time litter-side	Feb 2002	16,500	500	630	450	240	60	60
[†] Annual litter	Feb 2002	5,170	160	200	145	75	20	20
	Feb 2003	6,460	165	150	160	100	25	25
	Feb 2004	7,480	170	135	130	110	30	25

[†]Mean (range) layer litter N concentrations (on an as sampled basis) were as follows: Total-N 2.64% (2.28-3.09%), organic-N 2.24% (2.07-2.48%), HN₄-N 0.31% (0.15-0.49%) and NO₃-N 0.09% (0.06-0.12%). Mean micro-nutrient concentrations were: B 35 ppm, Cu 245 ppm, and Zn 235 ppm over the 3-year litter analysis period. Litter solids averaged 77% (73-80% range).

Table 2. Surface soil (0-6") pH, available (Mehlich I) nutrients and total nitrogen in the thinned old-field 1980 planted, 1999 thinned slash pine stand in Mitchell County, Georgia (Bonneau, Troup and Wagram soils).

Date	Treatment	pH	P	K	Ca	Mg	Mn	B	Cu	Zn	Total-N
			-----lbs per acre -----								Percent
Dec2001 (pretreatment)	Control	5.7	10.39	40.80	414	59.4	17.2	0.18 b	0.53	1.09	0.021
	NP	5.7	9.08	38.77	426	70.1	20.1	0.22 b	0.45	0.88	0.026
	One-time R	5.8	10.26	35.11	412	62.6	18.3	0.40 a	0.54	1.29	0.025
	One-time S	5.8	19.01	43.76	493	69.6	14.7	0.24 b	0.82	2.46	0.027
	Annual litter	5.7	7.48	34.52	402	62.6	16.0	0.26 b	0.61	0.38	0.037
Jan2004	Control	5.7	6.8	46.0	361	53.4	12.4	0.38		1.79	0.028
	NP	5.3	42.6	39.8	349	53.1	22.1	0.45		1.07	0.042
	One-time R	5.5	35.6	47.7	382	61.2	13.1	0.47		2.42	0.023
	One-time S	5.7	21.7	51.7	427	71.9	16.8	0.43		1.61	0.031
	Annual litter	5.6	43.7	64.4	358	71.2	13.3	0.40		2.00	0.027
Dec2005	Control	5.2	10.0 c	38.5	420	54.9 b	20.4			1.29	
	NP	5.0	32.6 b	36.1	418	52.9 b	26.2			1.00	
	One-time R	5.4	32.3 b	49.8	531	80.4 a	22.1			3.58	
	One-time S	5.5	48.6 ab	76.8	547	79.9 a	19.8			3.89	
	Annual litter	5.3	62.3 a	63.1	507	79.2 a	22.9			2.02	

Means followed by a different letter are significantly different within a measurement year for the growth parameters tested above using Duncan's Multiple Range Procedure at the 5% alpha level.

Table 3. Foliar nutrient status in the thinned old-field 1980 planted, 1999 thinned slash pine stand in Mitchell County, Georgia (Bonneau, Troup and Wagram soils).

Date	Treatment	N	P	K	Ca	Mg	Mn	B	Cu	Zn
-----percent-----						-----parts per million -----				
Jan2002	Control	1.05	0.10	0.32	0.24	0.09	298.6	9.92	2.24	20.05
	NP	1.09	0.09	0.32	0.20	0.10	241.6	9.21	2.64	32.43
	One-time R	1.05	0.10	0.32	0.29	0.11	256.3	10.66	2.81	39.90
	One-time S	1.21	0.10	0.31	0.26	0.13	274.0	13.38	2.27	32.73
	Annual litter	1.10	0.09	0.29	0.25	0.09	257.6	7.62	2.56	30.56
Jan2003	Control	1.19	0.11	0.36	0.29	0.14	320.2	13.04	1.67	32.60
	NP	1.43	0.10	0.39	0.23	0.10	208.5	12.24	1.52	27.94
	One-time R	1.35	0.11	0.36	0.18	0.09	201.5	10.85	2.64	31.04
	One-time S	1.41	0.11	0.37	0.27	0.13	216.9	17.12	1.91	36.68
	Annual litter	1.33	0.12	0.43	0.25	0.13	214.2	19.52	1.67	32.03
Jan2004	Control	1.11	0.09	0.30	0.18	0.09	186.8	12.04	2.84	26.42
	NP	1.12	0.08	0.35	0.26	0.10	251.5	13.06	2.09	30.78
	One-time R	1.19	0.10	0.39	0.20	0.10	208.1	13.76	4.02	22.88
	One-time S	1.37	0.10	0.35	0.28	0.15	208.8	22.05	3.14	22.44
	Annual litter	1.21	0.10	0.45	0.25	0.11	201.1	17.67	2.61	22.93
Feb2006	Control	1.35	0.10	0.34	0.16	0.10	151.8	9.03	2.19	23.57
	NP	1.26	0.10	0.34	0.20	0.10	156.5	9.48	2.54	20.29
	One-time R	1.16	0.10	0.37	0.18	0.12	124.1	11.53	2.48	26.91
	One-time S	0.94	0.10	0.36	0.23	0.11	141.4	12.81	2.52	29.16
	Annual litter	1.31	0.11	0.38	0.20	0.11	146.9	10.68	2.72	24.21

Slash pine foliar nutrient sufficiency (minimum) guidelines: 1.0% N, 0.09% P, 0.25-0.30% K, 0.08-0.12% Ca, 0.06% Mg, 20-40 ppm Mn, 4-8 ppm B, 1.5-3.0 ppm Cu, 10-20 ppm Zn.

Table 4. Mean trees per acre, dbh, live crown ratio, height, and volume/tree by treatment in the old-field 1980 planted, 1999 thinned slash pine stand in Mitchell County, Georgia (Bonneau, Troup and Wagram soils).

Month Year	Fertilizer Treatment	Trees/ acre	Dbh (in)	Basal area (ft ² /ac)	Live crown ratio (%)	Total height (ft)	Volume /tree (ft ³)	Volume /ac (ft ³)
Dec 2001 (pretreatment)	Control	152	10.1	85ab	45	61.3	16.3	2423a
	NP	144	9.7	74 c	44	59.1	14.6	2052b
	One-time litter R	162	9.9	88 a	44	59.9	15.1	2452a
	One-time litter S	162	9.4	78bc	43	60.0	14.1	2167b
	Annual litter	148	9.6	76bc	44	59.6	14.4	2127b
Dec 2003	Control	152	10.6	95	46	67.0	19.4	2896
	NP	144	10.3	84	46	64.6	17.7	2495
	One-time litter R	160	10.4	97	45	65.0	17.9	2865
	One-time litter S	156	10.1	90	43	65.9	17.5	2722
	Annual litter	146	10.1	84	44	64.7	17.1	2495
Dec 2005	Control	144	11.3	102	44	71.1	23.1	3263
	NP	142	11.0	96	43	68.4	21.2	2988
	One-time litter R	154	11.0	105	43	71.0	21.5	3314
	One-time litter S	150	10.8	99	43	70.7	21.1	3168
	Annual litter	136	10.8	89	43	69.4	20.7	2816

Means followed by a different letter are significantly different within a measurement year for the growth parameters tested above using Duncan's Multiple Range Procedure at the 5% alpha level.

Table 5. Growth increment between measurement periods for dbh, basal area, height, and volume/tree by treatment in the old-field 1980 planted, 1999 thinned slash pine stand in Mitchell County, Georgia (Bonneau, Troup, and Wagram soils).

Period	Treatment	Mortality (%)	Dbh (in)	BA/ac (ft ²)	Total height (ft)	Volume/ tree (ft ³)	Volume/ acre (ft ³)
2001-2003	Control	0.0	0.6	9.9	5.7	3.2	473
	NP	0.0	0.6	9.9	5.5	3.1	443
	One-time litter R	1.2	0.5	8.4	5.1	2.8	414
	One-time litter S	3.7	0.7	12.7	6.0	3.4	554
	Annual litter	1.4	0.5	7.7	5.0	2.7	368
2003-2005	Control	5.3	0.7	6.9	4.1	3.7	367
	NP	1.4	0.7	11.8	3.8	3.5	493
	One-time litter R	3.8	0.6	8.0	6.0	3.6	449
	One-time litter S	3.8	0.7	9.0	4.8	3.6	446
	Annual litter	6.8	0.7	5.2	4.8	3.6	322
2001-2005	Control	5.3	1.3	16.8	9.8	6.9	840
	NP	1.4	1.3	21.7	9.3	6.6	936
	One-time litter R	4.9	1.1	16.4	11.1	6.4	862
	One-time litter S	7.4	1.4	21.7	10.8	7.0	1000
	Annual litter	8.1	1.2	12.9	9.8	6.3	689

There were no statistically significant differences between treatment means within a measurement year for the parameters listed above using Duncan's Multiple Range Procedure at the 5% alpha level.

Table 6. Mean Product class volumes by treatment in the old-field 1980 planted, 1999 thinned slash pine stand in Mitchell County, Georgia (Bonneau, Troup and Wagram soils).

Month Year	Fertilizer Treatment	Pulpwood (ft ³ /acre)	Superpulp (ft ³ /acre)	Total Pulpwood (ft ³ /acre)	Chip-n-Saw (ft ³ /acre)	Sawtimber (ft ³ /acre)
Dec 2001	Control	29	145	174	1675	261
	NP	24	218	242	1410	137
	One-time litter R	23	221	244	1780	124
	One-time litter S	37	221	258	1642	0
	Annual litter	37	253	290	1428	152
Dec 2003	Control	34	74	108	1768	643
	NP	16	174	191	1533	456
	One-time litter R	16	191	207	1986	336
	One-time litter S	32	181	213	1733	425
	Annual litter	19	245	264	1573	364
Dec 2005	Control	36	38	75	1774	1139
	NP	6	138	143	1855	726
	One-time litter R	6	120	127	1973	915
	One-time litter S	19	94	113	1593	1159
	Annual litter	21	189	210	1435	931

Means followed by a different letter are significantly different within a measurement year for the growth parameters tested above using Duncan's Multiple Range Procedure at the 5% alpha level.

Table 7. Product class volume increment change between measurement periods in the old-field 1980 planted, 1999 thinned slash pine stand in Mitchell County, Georgia (Bonneau, Troup, and Wagram soils).

Period	Fertilizer Treatment	Pulpwood (ft ³ /acre)	Superpulp (ft ³ /acre)	Total Pulpwood (ft ³ /acre)	Chip-n-Saw (ft ³ /acre)	Sawtimber (ft ³ /acre)
2001-2003	Control	6	-72	-66	92	383
	NP	-8	-44	-51	123	318
	One-time litter R	-7	-30	-37	206	212
	One-time litter S	-5	-39	-44	91	425
	Annual litter	-18	-8	-26	145	212
2003-2005	Control	2	-35	-33	6	496
	NP	-11	-37	-47	322	271
	One-time litter R	-9	-71	-81	-13	579
	One-time litter S	-13	-88	-101	-141	734
	Annual litter	3	-56	-53	-137	567
2001-2005	Control	8	-107	-99	98	878
	NP	-18	-81	-99	445	589
	One-time litter R	-17	-101	-117	193	791
	One-time litter S	-18	-127	-145	-49	1159
	Annual litter	-16	-64	-79	8	779

There were no statistically significant differences between treatment means within a measurement year for the parameters listed above using Duncan's Multiple Range Procedure at the 5% alpha level.

Table 8. Product class values by treatment prior initial application, 4-years post application, \$/ac gains, and value growth per acre per year in the old-field 1980 planted, 1999 thinned slash pine stand in Mitchell County, Georgia (Bonneau, Troup and Wagram soils).

Month Year	Fertilizer Treatment	Pulpwood (\$/acre)	Superpulp (\$/acre)	Chip-n- Saw (\$/acre)	Sawtimber (\$/acre)	Total value (\$/acre)	Value/ ac/yr (\$)
Dec 2001	Control	6.09	53.94	1363.45	365.40	1788.88	
	NP	5.04	81.10	1147.74	193.20	1427.08	
	One time litter rear	5.03	82.64	1442.21	192.12	1722.00	
	One-time litter side	7.77	82.21	1336.59	0	1426.57	
	Annual litter	7.77	94.12	1162.39	212.8	1477.08	
Dec 2005	Control	7.56	14.14	1444.04	1594.60	3060.34	
	NP	1.26	51.34	1509.97	1016.40	2578.97	
	One time litter rear	1.26	44.87	1598.59	1283.13	2927.85	
	One-time litter side	3.99	94.37	1296.70	1622.60	3017.66	
	Annual litter	4.41	70.31	1168.09	1303.40	2546.21	
4-yr \$ increase (age 21 through age 25-yrs)	Control					<u>1271</u>	<u>318</u>
	NP					1152	288
	One time litter rear					1206	301
	One-time litter side					<u>1591</u>	<u>398</u>
	Annual litter					1069	267

Stumpages prices used were from Timber Mart South Georgia Coastal Plain 3rd Quarter 2005 (prices within six months of study conclusion timeframe); pulpwood @ \$6.75/ton, superpulp @ \$12/ton, chip and saw @ \$26/ton, and sawtimber @ \$45/ton (2.68 tons = 1 cord wood+bark).

CITATION

Dickens, E.D., D.J. Moorhead, B.C. McElvany, B. Mitchell, and W.E. Harrison. 2010. Impact of a Broiler Litter and DAP+Ammonium Nitrate Application in an Old-field Thinned Slash Pine Stand in Mitchell County, Georgia – Four Year Growth Results Georgia Forest Productivity Series No. 003R-2010. www.bugwood.org/productivity. 9 p.

Keywords

Slash pine, old-field, fertilization, poultry litter, soil nutrients, foliar nutrients, growth and yield

Athens, Georgia 30602-2152
Phone: 706.542.6819 • fax: 706.542.5073
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