FOREST HEALTH REPORT

REASSESSMENT OF LOBLOLLY PINE DECLINE

ON THE OAKMULGEE DISTRICT

TALLADEGA NATIONAL FOREST, ALABAMA

Alexandria Field Office

USDA Forest Service
Southern Region
Forest Health

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Abstract

Declining loblolly stands have been a management concern on the Oakmulgee District since the 1960's. The symptoms include sparse crowns, reduced radial growth, deterioration of fine roots and decline and mortality of loblolly pine by age 50. Reassessment of the decline sites began in May of 1998 in order to evaluate the cause of the decline/mortality complex and to re-evaluate management options. Fifteen variable radius plots were established on four compartments, representing five declining stands. Three dominant/co-dominant symptomatic trees were selected from each plot for root sampling and data collection. Two primary lateral roots were excavated from each sample tree and the fine roots examined and sampled. Root samples were placed on selective media for isolation of *Heterobasidion annosum*, *Phytophthora cinnamomi*, *Pythium* spp. and *Letptographium* species. *Pythium* spp. and *Phytophthora cinnamomi* were recovered from the fine root samples of all 15 plots. *Leptographium* spp. were recovered from the primary lateral root samples of 7 of the 15 plots. There was no *H. annosum* found in any of the root samples. Littleleaf disease appears to be the primary cause of the loblolly decline symptoms and mortality. Management options on these sites include managing for loblolly pine on shorter rotations of 50 years, or accelerating harvest of damaged stands with conversion to longleaf management type and fertilization to mitigate root damage.

28, 12, 13, 6
31, 15, 6,
12, 42, 41,
34, 25, 1,
15, 11, 6
15
4
4
4 Counties

129 43, 42, 41
31, 26, 13, 24
13

INTRODUCTION

The Oakmulgee Ranger District is part of the Talladega National Forest. It is located in portions of six west-central Alabama counties with the district office at Centreville, 35 miles south of Tuscaloosa, AL. The District consists of 158,000 acres of which approximately 99,000 acres are pine forest type. The dominant forest type in the presettlement era was longleaf pine (*Pinus palustris* Mill.) which was extensively cut over and the land cultivated prior to establishment of the Talladega National Forest (Johnson 1947). During the 1930's forestry practice emphasized watershed protection and much of this area was regenerated to loblolly pine (*Pinus taeda* L.).

The Oakmulgee Ranger District falls within the Upper Gulf Coastal Plain province and during the 1940's & 50's surveys found extensive damage to shortleaf pine (*Pinus echinata* Mill.) stands caused by littleleaf disease which is associated with *Phytophthora cinnamomi* Rands, and soils with poor internal drainage (Roth 1954, Campbell and Copeland 1954). The first reports of the declining loblolly pine were in 1959 on the Talladega National Forest. Symptoms include trees with short, chlorotic needles, sparse crowns, and reduced radial growth in the 40-50 year age class. Mortality occurred two to three years after symptom expression.

In 1966, a five year study was established on 24 one-quarter acre plots on the Oakmulgee Ranger District to determine the cause, rate of decline, and degree of the mortality of loblolly pine stands (Brown and McDowell 1968). Further evaluations of the 24 plots were concluded in 1976. Results of these studies did not confirm a specific pathogen as the causal agent; however, several important observations were made. Decline symptoms appeared at approximately age 50, but lateral and fine root deterioration and mortality preceded the presence of foliage symptoms of decline. *Heterobasidion annosum* (Fr.) Bref. and *Phytophthora cinnamomi* (Fr.) Bref. were recovered from some of the plots but annosum root and littleleaf disease were not implicated as the primary cause of the decline. The conclusions from the evaluation and follow-up study indicated reductions in growth of the loblolly pine by age 50 and that site conditions and a combination of other interactions caused the decline and mortality. Recommendations were to reduce rotation age of loblolly pine from 70 to 60 years on these sites, maintain a basal area of 60-70 square feet per acre and convert these stands to longleaf pine management type (Loomis 1976).

For the past 15 years, the Oakmulgee has converted an average of 1,000 acres/year of these sites to longleaf pine, but there are approximately 40,000 acres of loblolly pine decline/dieback sites remaining on the Oakmulgee having an estimated loss of 12 MMBF per year to mortality and reduced growth. There are an additional 10,000 to 20,000 acres of similar sites and conditions on the Shoal Creek and Talladega Districts.

The National Forests in Alabama have recognized that the complexity of managing these sites within the scope of ecosystem management, wildlife habitat needs, and enhanced regulatory compliance has greatly affected their ability to achieve the desired future conditions for a sustainable ecosystem. During a FHP Management Review, the National Forests in Alabama requested a re-evaluation and reassessment of the loblolly pine decline sites.

Forest Health Protection, Alexandria Field Office; Southern Research Station, Tree Root Biology Unit in Athens, GA, and National Forests in Alabama implemented a field evaluation of four compartments on the Oakmulgee Ranger District, May, 1998. This report gives the results of the field evaluation and presents biological limitations present on these decline sites.

METHODS

Oakmulgee District personnel selected four compartments that included five stands that represented a range of the loblolly decline/dieback symptoms. The five stands represented 135 acres on which 15 randomly placed 10 factor prism plots were established. The three dominant/co-dominant symptomatic trees nearest plot center were selected for root sampling and data collection. Two primary lateral roots were excavated from each tree to sample fine roots and lateral roots. Root samples were put in plastic baggies and placed in an ice chest for transport to laboratories for isolations of pathogenic fungi. Additional root samples were collected from two stands by pushing over six trees with a dozer. Random samples were taken from the whole root mass of these trees.

Data collected in the plots included tree measurements, site information, and soil profile. Species, diameter at breast height (dbh), age, 5 and 10 year growth increments were collected from each of the root sampled trees. Site descriptions included pine and total basal area (10 factor prism) and a soil profile description.

Pythiaceous fungal assay

Isolations and identifications of pythiaceous fungi were conducted at Louisiana State University Agriculture Center. Portions of the 225 pine feeder roots samples were cut into1cm pieces and surface sterilized in a 10% commercial bleach, 10% 95 percent ETOH and 80% H_2O for one minute and rinsed with distilled water. Ten 1cm root pieces per plot sample were plated on the following selective media: PARPH medium (Pimaricin 5 mg; Sodium Ampicillin 250 mg; Rifampicin 10 mg in 1 ml DMSO; PCNB 25 mg in 5 ml of 95% ETOH; Hymexazol 50 mg of 70% WP) which is selective for

Phytophthora cinnamomi and PV medium (Vancomycin 300 mg/l; Pimaricin 0.4 mls of 2.5% SOLN/l; PCNB 25 mg in 5 ml 95% ETOH) which is selective for *Pythium* species.

Leptographium and *H. annosum* isolations

The primary lateral root samples were transported to the Tree Root Biology Laboratory in Athens, GA to determine the presence of *H. annosum* and *Leptographium* species.

Lateral woody root samples from each plot ranged from two to six centimeters in diameter. The root samples were cut into 10 cm long segments and surface sterilized by dipping in 95% ethanol followed by brief flaming. The outer bark was then removed and pieces of root wood from each sample were plated onto 1.25% malt extract agar (12.5g malt extract broth and 17g agar per liter of distilled water) or 1.25% malt extract agar amended with 200 ppm cycloheximide. The latter medium is selective for Ophiostomoid fungi. Plates were left to incubate on a laboratory bench at 22°C for approximately 10 days or until fungal growth was observed. Ophiostomoid fungal presence was recorded after viewing cultures growing on either medium under a stereomicroscope.

Soil Profile

A soil profile was described at the center of each of the 15 plots (Art Goddard, Soil Scientist for NF's in Alabama). The profiles were established by using a 3 inch diameter bucket auger core down to 60 inches using National Cooperative Soil Sampling Standards. Soil color description were compared to the Munsell color charts.

Soil Analysis

One pint soil samples were collected from the top 12 inches of each profile core of the 15 plots and sent to a commerical soil testing laboratory (A&L Analytical Laboratories in Memphis, TN) for nutrient analysis.

Histology of fine root pices

Random samples of unwashed fine roots were taken from each plot root sample and placed in formalin/acetic acid/acohol fixative (FAA) and left for 14 days (Sass 1951). Fixed root specimens were cut to 1 to 3 mm, dehydrated in an alcohol series, embedded in paraffin, and sliced into 7 to 10 micrometer transverse sections. Slides were stained with a variety of schedules, including Papanicolaou's hemotoxylin-eosin, or an acid-Schiff procedure (Hass 1980). Stained sections were then observed under a compound microscope and evaluated for signs of abnormalities.

RESULTS

The average range of diameters at breast height (dbh) for the trees sampled were 9.1 inches to 14.3 inches (Table 1). The stand age for the four compartments ranged from 43 to 56 years. Stand density ranged from 37 sq. ft. to 55 sq. ft. for pine and total basal area ranged from 40 sq. ft. to 57 sq. ft. The average five year growth increment for these sites ranged from 8 mm to 10 mm and 10 year growth was 16 mm to 20 mm.

Pythium species were isolated from an average of 54% of samples from all plots (range 10% to 90%). *P. cinnamomi* recovered from root samples ranged from 10 percent to 50 percent with an average of 26 percent from all trees sampled. *Pythium* spp. and *P. cinnamomi* were recovered from root samples in all plots (Table 2).

Leptographium spp. were recovered from 7 of the the 15 plots, or 47 percent. No *H. annosum* was found in any of the root samples, nor were any fruiting bodies of the fungus found during the field survey.

The soil profile descriptions identified six soil series with Smithdale fine sandy loam on 40 percent of the plots. The other soil series identified on the plots were Maubila sandy loam, Troup loamy sand, Saffell gravelly sandy loam and Luverne fine sandy loam. Each of these soils series comprised 13 percent of the plots, with the Suffolk fine sandy loam found on one plot (Table 2).

Smithdale, Maubila, Luverne and Suffolk are described as well-drained to moderately well-drained soils with moderate to slow permeability, with clay loam or sandy clay loam within 10-20 inches of the surface. Troup and Saffell are excessively drained to well-drained soils with moderate permeability. They are deep loamy sands or gravelly sandy loams without a clay component near the surface.

Compared to agricultural soils, the soil analysis revealed that 73 percent of the plots were very low in potassium (K), calcium (Ca), and sodium (Na). All plots except for those with the Troup loamy sand were low in Ca. Some of the plots were also low in manganese (Mn) and zinc (Zn). All of these values were within the expected range for forest soils of these types. The pH ranged from 4.6 to 5.2 on the sampled plots.

The histology of the 95 fine roots that were sectioned showed that 13 were dead and 12 had large necrotic zones. Six roots had one or more dead resin ducts. The range in mortality among plots was 0 to 30%.

DISCUSSION

This study confirmed the conditions found in the evaluations during the 1960's and 70's. The sparse crowns, reduced radial growth, deterioration of fine roots and decline and mortality by age 50 are conditions that have prevailed on these sites since the 1960's. These symptoms are most commonly associated with littleleaf disease of shortleaf pine. Littleleaf has been reported to affect loblolly pine (Campbell and Copeland 1954, Lorio 1966, Oak and Tainter 1988). Loblolly pine affected with littleleaf symptoms are found most frequently on sites where the disease has been particularly severe on shortleaf (Campbell and Copeland 1954). Littleleaf was first detected in central Alabama in the early 1900's and by 1940 littleleaf occurrence was widespread in Alabama, South Carolina, and Georgia and was causing serious limitation to sustained management of shortleaf pine in the Upper Coastal Plain of Alabama (Tainter and Baker 1996) including the area that is now the Oakmulgee Ranger District (Johnson 1947).

Littleleaf disease symptoms result from nitrogen deficiency in the trees, and are characterized by dying of new root tips and fine roots. Although *P. cinnamomi* is considered the primary pathogen, other factors such as poor aeration, low fertility, and periodic moisture stress are also damaging to fine roots. Zoospores of *P. cinnamomi* are the putative agents of infection and are produced only under conditions of abundant moisture. High soil moisture associated with poor internal soil drainage is common on littleleaf sites. *P. cinnamomi* is pathogenic to many plants other than pine and is commonly found in the absence of pine. It can also be present in pine stands without causing littleleaf. *P. cinnamomi* is more commonly associated with eroded lands and severity of littleleaf disease increases as the internal drainage decreases and as site index decreases. Cultivation of soils has been shown to hasten the decline of littleleaf trees. However, the development of littleleaf disease symptoms in healthy trees has been delayed and improvement in the condition of trees in the early stages of the disease has been obtained with soil applications of inorganic nitrogen (Campbell and Copeland 1954).

Pythium spp. have also been reported to be associated with littleleaf sites (Otrosina and Marx 1975) and with loblolly pine decline (Lorio 1966). *Pythium* spp. have a life cycle similar to *Phytophthora* and are most commonly associated with damping-off, a root disease in pine nurseries on wet sites (Tainter 1997).

Two important factors in determining if littleleaf disease is the primary factor in decline of loblolly pine on the Oakmulgee sites are the internal drainage of soils and the isolation of *Phytophthora cinnamomi/Pythium* spp. from the fine roots.

The Oakmulgee soils having clay loam close to the surface horizon and exhibiting slow to moderate permeability generally maintain high moisture content and would favor

Pythium/Phytophthora fungal populations (Table 3). The Troup and Saffell soils are described as deep, well-drained loamy soils without a clay component and moderate permeability. However, the absence of an A horizon, low soil fertility, and evidence of plow layer on some sites indicate that these areas were heavily farmed prior to planting of pines. The Oakmulgee soils are located in the upper Gulf Coastal Plain Province and the soil series descriptions do not generally indicate high risk sites for littleleaf disease; however, the agricultural history and its effect on the soil nutrients and permeability may explain the occurrence of littleleaf disease. Soil profile descriptions and soil analysis results are in the Appendix.

Isolations and detection procedures forpythiaceous fungi have become more efficient since the early surveys of the Oakmulgee sites in 60's and 70's. Quantitative methods of soil dilution for propagule counts and soil population assay have been developed. The use of selective media to isolate *P. cinnamomi* and *Pythium* spp. from necrotic root tips more accurately relates the association of the pathogens to fine root mortality (Tainter and Baker 1996). The isolations of *Pythium* spp. and *P. cinnamomi* from the survey (Table 2) in general shows a greater concentration of *Pythium* spp. than *P. cinnamomi* in the fine roots. *P. cinnamomi* is considered the primary pathogen as the fungus attacks and quickly kills only the succulent root tips of the pine host and enables saprophytic colonization of soil microorganisms.

Leptographium species have been associated with conifer mortality, primarily as associates of root-feeding bark beetles (Scolytidae) and weevils (Curculionidae) that attack living trees. Some of the *Leptographium* species are weak pathogens and further damage roots already damaged by insect-feeding and egg laying. Pines respond to this damage by producing resin and *Leptographium* spp. are most often recovered from these resin-soaked tissues and may exacerbate the damage by inducing further resin production (Harrington and Wingfield 1997). Because of these characteristics these fungi may serve as indicators of site stress and predispose infected trees to attack by southern pine beetle (*Dendroctonus frontalis*, Zimmerman) and other agents (Otrosina and others 1997).

Histology studies indicate that a high proportion of loblolly pine roots are in poor condition or are dead. Death of resin canals is unusual in loblolly pine roots but can indicate root damage.

Table 1.--Range of Growth and Age.

Stand Data/ Averaged by Compartments	dbh (avg. of plots in inches)	Age	Growth Increment (mm)		Basal Area sq. ft. (10 factor)	Total
			5 Years	10 Years		
C-20, Stands 29 & 25	9.1	43	10	19	55	57
C-137, Stand 6	13.2	56	8	16	43	50
C-125, Stand 10	13.1	51	9	19	45	45
C-126, Stand 28	14.3	53	10	20	37	40

Table 2.--Recovery of Pathogenic Fungi from Root Samples by Plot and Soil Series.

Comp/Plot#	Soil Series	*Pythium*	*P. cinnamomi*	*Lepto* spp	
				Yes	No
C-20, Plot 1	Smithdale, fine sandy loam	70%	10%		X
C-20, Plot 2	Smithdale, fine sandy loam	40%	10%		X
C-20, Plot 3	Saffell, gravelly sandy loam	85%	40%		X
C-20, plot 4	Maubila, sandy loam	55%	35%		X
C-137, Plot 1	Smithdale, fine sandy loam	50%	20%	X	
C-137, Plot 2	Smithdale, fine sandy loam	45%	30%	X	
C-137, Plot 3	Smithdale, fine sandy loam	70%	25%	X	
C-125, Plot 1	Suffolk, fine sandy loam	50%	25%	X	
C-125, plot 2	Troup, loamy sand	10%	20%	X	
C-125, plot 3	Troup, loamy sand	30%	10%	X	
C-125, Plot 4	Saffell, gravelly sandy loam	20%	40%		X
C-126, Plot 1	Maubila, sandy loam	60%	50%	X	
C-126, plot 2	Luverne, fine sandy loam	60%	10%		X
C-126, plot 3	Smithdale, fine sandy loam	70%	40%		X
C-126, Plot 4	Luverne, fine sandy loam	90%	20%		X

Table 3.--Soil Series Descriptions Relative To Recovery of Root Pathogens.

Soil Series	Range of *Pythium* %	Range of *Phytophthora* %	*Leptographium* spp Yes	No
Smithdale FSL	40 - 70	10 - 40	X	
Suffolk FSL	50	25	X	
Maubila SL	55 - 60	35 - 50	X	
Luverne	60 - 90	10 - 20		X
Saffell GSL	20 - 85	40		X
Troup LS	10 - 30	10 - 20	X	

CONCLUSIONS

Phytophthora cinnamomi and *Pythium* spp. appear to be the primary pathogens associated with the deterioration of loblolly fine root systems coupled with altered soil/site conditions. The restricted internal drainage of the soils as a result of past agricultural practices within the historical range of littleleaf disease and the extensive planting of loblolly pine to recover these sites indicate that littleleaf disease is the primary cause of the loblolly decline symptom and mortality on the Oakmulgee District. Bulk density test of the soils and foliar analysis of symptomatic trees for nitrogen deficienty would be helpful to validate this diagnosis.

The *Leptographium* spp. recovered from the larger root systems exacerbate the decline of the loblolly stands. The declining stands are also more susceptible to southern pine beetle attacks.

Management options for loblolly decline sites on the Oakmulgee Ranger District

A. Maintain loblolly as a short rotation crop.
- Age 50 is the recommended rotation age on the decline sites.
- Use periodic salvage/sanitation cuts of symptomatic trees until stands reach rotation age.
- Convert to longleaf management type upon final harvest at age 50.

B. Accelerate conversion of loblolly to longleaf management within 10-15 year planning cycle.
   - Convert 7% to 10% of loblolly decline sites to longleaf management each year.
   - Select most severely damaged stands as priority for conversion.

C. Disease abatement/conversion by condition class.
   - Inventory the remaining 40,000 acres of decline sites and classify by age class and condition class.
   - Schedule harvest and conversion based on stand age and condition classes.
   - Stands in age classes 40 and older with a condition class of sparse, damaged, or diseased are high risk sites and should be first priority for management conversion to longleaf pine.
   - Second priority are age classes 25 to 40, with poletimber condition class which may also have some symptomatic trees. Most of these stands will already have some fine root damage due to littleleaf disease but may not be showing advanced symptoms or mortality. Use a fertilization program to reduce disease impact and extend rotation age beyond age 50 for RCW habitat management.
   - Stands in age classes 15-25 should use standard silvicultural practices of prescribed burning and thinnings to maintain stand vigor.

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APPENDIX

Soil Profile

Soil Analysis

Soil Plot Descriptions
Oakmulgee RD
Forest Health

Following are soil profile descriptions taken on May 12 and 13 with Forest Health Unit, Nolan Hess, Pineville, LA on the Oakmulgee RD, Talladega NF. Soil described from an auger. Soil moisture is dry. Colors described are for moist soil.

Plot 1 - Compartment 137

Smithdale fine sandy loam - deep, well drained soils that formed in thick beds of loamy upper coastal plain sediments. Permeability is moderate.

A--0 to 6 inches; dark grayish brown (10YR 4/2) fine sandy loam; weak fine granular structure; very friable; common fine and few medium roots; strongly acid; clear smooth boundary.

E--6 to 11 inches; light yellowish brown (10YR 6/4) fine sandy loam; weak medium granular structure; very friable; common fine and few medium roots; strongly acid; clear smooth boundary.

Bt1--11 to 36 inches; yellowish red (5YR 5/6) clay loam; moderate medium subangular blocky structure; friable; thin patchy clay films on faces of peds; sand grains coated and bridged with clay; few medium and coarse roots; few fine mica flakes; strongly acid; clear smooth boundary.

Bt2--36 to 45 inches; yellowish red (5YR 5/6) sandy clay loam; common medium faint strong brown (7.5YR 5/8) mottles; weak medium subangular blocky structure; friable; sand grains coated and bridged with clay; few fine mica flakes; strongly acid; clear smooth boundary.

Bt3--45 to 56 inches; yellowish red (5YR 5/6) sandy loam; common medium distinct strong brown (7.5YR 5/8) mottles; weak medium subangular blocky structure; very friable; sand grains coated and bridged with clay; few fine mica flakes; strongly acid; clear wavy boundary.

BC--56 to 60+ inches; strong brown (7.5YR 5/6) sandy loam; common medium distinct yellowish red (5YR 5/8) and yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; common uncoated sand grains, pockets of clay loam; few fine mica flakes; strongly acid.

Plot 2 - Compartment 137

Smithdale fine sandy loam - deep, well drained soils that formed in thick beds of loamy upper coastal plain sediments. Permeability is moderate.

A--0 to 4 inches; brown (10YR 5/3) fine sandy loam; weak fine granular structure; very friable; common fine and few medium roots; strongly acid; clear smooth boundary.

E--4 to 10 inches; yellowish brown (10YR 5/6) fine sandy loam; weak medium granular structure; very friable; common fine roots; strongly acid; clear smooth boundary.

Bt1--10 to 26 inches; yellowish red (5YR 5/6) clay loam; moderate medium subangular blocky structure; friable; thin patchy clay films on faces of peds; sand grains coated and bridged with clay; few medium and coarse roots; few fine mica flakes; strongly acid; clear smooth boundary.

Bt2--26 to 38 inches; yellowish red (5YR 5/6) sandy clay loam; weak medium subangular blocky structure; friable; sand grains coated and bridged with clay; few fine mica flakes; strongly acid; clear smooth boundary.

Bt3--38 to 49 inches; strong brown (7.5YR 5/8) sandy clay loam; weak medium subangular blocky structure; very friable; sand grains coated and bridged with clay; few fine mica flakes; strongly acid; clear wavy boundary.

BC--49 to 60+ inches; strong brown (7.5YR 5/8) sandy loam; common medium distinct yellowish red (5YR 5/8) and yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; common uncoated sand grains, pockets of clay loam; few fine mica flakes; strongly acid.

Plot 3 - Compartment 137

Smithdale fine sandy loam - deep, well drained soils that formed in thick beds of loamy upper coastal plain sediments. Permeability is moderate.

A--0 to 4 inches; very dark grayish brown (10YR 3/2) fine sandy loam; weak fine granular structure; very friable; common fine and few medium roots; strongly acid; clear smooth boundary.

E--4 to 12 inches; dark yellowish brown (10YR 4/4) fine sandy loam; weak medium granular structure; very friable; common fine roots; strongly acid; clear smooth boundary.

Bt1--12 to 18 inches; yellowish red (5YR 5/6) sandy clay loam; moderate medium subangular blocky structure; friable; thin patchy clay films on faces of peds; sand grains coated and bridged with clay; few medium and coarse roots; few fine mica flakes; strongly acid; clear smooth boundary.

Bt2--18 to 33 inches; yellowish red (5YR 5/6) clay loam; weak medium subangular blocky structure; friable; sand grains coated and bridged with clay; few fine mica flakes; strongly acid; clear smooth boundary.

Bt3--33 to 46 inches; strong brown (5YR 5/6) sandy clay loam; weak medium subangular blocky structure; very friable; sand grains coated and bridged with clay; few fine mica flakes; strongly acid; clear wavy boundary.

BC--46 to 60+ inches; strong brown (7.5YR 5/8) sandy loam; common medium distinct yellowish red (5YR 5/8) and 10YR 5/6) mottles; weak medium subangular blocky structure; common uncoated sand grains, pockets of clay loam; few fine mica flakes; strongly acid.

Plot 1 - Compartment 20

Smithdale fine sandy loam, slightly eroded - deep, well drained soils that formed in thick beds of loamy upper coastal plain sediments. Permeability is moderate.

A--0 to 4 inches; dark yellowish brown (10YR 4/6) sandy loam; weak fine granular structure; very friable; common fine and few medium roots; strongly acid; clear smooth boundary.

Bt1--4 to 30 inches; yellowish red (5YR 5/6) sandy clay loam; moderate medium subangular blocky structure; friable; thin patchy clay films on faces of peds; sand grains coated and bridged with clay; few medium and coarse roots; few fine mica flakes; strongly acid; clear smooth boundary.

Bt2--30 to 42 inches; yellowish red (5YR 5/6) clay loam; weak medium subangular blocky structure; friable; sand grains coated and bridged with clay; few fine mica flakes; strongly acid; clear smooth boundary.

Bt3--42 to 60 inches; yellowish red (5YR 5/6) sandy loam; weak medium subangular blocky structure; very friable; sand grains coated and bridged with clay; few fine mica flakes; strongly acid; clear wavy boundary.

Plot 2 - Compartment 20

Smithdale fine sandy loam, slightly eroded - deep, well drained soils that formed in thick beds of loamy upper coastal plain sediments. Permeability is moderate.

A--0 to 3 inches; dark yellowish brown (10YR 4/6) sandy loam; weak fine granular structure; very friable; common fine and few medium roots; strongly acid; clear smooth boundary.

Bt1--3 to 10 inches; red (2.5YR 4/8) clay loam; moderate medium subangular blocky structure; firm; thin patchy clay films on faces of peds; sand grains coated and bridged with clay; few medium and coarse roots; few fine mica flakes; strongly acid; clear smooth boundary.

Bt2--10 to 18 inches; yellowish red (5YR 5/8) sandy clay loam; weak medium subangular blocky structure; friable; sand grains coated and bridged with clay; few fine mica flakes; strongly acid; clear smooth boundary.

Bt3--18 to 54+ inches; yellowish red (5YR 5/8) sandy loam; weak medium granular structure; very friable; sand grains coated and bridged with clay; few fine mica flakes; strongly acid; clear wavy boundary.

BC--54 to 60+ inches; strong brown (7.5YR 5/6) sandy loam; common medium distinct yellowish red (5YR 5/8) and yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; common uncoated sand grains, pockets of clay loam; few fine mica flakes; strongly acid.

Plot 3 - Compartment 20

Saffell gravelly sandy loam - deep, well drained soils that formed in thick beds of loamy and gravelly coastal plain sediments. Permeability is moderate.

A--0 to 6 inches; dark grayish brown (10YR 4/2) gravelly sandy loam; weak fine granular structure; very friable; common fine and few medium roots; about 30% by volume of pebbles; strongly acid; clear smooth boundary.

E--6 to 16 inches; yellowish brown (10YR 5/6) very gravelly sandy loam; weak fine granular structure; very friable few fine and medium roots; 40% by volume of pebbels; strongly acid; clear smooth boundary.

Bt1--16 to 30 inches; reddish yellow (7.5YR 6/8) very gravelly sandy loam; weak medium subangular blocky structure; friable; about 50% by volume of pebbles; common thin patchy clay films on faces of peds; strongly acid; clear smooth boundary.

Bt2--30 to 33+ inches (hit large rock); brown (7.5YR 5/4) very gravelly sandy loam; weak medium subangular blocky structure; friable; about 50% by volume of pebbles; common thin patchy clay films on faces of peds; few fine mica flakes; strongly acid; clear wavy boundary.

Plot 4 - Compartment 20

Maubila sandy loam - very deep, moderately well drained soils that formed in thick beds of clayey coastal plain marine sediments. Permeability is slow.

A--0 to 4 inches; brown (10YR 4/3) sandy loam; weak fine granular structure; very friable; common fine and few medium roots; about 15% angular fragments of ironstone; very strongly acid; clear smooth boundary.

E--4 to 8 inches; light brownish gray (10YR6/2) sandy loam; weak fine granular structure; very friable; common fine and few medium roots; about 15% angular fragments of ironstone; very strongly acid; clear smooth boundary.

Bt1--8 to 12 inches; red (2.5YR 5/8) sandy clay loam; weak fine subangular blocky structure; firm; few faint clay films on faces of peds; about 5% angular fragments of ironstone; very strongly acid; clear smooth boundary.

Bt2--12 to 20 inches; strong brown (7.5YR 5/8) clay; moderate medium subangular blocky structure; very firm; common faint clay films on faces of peds; common medium distinct red (2.5 YR 4/6) and light brownish gray (10YR 6/2) mottles; very strongly acid; clear smooth boundary.

Bt3--20 to 40 inches; strong brown (7.5YR 5/8) clay; moderate medium subangular blocky structure; very firm; common distinct clay films on faces of peds; many fine and medium prominent yellowish brown (10YR 5/6), red (2.5YR 4/6), and light gray (10YR 7/2) mottles; very strongly acid; clear smooth boundary.

BC--40 to 60+ inches; gray (10YR 6/1), strong brown (7.5YR 5/6), red (2.5YR 4/6), and weak red (10R 4/3) clay loam; weak coarse subangular blocky structure; firm; very strongly acid.

Plot 1 - Compartment 125

Suffolk fine sandy loam - very deep, well drained soils that formed in thick beds of loamy upper coastal plain fluvial and marine sediments. Permeability is moderate.

A--0 to 6 inches; dark brown (10YR 3/3) fine sandy loam; weak fine granular structure; very friable; common fine and few medium roots; strongly acid; clear smooth boundary.

E--6 to 10 inches; yellowish brown (10YR 5/6) fine sandy loam; weak medium granular structure; very friable; common fine and few medium roots; strongly acid; clear smooth boundary.

BE--10 to 20 inches; yellowish brown (10YR 5/8) sandy loam; weal medium granular structure; friable; few fine and medium roots; strongly acid; clear smooth boundary.

Bt1--20 to 26 inches; yellowish brown (10YR 5/6) sandy clay loam; weak medium subangular blocky structure; friable; thin patchy clay films on faces of peds; few medium and coarse roots; strongly acid; clear smooth boundary.

Bt2--26 to 36 inches; strong brown (7.5YR 5/8) sandy clay loam; few medium distinct red (2.5YR 4/8) mottles; weak medium subangular blocky structure; friable; few faint clay films on faces of peds; strongly acid; clear smooth boundary.

Bt3--36 to 41 inches; strong brown (7.5YR 5/8) sandy clay loam; weak medium subangular blocky structure; friable; few faint clay films on faces of peds; 10% by volume of ironstone fragments; strongly acid; clear wavy boundary.

BC--41 to 60+ inches; strong brown (7.5YR 5/8) sandy loam; weak medium subangular blocky structure; friable; sand grains coated and bridged with clay; pockets of clay loam; strongly acid.

Plot 2 - Compartment 125

Troup loamy sand - deep, somewhat excessively drained soils with thick sandy surface and loamy subsoils that formed in unconsolidated sandy and loamy marine sediments on Coastal Plain uplands. Permeability is moderate.

A--0 to 2 inches; very dark grayish brown (10YR 3/2) loamy sand; single grained; very friable; few fine roots; strongly acid; clear smooth boundary.

E1--2 to 12 inches; yellowish brown (10YR 5/6) loamy sand; single grained; very friable; few fine and medium roots; strongly acid; clear smooth boundary.

E2--12 to 33 inches; strong brown (7.5YR 5/6) loamy sand; single grained; very friable; few medium roots; strongly acid; clear smooth boundary.

E3--33 to 51 inches; strong brown (7.5YR 5/8) loamy sand; single grained; loose structure; few fine faint red (2.5YR 5/8) mottles in lower part with sand grains coated and bridged with clay; common medium sized pockets of pale brown (10YR 6/3) uncoated sand grains; strongly acid; gradual wavy boundary.

Bt1--51 to 60+ inches; red (2.5YR 5/6) sandy clay loam; weak medium subangular blocky structure; friable; sand grains coated and bridged with clay; strongly acid; clear smooth boundary.

Plot 3 - Compartment 125

Troup loamy sand - deep, somewhat excessively drained soils with thick sandy surface and loamy subsoils that formed in unconsolidated sandy and loamy marine sediments on Coastal Plain uplands. Permeability is moderate.

A--0 to 8 inches; brown (10YR 5/3) loamy sand; single grained; very friable; few fine roots; strongly acid; clear smooth boundary.

E1--8 to 15 inches; yellowish brown (10YR 5/6) loamy sand; single grained; very friable; few fine and medium roots; strongly acid; clear smooth boundary.

E2--15 to 36 inches; strong brown (7.5YR 5/6) loamy sand; single grained; very friable; few medium roots; strongly acid; clear smooth boundary.

E3--36 to 60+ inches; strong brown (7.5YR 5/6) loamy sand; single grained; loose structure; few fine faint yellowish red (5YR 5/6) mottles in lower part with sand grains coated and bridged with clay; common medium sized pockets of pale brown (10YR 6/3) uncoated sand grains; strongly acid; gradual wavy boundary.

Plot 4 - Compartment 125

Saffell gravelly sandy loam - deep, well drained soils that formed in thick beds of loamy and gravelly coastal plain sediments. Permeability is moderate.

A--0 to 8 inches; yellowish brown (10YR 5/4) gravelly sandy loam; weak fine granular structure; very friable; common fine and few medium roots; about 30% by volume of pebbles; strongly acid; clear smooth boundary.

E--8 to 15 inches; yellowish brown (10YR 5/6) very gravelly sandy loam; weak fine granular structure; very friable few fine and medium roots; 40% by volume of pebbels; strongly acid; clear smooth boundary.

Bt1--15 to 30+ inches (hit too much gravel); reddish yellow (7.5YR 6/8) very gravelly sandy loam; weak medium subangular blocky structure; friable; about 50% by volume of pebbles; common thin patchy clay films on faces of peds; strongly acid; clear smooth boundary.

Plot 1 - Compartment 126

Maubila sandy loam - very deep, moderately well drained soils that formed in thick beds of clayey coastal plain marine sediments. Permeability is slow.

A--0 to 3 inches; dark yellowish brown (10YR 4/4) flaggy loam; weak fine granular structure; very friable; common fine and few medium roots; about 25% angular fragments of ironstone; very strongly acid; clear smooth boundary.

Bt1--3 to 12 inches; strong brown (7.5YR 5/6) sandy clay loam; weak fine subangular blocky structure; firm; few faint clay films on faces of peds; about 10% angular fragments of ironstone; very strongly acid; clear smooth boundary.

Bt2--12 to 21 inches; strong brown (7.5YR 5/6) clay; moderate medium subangular blocky structure; very firm; common faint clay films on faces of peds; common medium distinct red (2.5 YR 4/6) and light brownish gray (10YR 6/2) mottles; very strongly acid; clear smooth boundary.

Bt3--21 to 35 inches; strong brown (7.5YR 5/6) clay; moderate medium subangular blocky structure; very firm; common distinct clay films on faces of peds; many fine and medium prominent yellowish brown (10YR 5/6), red (2.5YR 4/6), and light gray (10YR 7/2) mottles; very strongly acid; clear smooth boundary.

BC--35 to 53 inches; gray (10YR 6/1), strong brown (7.5YR 5/6), red (2.5YR 4/6), and weak red (10R 4/3) clay loam; weak coarse subangular blocky structure; firm; very strongly acid.

C--53 to 60+ inches; gray (10YR 6/1), yellowish brown (10YR 5/6), strong brown (7.5YR 5/6), and red (10R 4/6) clay; massive; firm; few thin strata and pockets of sandy clay and clay loam; 10% by volume of ironstone; many fine flakes of mica; very strongly acid.

Plot 2 - Compartment 126

Luverne fine sandy loam - very deep, well drained soils that formed in stratified marine sediments of the southern Coastal Plain. Permeability is moderatly slow. Site has been farmed as evident by plow layer, slightly eroded.

Ap--0 to 4 inches; very dark grayish brown (10YR 3/2) fine sandy loam; weak fine granular structure; very friable; common fine and few medium roots; strongly acid; clear smooth boundary.

BE--4 to 12 inches; light yellowish brown (10YR 6/4) fine sandy loam; weak medium granular and subangular blocky structure; very friable; common fine and few medium roots; strongly acid; clear smooth boundary.

Bt1--12 to 30 inches; yellowish red (5YR 5/6) clay loam; moderate medium subangular blocky structure; firm; continuous clay films on faces of peds; common fine flakes of mica; few medium and coarse roots; strongly acid; gradual smooth boundary.

Bt2--30 to 38 inches; mottled brownish yellow (10YR 6/8), strong brown (7.5YR 5/6), yellowish red (5YR 5/8) and red (2.5YR 5/6) clay loam; moderate medium subangular blocky structure; friable; sand grains coated and bridged with clay; few fine mica flakes; strongly acid; clear smooth boundary.

BC--38 to 46 inches; mottled brownish yellow (10YR 6/8), strong brown (7.5YR 5/6), yellowish red (5YR 5/8) and red (2.5YR 5/6) sandy clay loam; moderate medium subangular blocky structure; friable; thin patchy clay films on faces of peds; common fine mica flakes; very strongly acid; clear wavy boundary.

C--46 to 60+ inches; mottled strong brown (7.5YR 5/6), yellowish red (5YR 5/8) and red (2.5YR 5/6) loam; moderate medium platy structure; friable; thin clay films on faces of peds; many fine flakes of mica; very strongly acid.

Plot 3 - Compartment 126

Smithdale fine sandy loam - deep, well drained soils that formed in thick beds of loamy upper coastal plain sediments. Permeability is moderate.

A--0 to 6 inches; very dark grayish brown (10YR 4/2) fine sandy loam; weak fine granular structure; very friable; common fine and few medium roots; strongly acid; clear smooth boundary.

E--6 to 9 inches; yellowish brown (10YR 5/6) fine sandy loam; weak medium granular structure; very friable; common fine and few medium roots; strongly acid; clear smooth boundary.

Bt1--11 to 36 inches; strong brown (7.5YR 5/6) clay loam; moderate medium subangular blocky structure; friable; thin patchy clay films on faces of peds; sand grains coated and bridged with clay; few medium and coarse roots; few fine mica flakes; strongly acid; clear smooth boundary.

Bt2--36 to 53 inches; strong brown (5YR 5/6) clay loam; weak medium subangular blocky structure; friable; sand grains coated and bridged with clay; few fine mica flakes; strongly acid; clear smooth boundary.

Bt3--45 to 60+ inches; yellowish red (5YR 5/6) sandy loam; common fine faint strong brown (7.5YR 5/8) mottles; weak medium subangular blocky structure; very friable; sand grains coated and bridged with clay; few fine mica flakes; strongly acid; clear wavy boundary.

Stop 4 - Compartment 126

Luverne fine sandy loam - very deep, well drained soils that formed in stratified marine sediments of the southern Coastal Plain. Permeability is moderatly slow. Site has been farmed as evident by plow layer, slightly eroded.

Ap--0 to 5 inches; very dark grayish brown (10YR 3/2) fine sandy loam; weak fine granular structure; very friable; common fine and few medium roots; strongly acid; clear smooth boundary.

Bt1--5 to 14 inches; yellowish red (5YR 5/6) clay; moderate medium subangular blocky structure; firm; continuous clay films on faces of peds; common fine flakes of mica; few medium and coarse roots; strongly acid; gradual smooth boundary.

Bt2--14 to 32 inches; mottled brownish yellow (10YR 6/8), strong brown (7.5YR 5/6), yellowish red (5YR 5/8) and red (2.5YR 5/6) clay loam; moderate medium subangular blocky structure; friable; sand grains coated and bridged with clay; few fine mica flakes; strongly acid; clear smooth boundary.

BC--32 to 38 inches; mottled brownish yellow (10YR 6/8), strong brown (7.5YR 5/6), yellowish red (5YR 5/8) and red (2.5YR 5/6) sandy clay loam; moderate medium subangular blocky structure; friable; thin patchy clay films on faces of peds; common fine mica flakes; very strongly acid; clear wavy boundary.

C--38+ inches; mottled strong brown (7.5YR 5/6), yellowish red (5YR 5/8) and red (2.5YR 5/6) loam; moderate medium platy structure; friable; thin clay films on faces of peds; many fine flakes of mica; very strongly acid.

C-125 P-2

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SOIL ANALYSIS

CLIENT	GROWER	REPORT
U.S. DEPT OF AGRI FORESTRY SCIENCES LAB 320 GREEN ST. ATHENS, GA [illegible]	WILLIAM [illegible] DATE [illegible]	DATE [illegible] ACCOUNT [illegible] PAGE [illegible] A&L AGRONOMIST [illegible]

LAB NUMBER 08974 **SAMPLE ID** B-11 **SIGNATURE** Richard Large

TEST	RESULTS
Soil pH	4.9
Buffer pH	7.89
Phosphorus (P)	10 LB/ACRE
Potassium (K)	70 LB/ACRE
Calcium (Ca)	324 LB/ACRE
Magnesium (Mg)	80 LB/ACRE
Sulphur (S)	20 LB/ACRE
Boron (B)	1.0 LB/ACRE
Copper (Cu)	2.2 LB/ACRE
Iron (Fe)	122 LB/ACRE
Manganese (Mn)	106 LB/ACRE
Zinc (Zn)	1.0 LB/ACRE
Sodium (Na)	30 LB/ACRE
Soluble Salts	
Organic Matter	3.2 % ENR 108
NO_3-N	
TKN	512 LB/ACRE

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

CATION EXCHANGE CAPACITY

2.2 meq/100g

CATION SATURATION

%K	4.1
%Ca	36.8
%Mg	15.2
%H	40.0
%Na	3.0

SOIL TEST METHOD

MEHLICH EXTRACTION

SOIL FERTILITY GUIDELINES

CROP: **YIELD GOAL:**

LIME	N	P_2O_5	K_2O	Mg	S	B	Cu	Mn	Zn

C-126 P-4

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SOIL ANALYSIS

CLIENT	GROWER	REPORT
U S DEPT OF AGRI FORESTRY SCIENCES LAB 320 GREEN ST [illegible] ATHENS GA 30602-2044	WILLIAM OSTROFSKY [illegible] DATE RECEIVED [illegible]	DATE [illegible] ACCOUNT [illegible] PAGE [illegible] A&L AGRONOMIST [illegible]

LAB NUMBER 08975 SAMPLE ID B-12 SIGNATURE Richard Large

TEST	RESULTS	Very Low	Low	Medium	Optimum	Very High	CATION EXCHANGE CAPACITY
Soil pH	4.9						6.1 meq/100g
Buffer pH	7.44						
Phosphorus (P)	8 LB/ACRE						
Potassium (K)	98 LB/ACRE						CATION SATURATION
Calcium (Ca)	410 LB/ACRE						%K 2.1
Magnesium (Mg)	94 LB/ACRE						%Ca 16.8
Sulphur (S)	102 LB/ACRE						%Mg 6.4
Boron (B)	0.8 LB/ACRE						%H 73.4
Copper (Cu)	2.4 LB/ACRE						%Na 1.1
Iron (Fe)	104 LB/ACRE						
Manganese (Mn)	120 LB/ACRE						SOIL TEST METHOD
Zinc (Zn)	1.6 LB/ACRE						MEHLICH EXTRACTION
Sodium (Na)	30 LB/ACRE						
Soluble Salts							
Organic Matter	4.1 % ENR 126						
NO_3-N							
TKN	426 LB/ACRE						

SOIL FERTILITY GUIDELINES

CROP: YIELD GOAL:

LIME	N	P_2O_5	K_2O	Mg	S	B	Cu	Mn	Zn

C-125-P-1

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SOIL ANALYSIS

CLIENT [illegible]	GROWER [illegible]	REPORT [illegible]
U S DEPT OF AGRI	WILLIAM [illegible]	DATE [illegible]
FORESTRY SCIENCES LAB	[illegible]	ACCOUNT [illegible]
[illegible]	[illegible]	PAGE [illegible]
ATHENS, GA [illegible]	[illegible]	[illegible]
	DATE [illegible]	

LAB NUMBER 08976 **SAMPLE ID** B-13 **SIGNATURE** Richard Large

TEST	RESULTS	Very Low	Low	Medium	Optimum	Very High
Soil pH	4.9					
Buffer pH	7.72					
Phosphorus (P)	14 LB/ACRE					
Potassium (K)	52 LB/ACRE					
Calcium (Ca)	322 LB/ACRE					
Magnesium (Mg)	68 LB/ACRE					
Sulphur (S)	18 LB/ACRE					
Boron (B)	0.6 LB/ACRE					
Copper (Cu)	2.4 LB/ACRE					
Iron (Fe)	130 LB/ACRE					
Manganese (Mn)	140 LB/ACRE					
Zinc (Zn)	1.0 LB/ACRE					
Sodium (Na)	28 LB/ACRE					
Soluble Salts						
Organic Matter	2.1 % ENR 86					
NO_3-N						
TKN	468 LB/ACRE					

CATION EXCHANGE CAPACITY
3.5 meq/100g

CATION SATURATION

%K	1.9
%Ca	23.0
%Mg	8.1
%H	64.0
%Na	1.7

SOIL TEST METHOD
MEHLICH EXTRACTION

SOIL FERTILITY GUIDELINES

CROP: **YIELD GOAL:**

LIME	N	P_2O_5	K_2O	Mg	S	B	Cu	Mn	Zn

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C-126 P-3

SOIL ANALYSIS

CLIENT
U S DEPT OF AGRIC.
FORESTRY SCIENCES LAB
320 GREEN ST
ATHENS, GA 30602 2044

GROWER
WILLIAM OSTR[illegible]
DATE RECEIVED [illegible]

REPORT [illegible]
DATE [illegible]
ACCOUNT [illegible]

LAB NUMBER 08977 **SAMPLE ID** B-14 **SIGNATURE** Richard Large

TEST	RESULTS	Very Low	Low	Medium	Optimum	Very High
Soil pH	4.9					
Buffer pH	7.57					
Phosphorus (P)	12 LB/ACRE					
Potassium (K)	60 LB/ACRE					
Calcium (Ca)	510 LB/ACRE					
Magnesium (Mg)	78 LB/ACRE					
Sulphur (S)	16 LB/ACRE					
Boron (B)	0.8 LB/ACRE					
Copper (Cu)	2.2 LB/ACRE					
Iron (Fe)	130 LB/ACRE					
Manganese (Mn)	96 LB/ACRE					
Zinc (Zn)	0.8 LB/ACRE					
Sodium (Na)	28 LB/ACRE					
Soluble Salts						
Organic Matter	1.9 % ENR 102					
NO_3-N						
TKN	398 LB/ACRE					

CATION EXCHANGE CAPACITY
5.2
meq/100g

CATION SATURATION
%K 1.5
%Ca 24.5
%Mg 6.3
%H 66.2
%Na 1.2

SOIL TEST METHOD
MEHLICH
EXTRACTION
--

SOIL FERTILITY GUIDELINES

CROP: **YIELD GOAL:**

LIME	N	P_2O_5	K_2O	Mg	S	B	Cu	Mn	Zn

C-137 P-2

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SOIL ANALYSIS

CLIENT	GROWER	
U S DEPT OF AGRI. FORESTRY SCIENCES LAB 320 GREEN ST ATHENS, GA 30602 2044	WILLIAM OSTR[illegible] DATE RECEIVED: [illegible]	REPORT DATE ACCOUNT PAGE A&L AGRONOMIST

LAB NUMBER 08978 SAMPLE ID B-15 SIGNATURE Richard Large

TEST	RESULTS	Very Low	Low	Medium	Optimum	Very High	CATION EXCHANGE CAPACITY
Soil pH	4.8						
Buffer pH	7.82						2.5 meq/100g
Phosphorus (P)	8 LB/ACRE						
Potassium (K)	52 LB/ACRE						
Calcium (Ca)	256 LB/ACRE						CATION SATURATION
Magnesium (Mg)	62 LB/ACRE						
Sulphur (S)	20 LB/ACRE						%K 2.7
Boron (B)	0.8 LB/ACRE						%Ca 25.6
Copper (Cu)	1.6 LB/ACRE						%Mg 10.3
Iron (Fe)	104 LB/ACRE						%H 57.6
Manganese (Mn)	62 LB/ACRE						%Na 2.3
Zinc (Zn)	1.0 LB/ACRE						
Sodium (Na)	26 LB/ACRE						SOIL TEST METHOD
Soluble Salts							
Organic Matter	1.6 % ENR 74						MEHLICH EXTRACTION
NO_3-N							
TKN	352 LB/ACRE						

SOIL FERTILITY GUIDELINES

CROP: YIELD GOAL:

LIME	N	P_2O_5	K_2O	Mg	S	B	Cu	Mn	Zn

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C-137 P-3

SOIL ANALYSIS

CLIENT	GROWER	REPORT
U S DEPT OF AGRI FORESTRY SCIENCES LAB 320 GREEN ST ATHENS GA 30602 2044	WILLIAM OSTROSINA [illegible] DATE RECEIVED: 06/07/[illegible]	REPORT [illegible] DATE [illegible] ACCOUNT [illegible] PAGE [illegible] A&L AGRONOMIST [illegible]

LAB NUMBER 08964 **SAMPLE ID** B-1 **SIGNATURE** Richard Large

TEST	RESULTS	SOIL TEST RATINGS: Very Low	Low	Medium	Optimum	Very High	CATION EXCHANGE CAPACITY
Soil pH	4.9						
Buffer pH	7.75						3.3
Phosphorus (P)	8 LB/ACRE						meq/100g
Potassium (K)	64 LB/ACRE						
Calcium (Ca)	338 LB/ACRE						**CATION**
Magnesium (Mg)	78 LB/ACRE						**SATURATION**
Sulphur (S)	18 LB/ACRE						%K 2.5
Boron (B)	0.8 LB/ACRE						%Ca 25.6
Copper (Cu)	2.0 LB/ACRE						%Mg 9.8
Iron (Fe)	136 LB/ACRE						%H 60.6
Manganese (Mn)	100 LB/ACRE						%Na 2.1
Zinc (Zn)	3.0 LB/ACRE						
Sodium (Na)	32 LB/ACRE						**SOIL TEST**
Soluble Salts							**METHOD**
Organic Matter	1.6 % ENR 96						MEHLICH
NO_3-N							EXTRACTION
TKN	270 LB ACRE						

SOIL FERTILITY GUIDELINES

CROP: **YIELD GOAL:**

LIME	N	P_2O_5	K_2O	Mg	S	B	Cu	Mn	Zn

C-20 P-3

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SOIL ANALYSIS

CLIENT	GROWER	REPORT
U S DEPT OF AGRI FORESTRY SCIENCES [illegible] 320 GREEN [illegible] ATHENS GA [illegible]	[illegible] DATE RECEIVED [illegible]	[illegible]

LAB NUMBER 08965 SAMPLE ID B-2 SIGNATURE Richard Large

TEST	RESULTS	Very Low	Low	Medium	Optimum	Very High
Soil pH	4.9					
Buffer pH	7.58					
Phosphorus (P)	12 LB/ACRE	█	█			
Potassium (K)	70 LB/ACRE	█				
Calcium (Ca)	428 LB/ACRE	█				
Magnesium (Mg)	74 LB/ACRE	█	█			
Sulphur (S)	22 LB/ACRE	█	█	█		
Boron (B)	0.8 LB/ACRE	█	█	█		
Copper (Cu)	3.0 LB/ACRE	█	█	█		
Iron (Fe)	300 LB/ACRE	█	█	█	█	
Manganese (Mn)	42 LB/ACRE	█	█			
Zinc (Zn)	3.6 LB/ACRE	█	█	█		
Sodium (Na)	30 LB/ACRE	█				
Soluble Salts						
Organic Matter	4.4 % ENR 132					
NO_3-N						
TKN	334 LB/ACRE					

CATION EXCHANGE CAPACITY

4.9 meq/100g

CATION SATURATION

%K	1.8
%Ca	21.8
%Mg	6.3
%H	68.6
%Na	1.3

SOIL TEST METHOD

MEHLICH EXTRACTION

SOIL FERTILITY GUIDELINES

CROP: YIELD GOAL:

LIME	N	P_2O_5	K_2O	Mg	S	B	Cu	Mn	Zn

C-137 P-1

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SOIL ANALYSIS

CLIENT	GROWER	REPORT
U S DEPT OF AGRI FORESTRY SCIENCES LAB 320 GREEN ST ATHENS, GA 30602 2044	WILLIAM [illegible] DATE RECEIVED: [illegible]	DATE ACCOUNT PAGE A&L AGRONOMIST

LAB NUMBER 08966 SAMPLE ID B-3 SIGNATURE Richard Large

TEST	RESULTS	SOIL TEST RATINGS: Very Low	Low	Medium	Optimum	Very High	CATION EXCHANGE CAPACITY
Soil pH	5.2						3.2 meq/100g
Buffer pH	7.73						
Phosphorus (P)	8 LB/ACRE						
Potassium (K)	52 LB/ACRE						CATION SATURATION
Calcium (Ca)	248 LB/ACRE						%K 2.1
Magnesium (Mg)	64 LB/ACRE						%Ca 19.4
Sulphur (S)	22 LB/ACRE						%Mg 8.3
Boron (B)	0.8 LB/ACRE						%H 67.5
Copper (Cu)	1.8 LB/ACRE						%Na 1.6
Iron (Fe)	134 LB/ACRE						
Manganese (Mn)	108 LB/ACRE						
Zinc (Zn)	1.2 LB/ACRE						SOIL TEST METHOD
Sodium (Na)	24 LB/ACRE						MEHLICH EXTRACTION
Soluble Salts							
Organic Matter	1.8 % ENR 80						
NO_3-N							
TKN	476 LB/ACRE						

SOIL FERTILITY GUIDELINES

CROP: YIELD GOAL:

LIME	N	P_2O_5	K_2O	Mg	S	B	Cu	Mn	Zn

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C-20 P-1

SOIL ANALYSIS

CLIENT	GROWER	
U S DEPT OF AGRI FORESTRY SCIENCES LAB 320 GREEN ST ATHENS GA 30602-2044	WILLIAM OSTROSINA [illegible] DATE RECEIVED: 06/01/98	REPORT [illegible] DATE [illegible] ACCOUNT [illegible] PAGE [illegible] A&L AGRONOMIST [illegible]

LAB NUMBER 08967 **SAMPLE ID** B-4 **SIGNATURE** Richard Large

TEST	RESULTS	SOIL TEST RATINGS: Very Low	Low	Medium	Optimum	Very High
Soil pH	4.9					
Buffer pH	7.61					
Phosphorus (P)	12 LB/ACRE					
Potassium (K)	114 LB/ACRE					
Calcium (Ca)	356 LB/ACRE					
Magnesium (Mg)	100 LB/ACRE					
Sulphur (S)	34 LB/ACRE					
Boron (B)	1.0 LB/ACRE					
Copper (Cu)	2.2 LB/ACRE					
Iron (Fe)	198 LB/ACRE					
Manganese (Mn)	262 LB/ACRE					
Zinc (Zn)	1.6 LB/ACRE					
Sodium (Na)	28 LB/ACRE					
Soluble Salts						
Organic Matter	1.3 % ENR 70					
NO_3-N						
TKN	428 LB/ACRE					

CATION EXCHANGE CAPACITY

4.6 meq/100g

CATION SATURATION

%K	3.2
%Ca	19.3
%Mg	9.1
%H	67.8
%Na	1.3

SOIL TEST METHOD

MEHLICH EXTRACTION

SOIL FERTILITY GUIDELINES

CROP: **YIELD GOAL:**

LIME	N	P_2O_5	K_2O	Mg	S	B	Cu	Mn	Zn

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C-126 P-2

SOIL ANALYSIS

CLIENT	GROWER	REPORT
U S DEPT OF AGRI, FORESTRY SCIENCES LAB 320 GREEN ST ATHENS, GA 30602-2044	WILLIAM OSTROSINA DATE RECEIVED: [illegible]	REPORT [illegible] DATE [illegible] ACCOUNT [illegible] PAGE [illegible] A&L AGRONOMIST [illegible]

LAB NUMBER 08968 **SAMPLE ID** B-5 **SIGNATURE** Richard Large

TEST	RESULTS	Very Low	Low	Medium	Optimum	Very High	CATION EXCHANGE CAPACITY
Soil pH	4.8						
Buffer pH	7.69						3.5
Phosphorus (P)	10 LB/ACRE						meq/100g
Potassium (K)	62 LB/ACRE						
Calcium (Ca)	256 LB/ACRE						**CATION**
Magnesium (Mg)	58 LB/ACRE						**SATURATION**
Sulphur (S)	24 LB/ACRE						%K 2.3
Boron (B)	0.8 LB/ACRE						%Ca 18.3
Copper (Cu)	2.0 LB/ACRE						%Mg 6.9
Iron (Fe)	102 LB/ACRE						%H 70.9
Manganese (Mn)	44 LB/ACRE						%Na 1.7
Zinc (Zn)	1.6 LB/ACRE						
Sodium (Na)	28 LB/ACRE						**SOIL TEST**
Soluble Salts							**METHOD**
Organic Matter	1.4 % ENR 92						MEHLICH
NO_3-N							EXTRACTION
TKN	534 LB/ACRE						

SOIL FERTILITY GUIDELINES

CROP:

YIELD GOAL:

LIME	N	P_2O_5	K_2O	Mg	S	B	Cu	Mn	Zn

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SOIL ANALYSIS

CLIENT [redacted]

GROWER [redacted]

LAB NUMBER 08969 SAMPLE ID B-6 SIGNATURE Richard Large

TEST	RESULTS	Very Low	Low	Medium	Optimum	Very High
Soil pH	4.6					
Buffer pH	7.51					
Phosphorus (P)	12 LB/ACRE					
Potassium (K)	84 LB/ACRE					
Calcium (Ca)	450 LB/ACRE					
Magnesium (Mg)	96 LB/ACRE					
Sulphur (S)	28 LB/ACRE					
Boron (B)	0.8 LB/ACRE					
Copper (Cu)	2.2 LB/ACRE					
Iron (Fe)	166 LB/ACRE					
Manganese (Mn)	30 LB/ACRE					
Zinc (Zn)	1.8 LB/ACRE					
Sodium (Na)	30 LB/ACRE					
Soluble Salts						
Organic Matter	2.9 % ENR 102					
NO_3-N						
TKN	398 LB/ACRE					

CATION EXCHANGE CAPACITY

5.6 meq/100g

CATION SATURATION

%K	1.9
%Ca	20.1
%Mg	7.1
%H	70.0
%Na	1.2

SOIL TEST METHOD

MEHLICH EXTRACTION

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SOIL FERTILITY GUIDELINES

CROP: YIELD GOAL:

LIME	N	P_2O_5	K_2O	Mg	S	B	Cu	Mn	Zn

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SOIL ANALYSIS

[redacted]

LAB NUMBER 08970 **SAMPLE ID** B-7 **SIGNATURE** Richard Large

TEST	RESULTS	SOIL TEST RATINGS: Very Low	Low	Medium	Optimum	Very High
Soil pH	4.9					
Buffer pH	7.82					
Phosphorus (P)	10 LB/ACRE					
Potassium (K)	58 LB/ACRE					
Calcium (Ca)	284 LB/ACRE					
Magnesium (Mg)	78 LB/ACRE					
Sulphur (S)	18 LB/ACRE					
Boron (B)	1.2 LB/ACRE					
Copper (Cu)	2.8 LB/ACRE					
Iron (Fe)	150 LB/ACRE					
Manganese (Mn)	238 LB/ACRE					
Zinc (Zn)	1.8 LB/ACRE					
Sodium (Na)	34 LB/ACRE					
Soluble Salts						
Organic Matter	3.8 % ENR 120					
NO_3-N						
TKN	470 LB/ACRE					

CATION EXCHANGE CAPACITY
2.6 meq/100g

CATION SATURATION

%K	2.9
%Ca	27.3
%Mg	12.5
%H	55.4
%Na	2.8

SOIL TEST METHOD
MEHLICH EXTRACTION

SOIL FERTILITY GUIDELINES

CROP: **YIELD GOAL:**

LIME	N	P_2O_5	K_2O	Mg	S	B	Cu	Mn	Zn

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SOIL ANALYSIS

CLIENT	GROWER	REPORT
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LAB NUMBER 08971 SAMPLE ID B-8 SIGNATURE Richard Large

TEST	RESULTS	Very Low	Low	Medium	Optimum	Very High
Soil pH	4.7					
Buffer pH	7.34					
Phosphorus (P)	8 LB/ACRE					
Potassium (K)	116 LB/ACRE					
Calcium (Ca)	598 LB/ACRE					
Magnesium (Mg)	206 LB/ACRE					
Sulphur (S)	44 LB/ACRE					
Boron (B)	1.0 LB/ACRE					
Copper (Cu)	2.4 LB/ACRE					
Iron (Fe)	60 LB/ACRE					
Manganese (Mn)	12 LB/ACRE					
Zinc (Zn)	1.2 LB/ACRE					
Sodium (Na)	32 LB/ACRE					
Soluble Salts						
Organic Matter	3.7 % ENR 118					
NO_3-N						
TKN	428 LB/ACRE					

CATION EXCHANGE CAPACITY

7.9 meq/100g

CATION SATURATION

%K	1.9
%Ca	18.9
%Mg	10.9
%H	66.8
%Na	.9

SOIL TEST METHOD

MEHLICH EXTRACTION

SOIL FERTILITY GUIDELINES

CROP: YIELD GOAL:

LIME	N	P_2O_5	K_2O	Mg	S	B	Cu	Mn	Zn

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SOIL ANALYSIS

CLIENT	GROWER	
U S DEPT OF AGRI FORESTRY SCIENCES LAB 320 GREEN ST [illegible] ATHENS, GA 30602 2044	WILLIAM [illegible] [illegible] DATE RECEIVED [illegible]	REPORT [illegible] DATE [illegible] ACCOUNT [illegible] PAGE [illegible] A&L AGRONOMIST [illegible]

LAB NUMBER 08972 **SAMPLE ID** B-9 **SIGNATURE** Richard Large

TEST	RESULTS	SOIL TEST RATINGS: Very Low	Low	Medium	Optimum	Very High
Soil pH	4.7					
Buffer pH	7.61					
Phosphorus (P)	8 LB/ACRE					
Potassium (K)	54 LB/ACRE					
Calcium (Ca)	336 LB/ACRE					
Magnesium (Mg)	78 LB/ACRE					
Sulphur (S)	30 LB/ACRE					
Boron (B)	1.0 LB/ACRE					
Copper (Cu)	2.4 LB/ACRE					
Iron (Fe)	128 LB/ACRE					
Manganese (Mn)	8 LB/ACRE					
Zinc (Zn)	1.4 LB/ACRE					
Sodium (Na)	28 LB/ACRE					
Soluble Salts						
Organic Matter	4.5 % ENR 134					
NO_3-N						
TKN	438 LB/ACRE					

CATION EXCHANGE CAPACITY

4.4 meq/100g

CATION SATURATION

%K	1.6
%Ca	19.1
%Mg	7.4
%H	70.9
%Na	1.4

SOIL TEST METHOD

MEHLICH EXTRACTION

SOIL FERTILITY GUIDELINES

CROP: **YIELD GOAL:**

LIME	N	P_2O_5	K_2O	Mg	S	B	Cu	Mn	Zn

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SOIL ANALYSIS

[redacted]

LAB NUMBER 08973 **SAMPLE ID** B-10 **SIGNATURE** Richard Large

TEST	RESULTS	Very Low	Low	Medium	Optimum	Very High	CATION EXCHANGE CAPACITY
Soil pH	4.9						4.2 meq/100g
Buffer pH	7.79						
Phosphorus (P)	10 LB/ACRE						
Potassium (K)	74 LB/ACRE						CATION SATURATION
Calcium (Ca)	674 LB/ACRE						%K 2.3
Magnesium (Mg)	170 LB/ACRE						%Ca 40.1
Sulphur (S)	18 LB/ACRE						%Mg 16.9
Boron (B)	1.0 LB/ACRE						%H 40.0
Copper (Cu)	4.8 LB/ACRE						%Na 1.7
Iron (Fe)	100 LB/ACRE						
Manganese (Mn)	168 LB/ACRE						SOIL TEST METHOD
Zinc (Zn)	2.0 LB/ACRE						MEHLICH
Sodium (Na)	32 LB/ACRE						EXTRACTION
Soluble Salts							
Organic Matter	1.7 % ENR 78						
NO_3-N							
TKN	374 LB/ACRE						

SOIL FERTILITY GUIDELINES

CROP: **YIELD GOAL:**

LIME	N	P_2O_5	K_2O	Mg	S	B	Cu	Mn	Zn

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