DETERMINATION OF LOBLOLLY PINE RESPONSE TO CULTURAL TREATMENTS BASED ON SOIL CLASS, BASE PRODUCTIVITY, AND COMPETITION LEVEL

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The objective of this research is to better understand what factors drive loblolly pine (*Pinus taeda* L.) growth response to intensive culture in the University of Georgia Plantation Management Research Cooperative's Culture x Density study in the Piedmont and Upper Coastal Plain. Twenty study sites were established ranging from southern Alabama to South Carolina in 1998 or 1999. Treatments included six planting densities [300; 600; 900; 1,200; 1,500; and 1,800 trees per acre (TPA)], in a factorial combination with two cultural treatments (intensive and operational). The intensive culture contained complete competing vegetation control, fertilization at time of planting and additional fertilization before the 3rd, 4th, 6th, 8th, 10th, and 12th growing seasons. The operational treatment included first-year banded weed control, fertilization at planting, and fertilization before the 8th and 12th growing seasons. Age 12 growth response was calculated as the difference between tree and stand values for intensive versus operational culture on the plots planted at 600 TPA.

Sites and soils at each installation were classified into four groups: (1) Piedmont with mixed clay subsoil and > 3 inches topsoil (two installations); (2) Piedmont with kaolinitic subsoil and > 3 inches topsoil (six installations); (3) Upper Coastal Plain with < 20 inches to the argillic horizon (nine installations); and (4) Upper Coastal Plain with > 40 inches to argillic horizon (three installations). Base site productivity at each installation was defined as the expressed site index of the operational culture plots planted at 600 TPA.

Competing vegetation measurements were taken on the operational plots only since the intensive culture plots had complete weed control. The competition measurements, taken at ages 2, 4, 6, 8, and 10, include percent cover and height of the following: andropogon grasses, other grasses, and broadleaf plants, as well as an herbaceous measurement which was the sum of all three. Measurements were also taken on small and large woody stems in the form of height, sum height per acre, area per acre, volume per acre, and number of stems per acre. Small woody material is defined as material < 1.6 inches diameter at breast height (d.b.h.) or < 4.5-feet tall, and large woody is defined as > 1.6 inches d.b.h. or taller than 4.5 feet.

Age 12 loblolly pine mean d.b.h., height, basal area per acre, and volume per acre for intensive culture, operational culture and the response to intensive culture are presented in table 1 along with standard deviations and ranges. The operational culture plots averaged 6.9 inches in d.b.h., 46 feet in height, 146 square feet per acre in basal area, and 3,256 cubic feet per acre in volume. The growth response averaged 0.6 inch in d.b.h., 3 feet in height, 24 square feet per acre in basal area, and 762 cubic feet per acre in volume. Growth response was highly variable ranging from -644 to 1,665 cubic feet per acre. Two study sites exhibited no growth response to the intensive treatment; the cause of this is unknown but possibly due to microsite conditions and only having single replicates.

We did not observe a strong relationship between age 12 volume per acre response and soil class, base site productivity, or competing vegetation level on operational plots Although significant differences were not detected among the site-soil classes (fig. 1), the Upper Coastal Plain sites with > 40 inches to the argillic have the largest observed pine growth response. Age 12 response was poorly related to base site

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Table 1--Summary statistics of age 12 tree and stand attributes for intensive culture, operational culture, and volume per acre responses for 20 study locations in the Piedmont and Upper Coastal Plain

Culture	Attributes	Mean	Std. dev.	Range
Intensive	Volume (*feet*^{3}*/acre*)	4,018	715	2,286 - 5,169
	BA (*feet*^{2}*/acre*)	170	23	111 - 215
	Height (*feet*)	50	4	41 - 57
	D.b.h (*inches*)	7.5	0.56	5.9 - 8.3
Operational	Volume (*feet*^{3}*/acre*)	3,256	688	1,878 - 4,482
	BA (*feet*^{2}*/acre*)	146	24	98 -187
	Height (*feet*)	46	4	39 - 53
	D.b.h. (*inches*)	6.9	0.74	5.6 - 8.9
Response	Volume (*feet*^{3}*/acre*)	762	608	-644 -1,665
	BA (*feet*^{2}*/acre*)	24	17	-15 - 54
	Height (*feet*)	3	3	-5 -10
	D.b.h. (*inches*)	0.6	0.69	-1.4 - 1.5

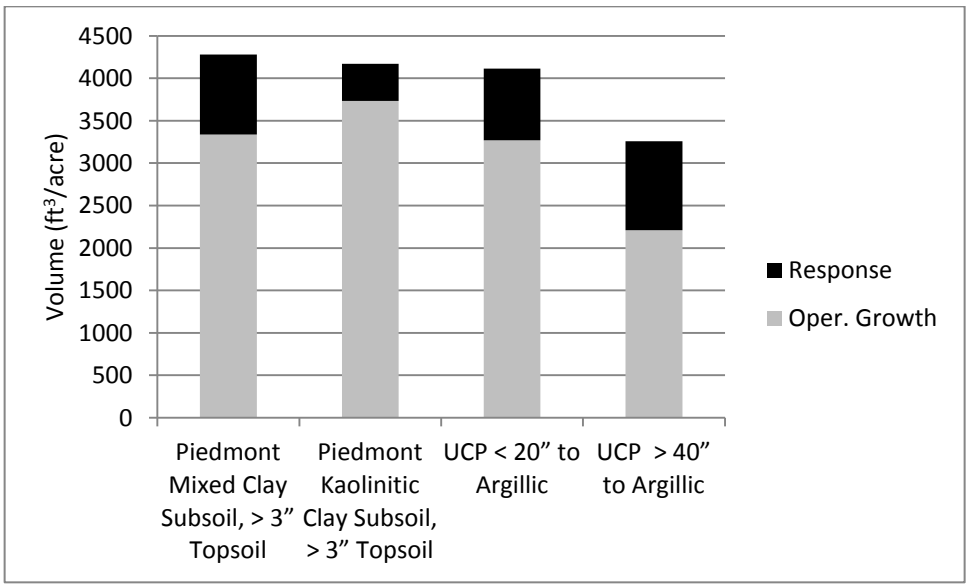

Figure 1--Age 12 mean loblolly pine standing volume per acre for operational culture and response to intensive culture by soil groups.

productivity on the operational plot (R^2 = 0.03, p = 0.40) although there did appear to be a trend of smaller responses as the site index increased. The best relationships between response and competition values were found using age 4 competition data. Age 12 volume response was significantly correlated with age 4 percent grass cover (R^2 = 0.21, p = 0 .031) and mean grass height (R^2 = 0.30, p = 0.011). The growth response tends to increase as competition levels increase on the operational plots.

Controlling competing vegetation has been proven to produce significant growth gains in a loblolly pine plantation system (Miller and others 2003). In addition, the application of fertilizer to loblolly pine has also increased the growth rates of southern plantations (Fox and others 2007). The combination of competition control and fertilization of loblolly pine produces the best results to increase pine growth response (Borders and Bailey 2001).While there was a significant range of age 12 response to intensive culture, the factors examined (soil class, base

site productivity, and competing vegetation) were not strong determinants of pine plantation response magnitude on these well drained Piedmont and Upper Coastal Plain sites. Using a different soil classification system could prove to be a better predictor for pine growth response. Also, incorporating a measure of soil moisture and rainfall records could provide additional insight to pine growth response. It should be noted that the response measured in this study is to a combination of fertilization and competition control, and the effects of only fertilization or only competition control cannot be calculated. Finally, even the operational treatment used in this study could be considered intensive compared to typical field operations, and it is possible that the growth responses exhibited in this experiment could have been achieved with fewer cultural inputs.

LITERATURE CITED

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