GROWTH POTENTIAL OF LOBLOLLY PINE PLANTATIONS IN THE GEORGIA PIEDMONT

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During the past 10 years over a million acres of marginal agricultural land in Georgia have been converted to loblolly pine plantations, much of it since 1986 as a result of the Conservation Reserve Program (Hays, 1989). A study to provide growth and yield information for genetically improved loblolly pine planted in such an old-field in the Georgia Piedmont was installed in 1983 at the B.F. Grant Memorial Forest of the Warnell School of Forest Resources, University of Georgia, in Putnam County. If growth rates observed in this study are indicative of what can be expected from similarly treated loblolly pine plantations in the region, it will have a profound impact, both on fiber supply and on profitability.

Description of the Study

The study is located in a region where the soils are dominated by Typic Kanhapludults (Cecil Series) and Rhodic Kandiudults (Davidson Series). The old-field is located on a gently sloping hilltop and had been planted to soybeans in previous years. It was hand-planted with a dibble in March 1983 at a 6 ft x 6 ft spacing with improved loblolly pine seedlings supplied by the state nursery. In May a small rubber-tired farm tractor was used to mow herbaceous competition between the rows, and one month later, to spray Oust with a boom sprayer at a rate of 8 ounces per acre to control herbaceous competition, primarily Johnson grass (*Sorghum halepense*) and vetch (*Vicia* sp.). In July, twenty four fifth-acre plots were installed, each with a tenth-acre interior measurement plot, and four plots were randomly assigned to each of 6 stocking levels, namely, 100, 200, 400, 600, 800 and 1000 trees per acre. Surviving seedlings in each plot were reduced to the required number by systematic selection to avoid bias and to assure uniform spacing.

A second herbicide release treatment with 8 ounces of Oust per acre was applied in May 1984 during the second growing season to eliminate reoccurring herbaceous competition. One year later, in May 1985, wildlings of both loblolly pine and sweetgum that had seeded in from neighboring stands, were eliminated on plots where this had occurred. As a result of these treatments all plots have been growing essentially free of any competing vegetation.

Results

Tree heights were measured with a telescoping height measurement pole during the 3rd growing season and again after the 5th, 8th and 10th growing seasons. Diameters (DBH) were measured with a diameter tape after the 5th, 8th and 10th growing seasons. The focus of this paper is on the growth potential of old-field loblolly pine plantations on similar sites in this region, but results are summarized separately for the 6 stocking levels since a comparison of the effects of different stocking levels on plantation growth and yield is of interest to forest managers.

1. Height

Height measurements are summarized below, and in Figures 1 and 2. After 10 growing seasons average tree heights ranged from 37 to 43 ft among the different planting densities. Based on Tukey's multiple comparisons test a difference of 5.7 ft between any two means would be statistically significant at the 95% confidence level. For planting densities from 200 to 1000 per acre the average heights are not significantly different, but for a planting density of 100 per acre, height growth appears to be inhibited. The highest periodic average annual growth rate occurred from age 8 to age 10, namely 4.6 ft for densities of 200 to 1000.

Average height for different planting densities (ft)

Age	Planting Survival at age 1					
	100	200	400	600	800	1000
3	10.2	11.2	12.8	12.3	11.5	11.5
5	16.5	17.8	19.9	19.6	18.1	18.4
8	28.2	29.6	33.2	33.0	31.1	31.9
10	36.6	40.3	43.0	41.8	40.0	40.1
Survival at age 10	100	200	398	572	762	925

There has been no appreciable mortality since the plots were installed at the required densities after the first growing season, but intra-specific competition is beginning to cause some mortality in planting densities above 600 per acre.

It is unlikely that any existing site index equation will provide a good approximation to the dominant/codominant height growth curves for old-field plantations in which competing vegetation is controlled as it has been in these study plots. With an average dominant/codominant height of 42 ft at age 10, Clutter and Lenhart's (1968) old-field site index equation estimates the site index as 80, while the Borders' and others (1990) equation for cutover and mechanically site-prepared plantations gives an estimate of 74. Average site index for cutover and mechanically site-prepared plantations on similar soils in this region without further competition control is between 55 and 60.

FIG 1. HEIGHT GROWTH FOR DIFFERENT PLANTING DENSITIES

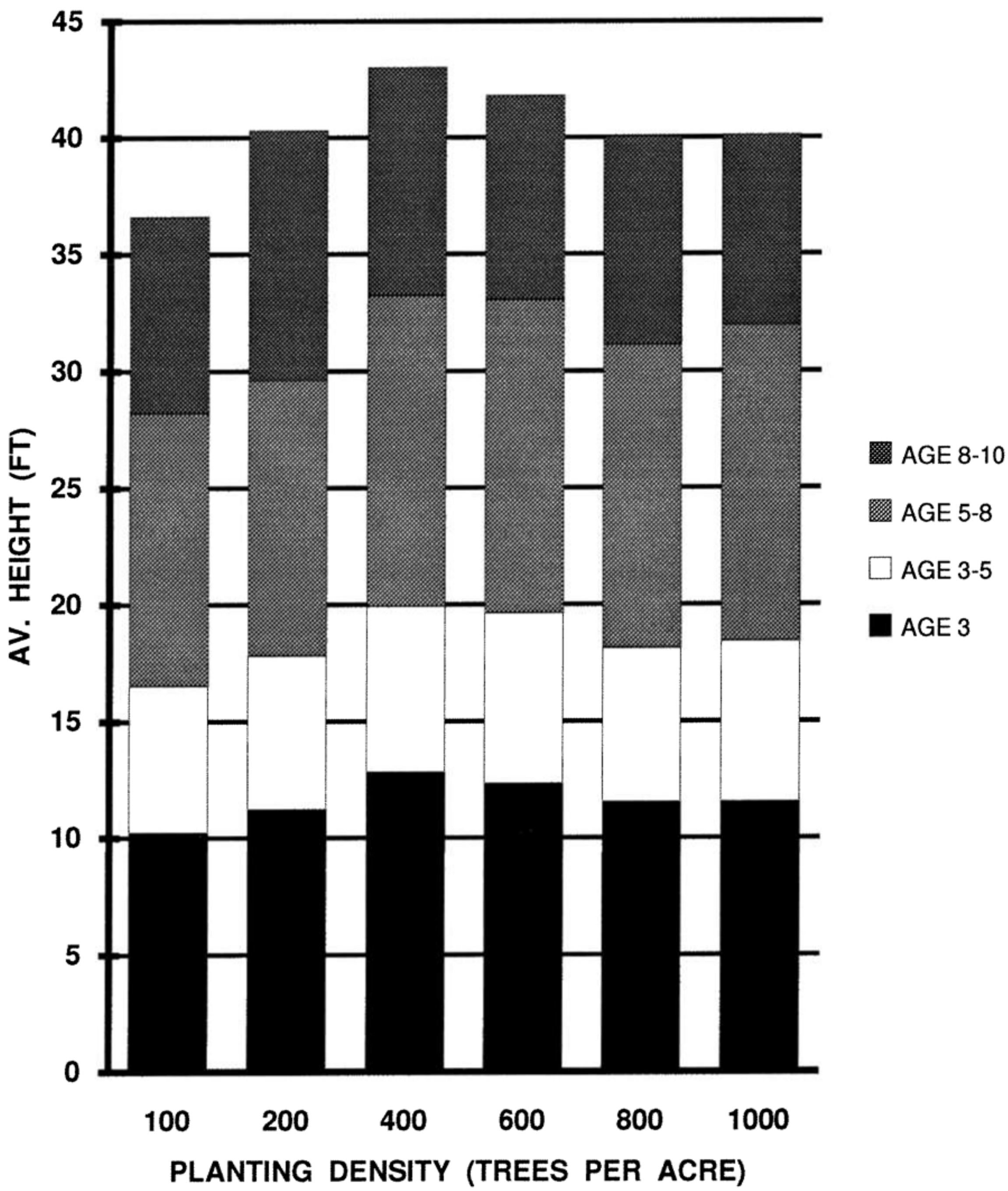
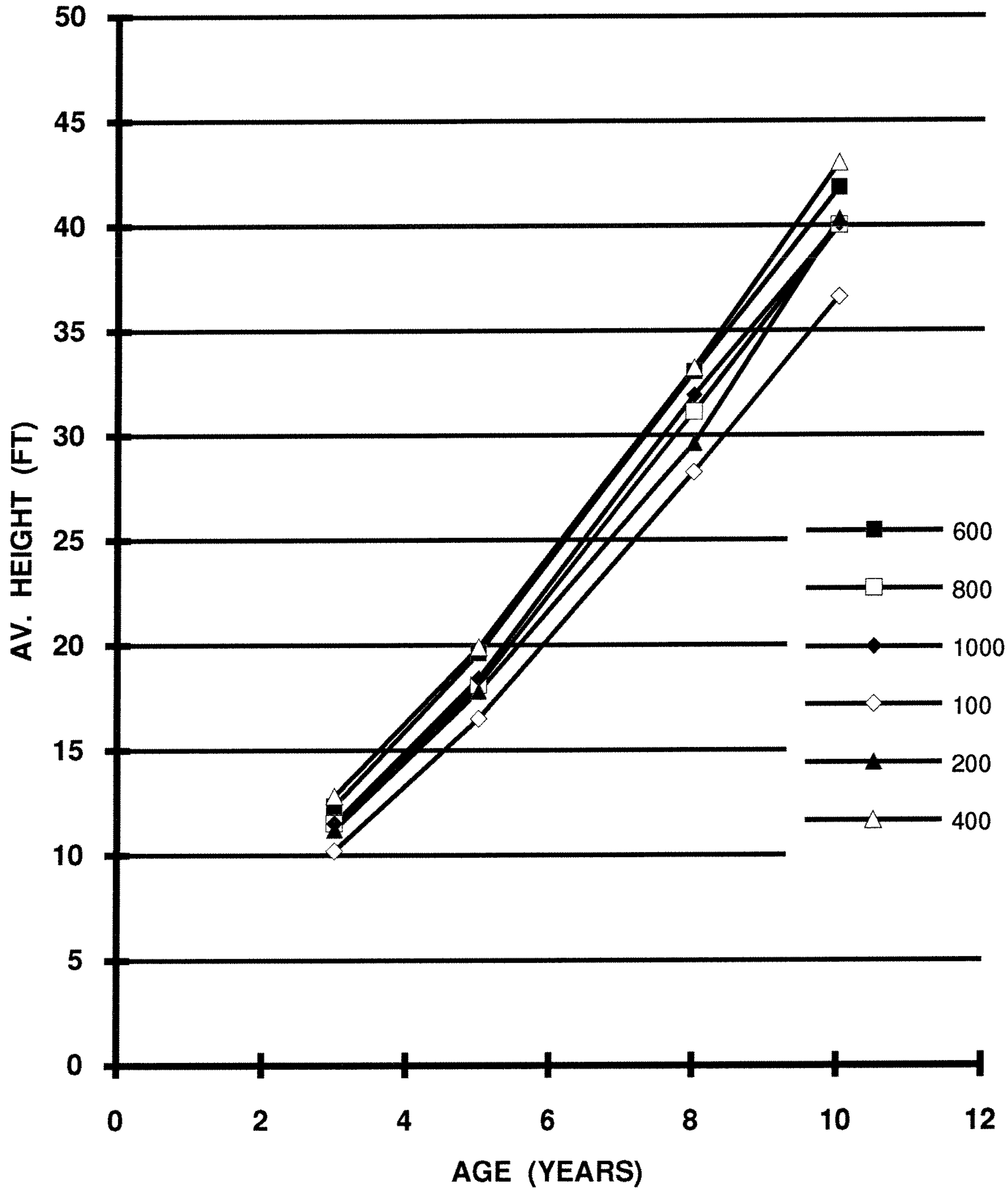


FIG 2. HEIGHT GROWTH FOR DIFFERENT PLANTING DENSITIES



2. Basal Area

Basal areas per acre are summarized below and in Figures 3 and 4 at ages 5, 8 and 10.

Average basal area per acre (sq ft)

	Planting survival at age 1					
Age	100	200	400	600	800	1000
5	7.38	18.13	39.63	46.85	53.45	61.09
8	34.28	67.03	108.92	119.12	132.57	139.00
10	53.88	94.23	140.92	150.17	165.53	172.55

Basal area at age 10 ranged from 53.88 sq ft per acre for a planting density of 100 to 172.55 sq ft for 1000 trees per acre. A difference of 25.46 sq ft between any two means would be significant at the 95% confidence level. There is a clear trend of increasing basal area with increasing planting density, but for planting densities of 600, 800 and 1000 per acre differences at age 10 are not significant at this confidence level.

Basal area growth has been exceptional compared to existing old-field yield prediction equations for the Georgia Piedmont. Lenhart and Clutter's equation predicts 114.8 sq ft at age 10 for 600 surviving trees for a site index of 70. The basal area prediction equation for cutover, mechanically site-prepared plantations (Borders and others, 1990) predicts 104.5 sq ft. In this study the average basal area for a planting density of 600 is 150.2 sq ft. with 572 trees surviving at age 10.

FIG 3. BASAL AREA GROWTH FOR DIFFERENT PLANTING DENSITIES

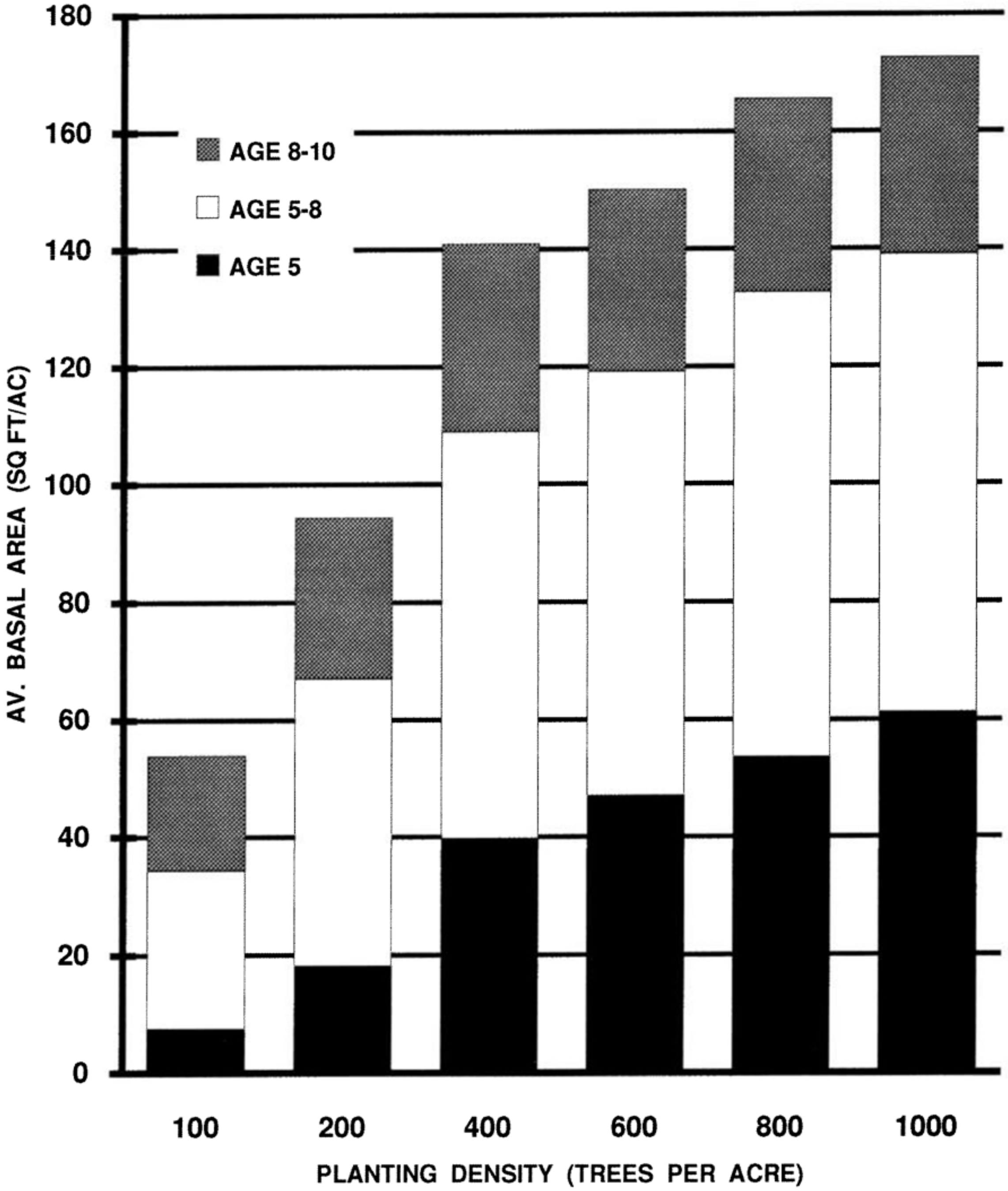
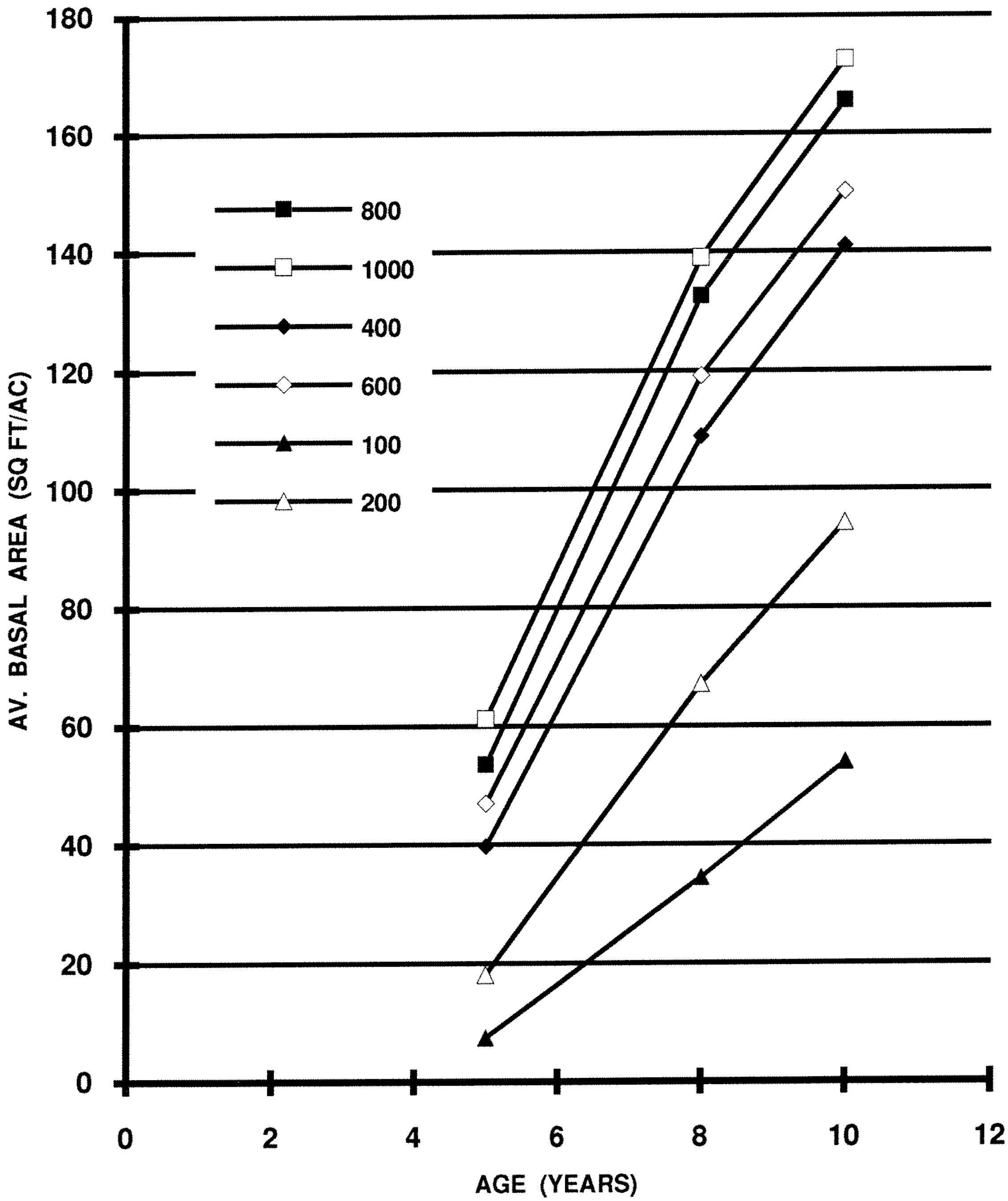


FIG 4. BASAL AREA GROWTH FOR DIFFERENT PLANTING DENSITIES



3. Average DBH

Diameter measurements at ages 5, 8 and 10 are summarized below and in Figures 5 and 6.

Average DBH for different planting densities (inches)

Age	Planting survival at age 1					
	100	200	400	600	800	1000
5	3.6	4.0	4.2	3.8	3.5	3.3
8	7.8	7.8	7.0	6.0	5.5	5.1
10	9.9	9.2	8.0	6.8	6.2	5.8

At age 10 average dbh's ranged from 5.8 inches for a planting density of 1000 to 9.9 inches for 100 per acre. A difference of 0.9 inches between any two means would be judged significant at the 95% confidence level. After only 10 years there is a clear trend of declining average dbh as the planting density increases even for stocking levels of 100 and 200 per acre. Differences in average tree size will increase in importance if such differences are reflected in price per unit of volume.

FIG 5. AV. DBH FOR DIFFERENT PLANTING DENSITIES

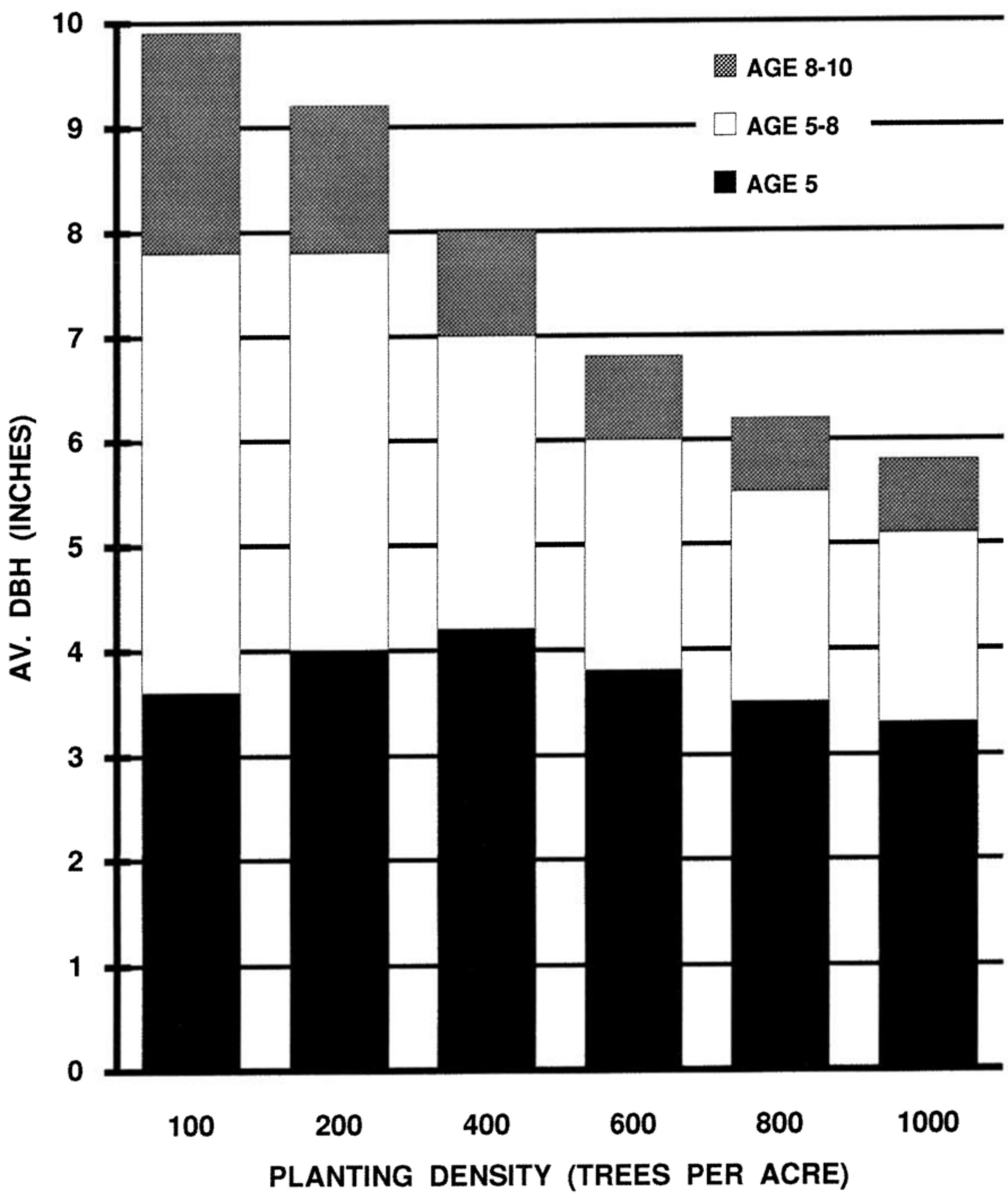
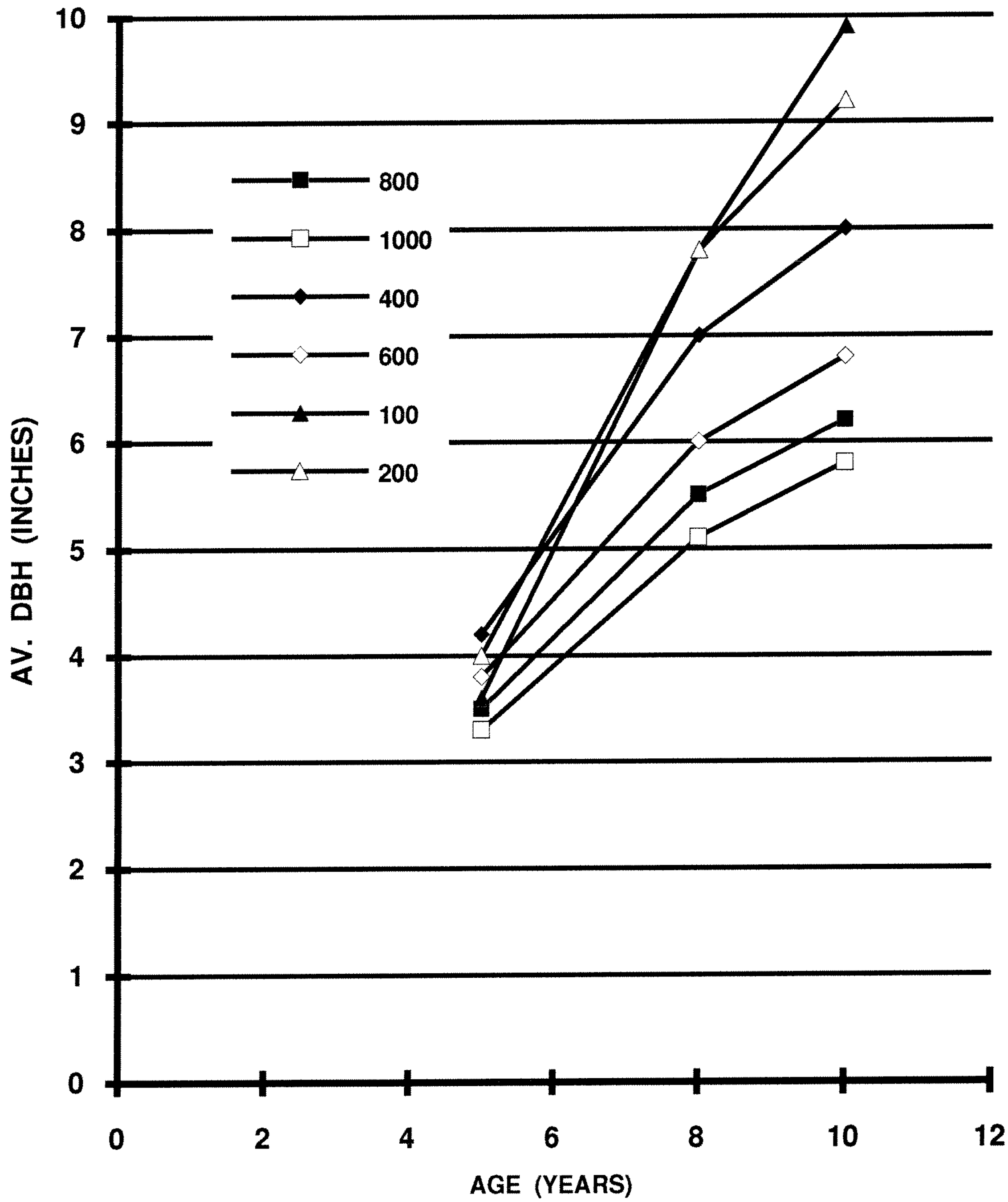


FIG 6. AV. DBH FOR DIFFERENT PLANTING DENSITIES



4. Merchantable Volume

Individual tree volumes were estimated with a simultaneous total and merchantable volume equation developed by Borders and others (1990), namely,

$$V_m = 0.004\ D^{1.8290}\ H^{0.9691} - 0.0025\ \left(\frac{D_m^{3.6847}}{D^{1.6847}}\right)(H - 4.5)$$

where

V_m = outside bark stem volume to a top diameter limit of D_m inches outside bark (cu ft)

D_m = top diameter limit outside bark (inches)

D = dbh (inches)

H = total height (ft)

Merchantable volume per acre estimates at ages 8 and 10 for trees with dbh >= 4.5 inches to a 2-inch top outside bark are summarized below and in Figures 7 and 8.

Average volume per acre (cu ft to 2" top and dbh >= 4.5")

Age	Planting survival at age 1					
	100	200	400	600	800	1000
8	456	924	1699	1869	1885	1907
10	883	1708	2774	2937	3091	3159

Volume per acre at age 10 increases as the planting density increases but above 400 per acre the increases are not significant. A difference of 625 cu ft between any two means would be judged significant at the 95% confidence level.

Lenhart and Clutter's (1971) old-field yield prediction equations predict 1700 cu ft for 600 surviving trees at age 10 for site index 70. The Borders and others (1990) yield equation for cutover, mechanically site-prepared plantations predicts 2000 cu ft at age 10, using the predicted basal area of 104.5 sq ft per acre. Average merchantable volume at age 10 for the 600 planting density in this study is 2937 cu ft per acre with an average annual growth rate of 294 cu ft per acre per year over the 10 years, and an average annual growth rate of over 500 cu ft from age 8 to age 10.

FIG 7. VOLUME GROWTH FOR DIFFERENT PLANTING DENSITIES

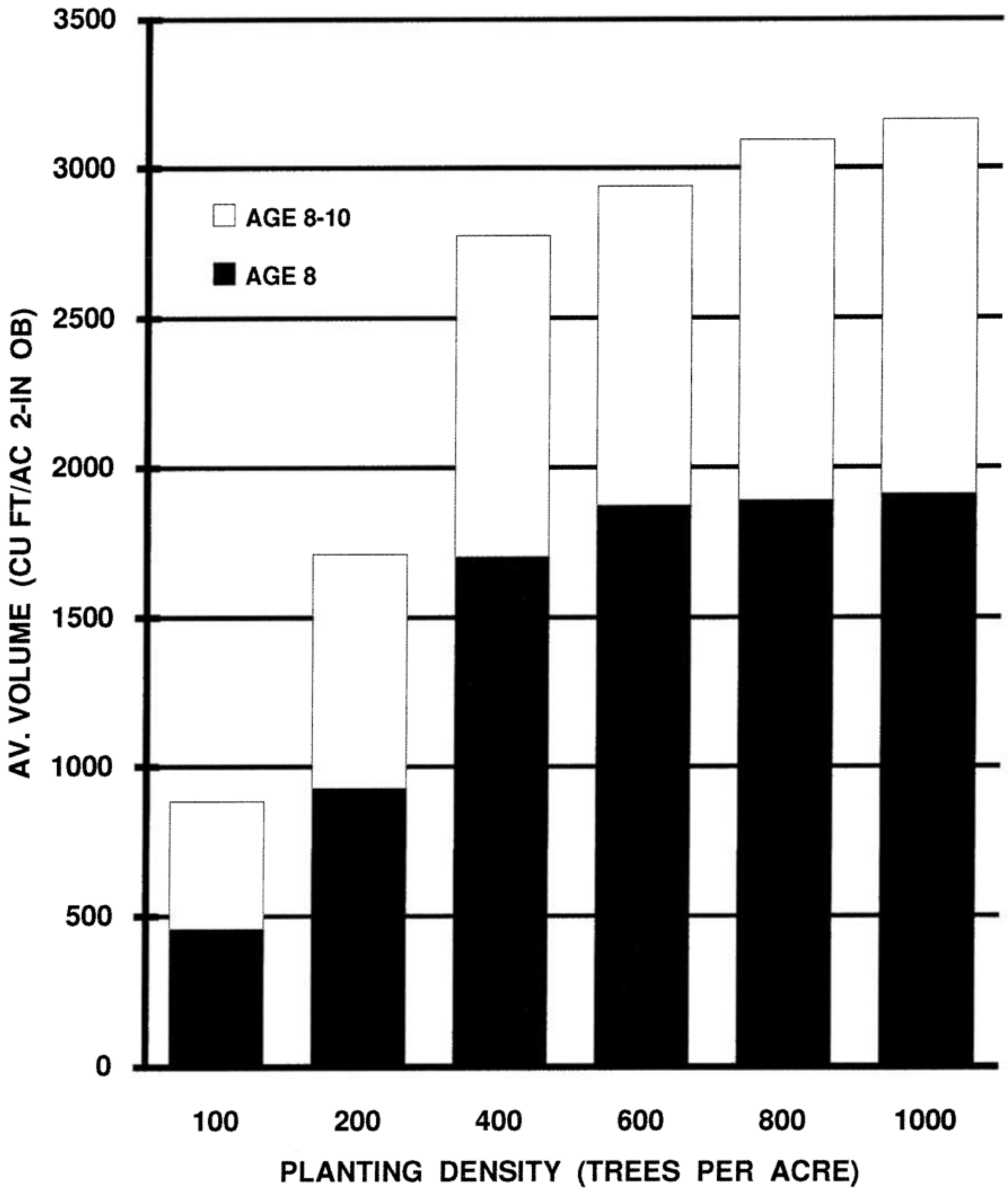
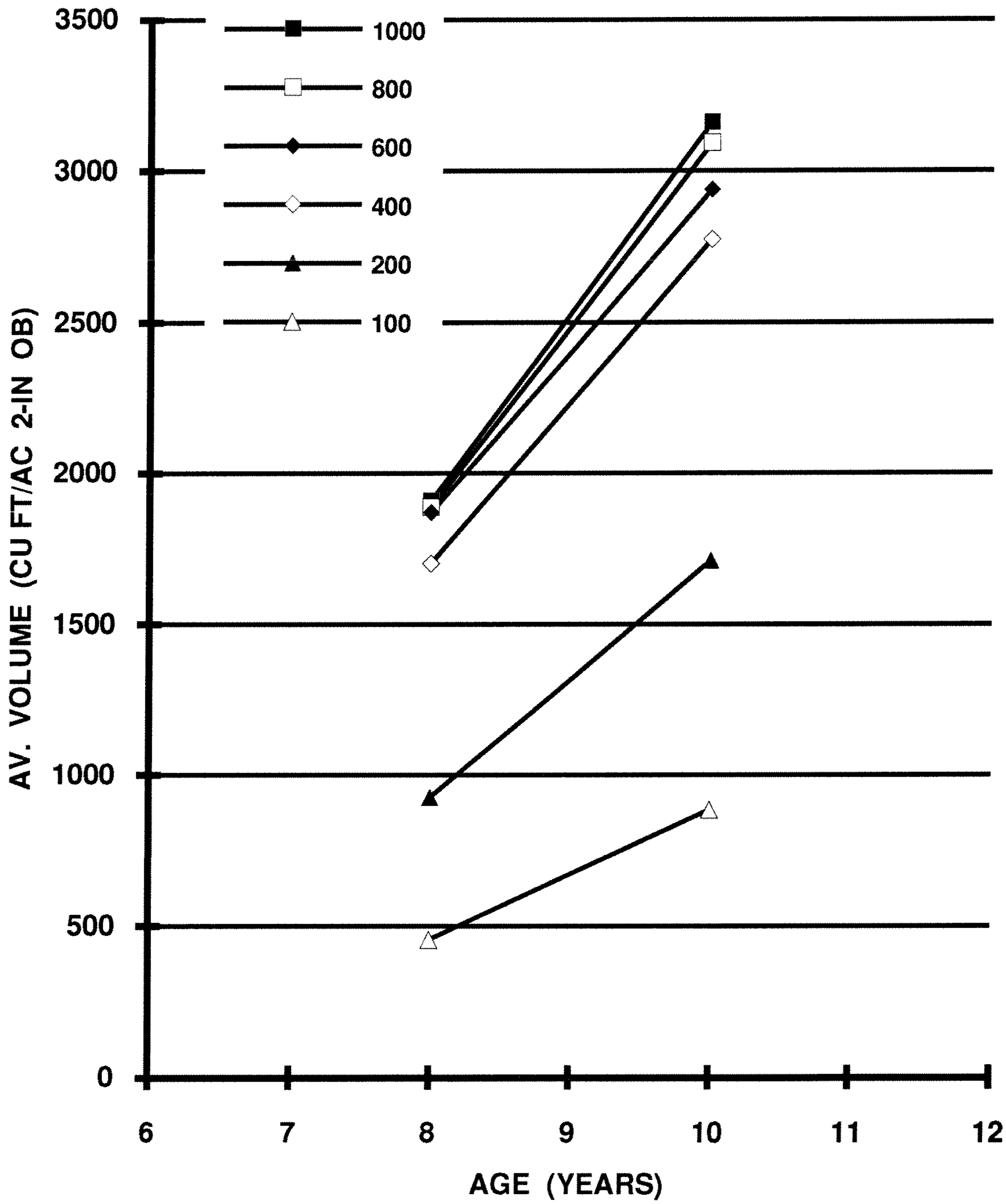


FIG 8. VOLUME GROWTH FOR DIFFERENT PLANTING DENSITIES



Conclusion

Old-field loblolly pine plantations in the Georgia Piedmont for which existing site index and yield prediction equations are available (Lenhart and Clutter, 1971) were established without any further weed control, and had an average site index of 62. The old-field plantation in this study with comparable stocking, and in which herbicide was used to control herbaceous competition, has been growing at 2.5 times the rate of previous old-field plantations and of cutover, mechanically site-prepared plantations without such control. Early results of a PMRC study (Rheney and Pienaar, 1993) indicate that similar growth rates can be achieved on cutover sites with chemical control of competing vegetation.

Future development of these experimental plots will be of great interest because the results are likely to have a significant impact on investment decisions and on future timber supply in this region.

Literature Cited

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