SLASH PINE IMPROVED PLANTING STOCK - VEGETATION CONTROL STUDY – AGE 9 RESULTS

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INTRODUCTION

A study was established in 1986/87 to estimate the impact of first generation genetically improved seedlings and of vegetation control on the productivity of slash and loblolly pine plantations in the Southeastern Coastal Plain and Piedmont physiographic regions. Control of competing vegetation leads to large increases in productivity (Pienaar and Rheney 1995). Increases in productivity from first generation genetic improvement range from 7 to 19 percent (Talbert et al. 1985, Hodge et al. 1989). The genetic improvement estimates of gain come from progeny test data that may be inappropriate for estimating the gain obtainable from operational plantations. More importantly, no estimates of stand structure differences between unimproved and improved plantations are available from progeny test data. Finally, the question of how genetic improvement gains interact with management cultural treatments such as vegetation control is an important one that will impact future investment in both genetic improvement programs and cultural treatments.

The loblolly and three slash installations were planted in the 1986-87 planting season. The remainder of 19 slash installations were planted the following year. Nine year results of the study on loblolly pine were presented in PMRC Technical Report 1997-2. This paper will present results on slash pine at nine years of age from 18 surviving installations (one installation is now a golf course).

METHODS

The slash pine portion of the study was established at 19 locations in the Coastal Plain region of southeast Georgia and north Florida. Genetically improved seed were obtained from the six top ranked families for each region as ranked by cooperating companies in consultation with personnel from the Slash Pine Tree Improvement Cooperative at the University of Florida. The seeds were from rogued, first generation open-pollinated seed orchards owned by cooperators. Unimproved seed was collected by species and region by International Forest Seed Company. Seed from seed orchards or seed production areas was excluded from unimproved seed. The families included in the study, identified by their Florida Cooperative number are 106-56, 187-57, 261-56, 35-60, 56-56, and 6-56.

Bulk lot improved stock was obtained by mixing equal amounts of seed from the six selected families for a particular region. Some seed from each family was kept separate and grown in nursery beds as single family lots. All seedlings were grown in a common nursery.

Eight 0.4 acre plots were installed at each location on cutover forest land scheduled for planting. Plots were assigned randomly to each of six 2 x 3 factorial treatment combinations. The two levels of vegetation control were either none, other than that provided by the operational site preparation treatment applied by the cooperator prior to planting, or complete control of all competing vegetation. Complete control was achieved and maintained by killing all woody vegetation prior to planting with prescribed herbicides and by spraying sulphometuron-methyl (Oust) in early spring in each of the first three growing seasons, and by directed sprays of glyphosate (Accord) as necessary during the growing season. The three levels of genetic improvement were unimproved, bulk lot improved, and single family improved seedlings. Each of the six single families was randomly assigned to either 2 or 3 locations within a region. At each location one of the two single family treatment combinations chosen at random and one of either the unimproved or bulk lot improved treatment combinations were replicated to provide information on the variability within locations.

Seedlings were hand-lifted and planted in January, 1988, at a density of 700-750 trees per acre. Pine trees were measured for total height on a 0.2 acre interior measurement plot after 3 growing seasons and were measured for Dbh and total height, and checked for evidence of fusiform rust, after the 6^{th} and 9^{th} growing seasons.

RESULTS AND ANALYSIS

The purpose of the analysis was to estimate the average effects on plantation growth due to complete control of competing vegetation and to the use of genetic improvement. The 9-year measurement data were summarized and analyzed separately for each region as a factorial design with installations considered randomly located in each region.

A summary of the 9-year remeasurement data is presented in Tables 1-6 where U and I refer to unimproved and improved (bulk lot + single family), respectively. Since the means for single family and for bulk lot improved were virtually identical, the single family means are not presented in the tables. Vegetation control treatments are abbreviated NC for no control and CC for complete control. Figures 1-6 illustrate the additive and interactive effects of improved genetic stock and vegetation control relative to the unimproved, no vegetation control treatment (UNC). An analysis of variance appropriate to the design was made of the 9-year remeasurement data for the following variables: average dbh, average dominant height, basal area per acre, total and merchantable stem volume per acre, percent fusiform rust infection and coefficient of variation in dbh. In the discussion of results and in the tables and figures, effects of genetic improvement are calculated by averaging across both vegetation control treatments. Similarly, vegetation control effects are obtained by averaging across all genetics treatments. There were 23 unimproved means and 49 improved means contributing to the numbers in the tables. All statements of statistical significance made in the discussion of results refer to tests made at the alpha = .05 level.

The only significant treatment effect on average tree dbh was complete vegetation control, with an average increase of 0.8 inches over all levels of genetic improvement (Table 1). Even though there was no effect of genetic improvement on average dbh in the absence of vegetation control, there was a larger gain in average dbh for the bulk lot improved plantings than for unimproved plots. This more than average response is shown in Figure 1.

Table 1. Summary of arithmetic means for average dbh (in).

	Vegetation Control		
Genetic Improvement	NC	CC	Avg.
U	3.9	4.6	4.3
I	3.9	4.8	4.4
Avg.	3.9	4.7	4.3

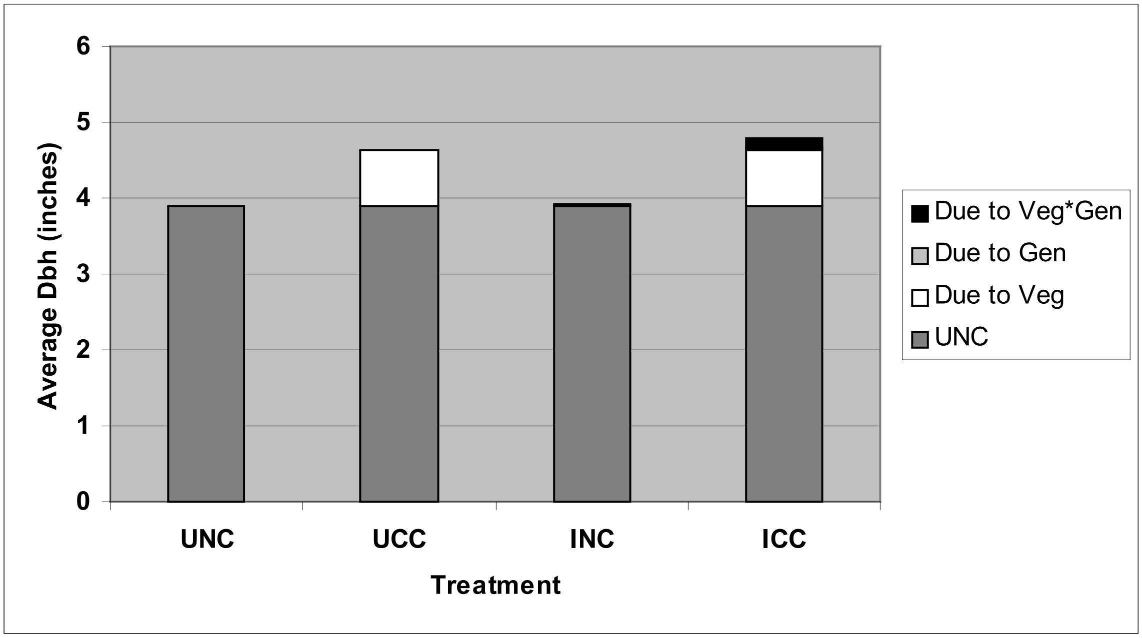

Figure 1. Average Dbh by treatment for 9 year old slash pine.

The analysis of average dominant height indicated that both vegetation control and genetic improvement affected dominant height significantly. Vegetation control resulted in a gain of 4.2 ft whereas genetic improvement resulted in a gain of 1.8 ft (Table 2). As with average dbh, the gain from using genetically improved stock in conjunction with complete vegetation control resulted in more than an additive gain (Figure 2).

Table 2. Summary of arithmetic means for average dominant height (ft).

	Vegetation	Control	
Genetic Improvement	NC	CC	Avg.
U	26.5	29.9	28.2
I	27.7	32.3	30.0
Avg.	27.3	31.5	29.4

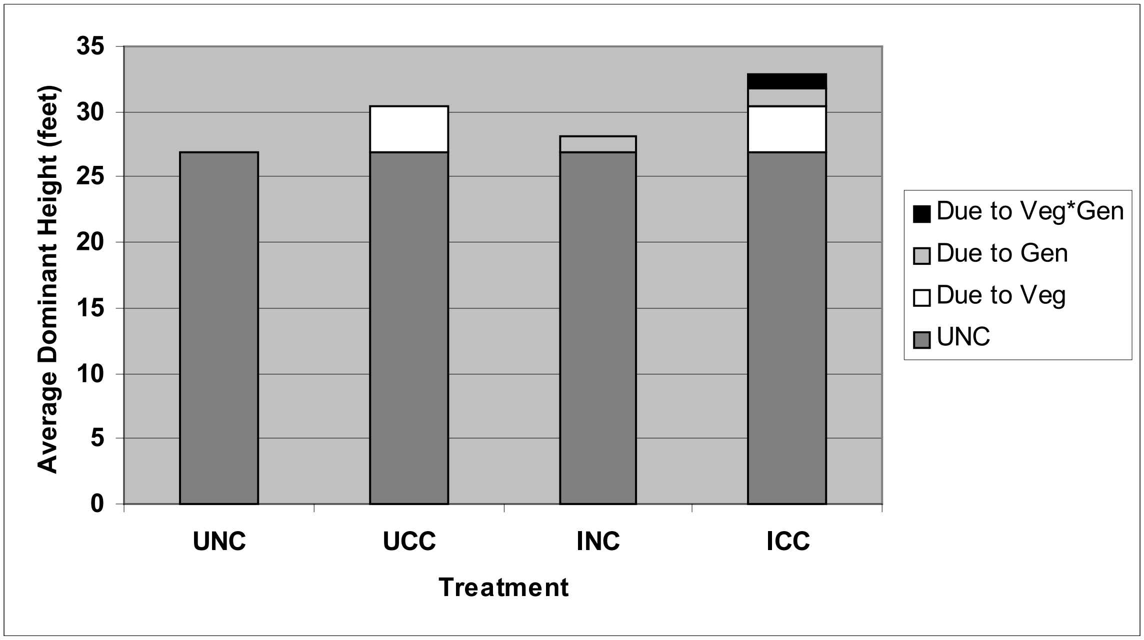

Figure 2. Average dominant height by treatment for 9-year old slash pine.

Basal area per acre is an interesting factor because it is highly correlated with volume and the development of basal area precedes volume. The analysis of age 9 basal area data revealed that the only significant treatment affecting basal area per acre was vegetation control. The genetic improvement treatment was almost significant at the .05 level (p-value = .0578). As shown in Table 3, the gain in average basal area per acre for vegetation control was 23.7 ft^2 and the gain from genetic improvement was 5.1 ft^2. Figure 3 shows the basal areas by treatment.

Table 3. Summary of arithmetic means for average basal area per acre (ft^2).

	Vegetation	Control	
Genetic Improvement	NC	CC	Avg.
U	60.7	79.3	70.0
I	62.0	88.2	75.1
Avg.	61.6	85.3	73.5

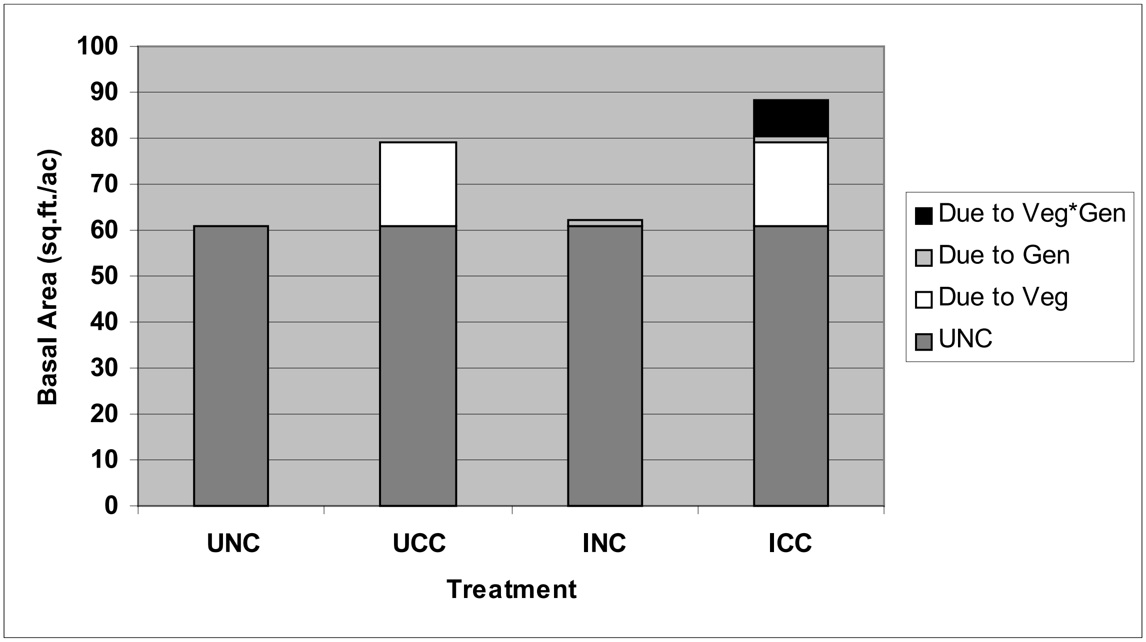

Figure 3. Basal area per acre by treatment for 9-year old slash pine.

The analysis of total volume per acre indicates that both vegetation control and genetic improvement significantly affect total volume per acre at age 9. The gain from vegetation control is 492.5 ft^3 while the gain from genetic improvement is 146.2 ft^3 (Table 4). The total volumes by treatment are shown in Figure 4.

Table 4. Summary of arithmetic means for average total volume (ft^3).

	Vegetation	Control	
Genetic Improvement	NC	CC	Avg.
U	841.7	1215.6	1028.7
I	900.7	1449.0	1174.9
Avg.	881.9	1374.4	1128.1

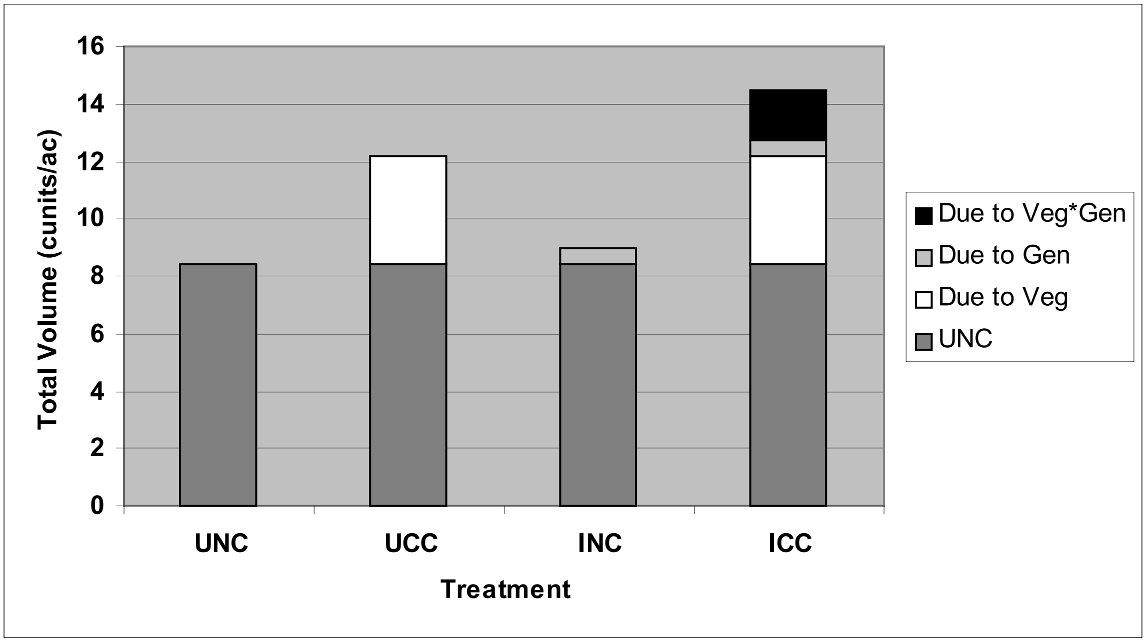

Figure 4. Total volume (cunits) by treatment for 9-year old slash pine.

Merchantable volume follows the same trend as total volume. Both genetic improvement and vegetation control are significant variables. The gain due to complete vegetation control was 651.5 ft^3 while the gain from genetic improvement was 162.3 ft^3 (Table 5). Merchantable volume production for the four treatments is shown in Figure 5.

Table 5. Summary of arithmetic means for average merchantable volume (ft^3).

	Vegetation	Control	
Genetic Improvement	NC	CC	Avg.
U	401.8	932.6	667.2
I	475.4	1183.6	829.5
Avg.	451.9	1103.4	777.7

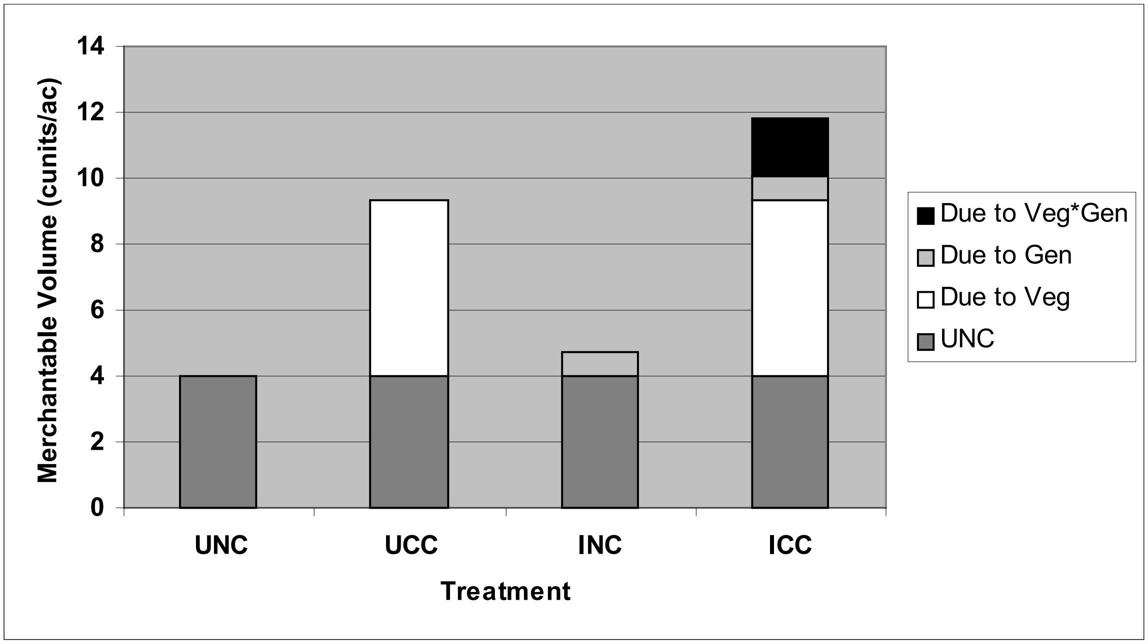

Figure 5. Merchantable volume (cunits) by treatment for slash pine.

Results from the analysis of percent cronartium infection are somewhat disappointing compared to the loblolly results. Both vegetation control and genetic improvement were significant treatments. Arithmetic means are shown in Table 6. Competing vegetation control resulted in a gain in percent cronartium infection of 5.4%. Genetic improvement resulted in a reduction of 6.2%. Unlike the loblolly pine results, when genetically improved slash pine trees have their growth accelerated by use of complete vegetation control, they suffer the same increase in infection as unimproved trees. The good news is that this is still at a level below that which would be suffered by unimproved trees since it is added to a smaller base. Treatment means are shown graphically in Figure 6.

Table 6. Summary of arithmetic means for percent cronartium infection.

	Vegetation	Control	
Genetic Improvement	NC	CC	Avg.
U	15.2	20.6	17.9
I	9.0	14.4	11.7
Avg.	11.0	16.4	14.4

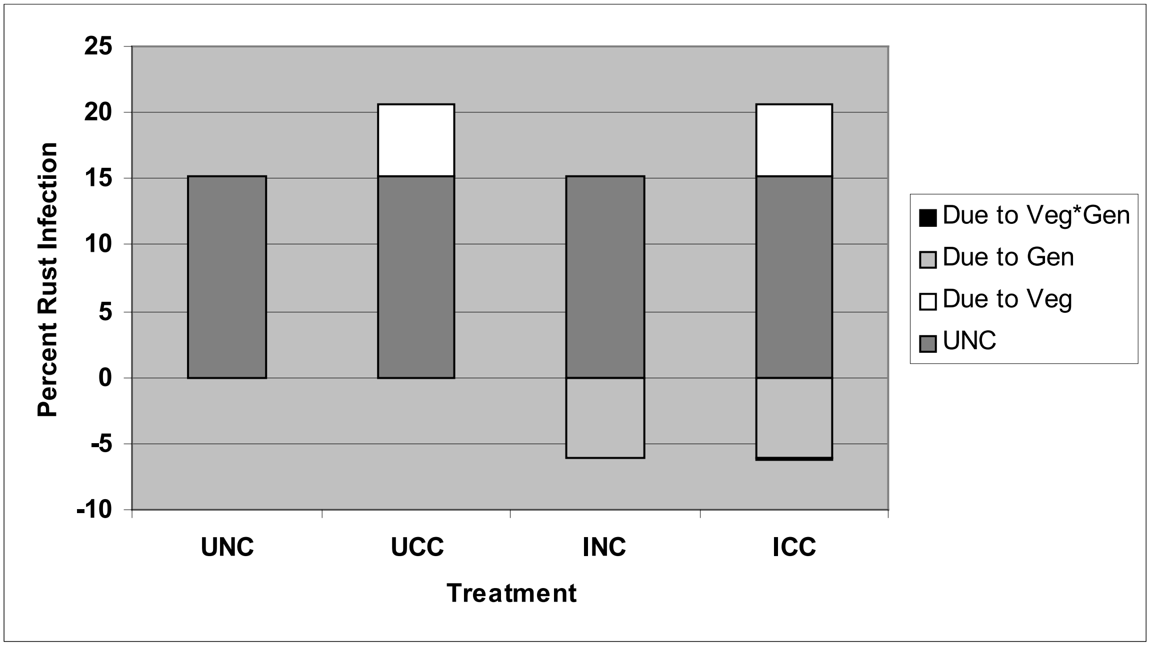

Figure 6. Percent cronartium infection for four treatments on 9-year old slash pine.

Vegetation control was the only significant treatment affecting the coefficient of variation in Dbh. Arithmetic means are shown in Table 7. Competing vegetation control resulted in a reduction in CV of 1.5%. Genetic improvement resulted in an increase of 0.5%. Treatment means are shown graphically in Figure 7.

Table 7. Summary of arithmetic means for coefficient of variation in Dbh.

	Vegetation	Control	
Genetic Improvement	NC	CC	Avg.
U	20.5	20.1	20.3
I	21.8	19.9	20.8
Avg.	21.4	19.9	20.6

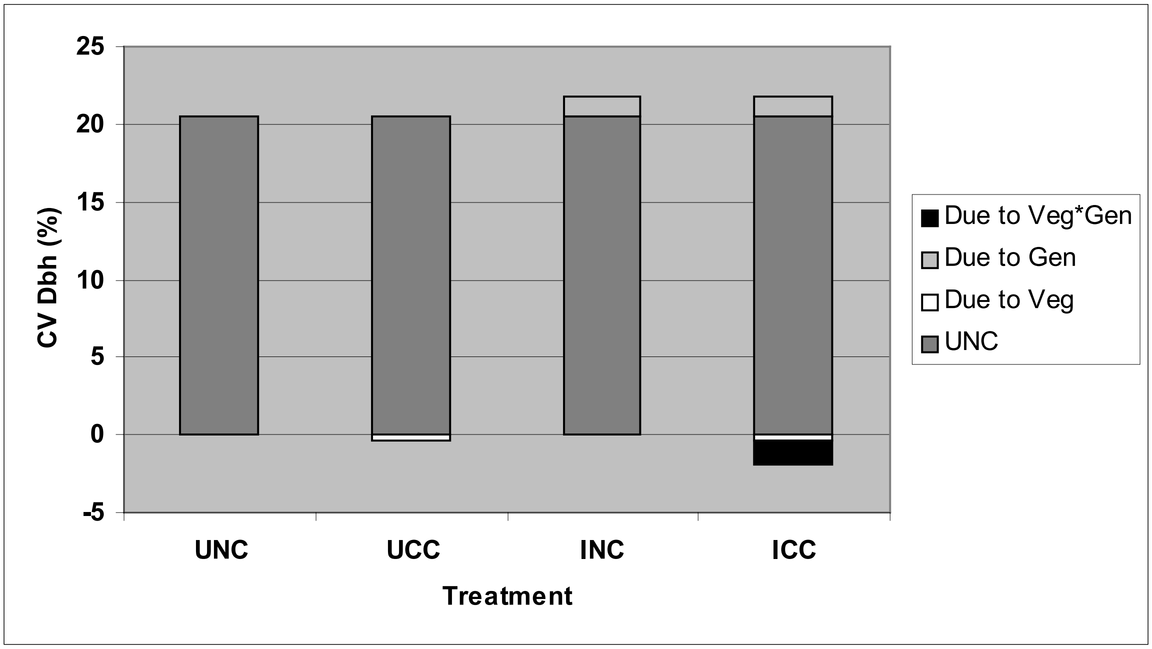

Figure 7. Coefficient of variation in Dbh (%) for four treatments on 9-year old slash pine.

Table 8 summarizes the percentage gains due to vegetation control and genetic improvement relative to the unimproved, no vegetation control treatment. None of the interaction terms shown in the table were statistically significant.

Table 8. Average gains due to vegetation control, genetic improvement and their interaction as a percentage of the unimproved, no vegetation control treatment means.

Variable	Vegetation Control	Genetic Improvement	Veg * Gen**
Dbh	19	NS	3
Dominant Height	13	5	2
Basal Area	30	NS	9
Total Volume	44	7	21
Merch. Volume	132	18	44
% Cronartium	36	-40	-2
CV Dbh	-2	NS	-7

**Not significant at alpha=0.05

CONCLUSIONS

The 9-year results of the improved planting stock - vegetation control study provide important information for forest managers. As with loblolly pine it appears that both genetic improvement and competing vegetation control are significant treatments for improving yields. In addition, there is a reduction in cronartium infection rates from using genetically improved stock regardless of whether the growth is accelerated by vegetation control or not.

For most of the variables documenting growth, results from the two treatments appear to be approximately additive. There was never a significant interaction between the two treatments. If the gain due to genetics was calculated only from the no vegetation control plots, that gain is always much smaller than the genetic improvement gain calculated as a weighted average over all plots. This could be taken as an indication that some of the genetic potential available from our breeding programs is not utilized with competing vegetation on site. The logical conclusion is that genetically improved trees should be given good cultural treatments such as vegetation control in order realize their potential.

This study is scheduled for remeasurement again at age 12. By the age 12 to 15 measurement we should begin to look at models incorporating these treatments. Already though, these results should be of interest and use for managers.

LITERATURE CITED

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