Dominance and Stand Structure Analyses of a GXE Interaction Trial

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Intra-specific competition of loblolly pine (*Pinus taeda*) is a key factor for individual tree development. Liu and Burkhart (1994) indicated that at the seedling stage environmental gradients dominate on tree growth, where intraspecific competition dominate later stages of the stand. However, little information has been provided on how genetic material and intensive silviculture interactions affect individual tree and stand performance. In addition, tree breeders have always been interested in early selection of future outstanding individual "dominant trees" to obtain maximum economic benefits and productivity of future stands (Bridgwater et al., 1985; Li et al., 1991). Our objective was to analyze how contrasting genotypes of loblolly pine, under contrasting nutrition treatments, differ in dominance and stand structure from planting until 8 years of age.

METHODS

At SETRES2 seedlings from five open-pollinated families (FAM) each of Atlantic Coastal Plain (ACP) and Lost Pines of Texas (LPT) provenances (PROV), were planted at 1.5m x 2m in 1993 and received two nutritional treatments (TRT) (CTRL=no fertilization vs. FERT=continuous fertilization) in a split-split plot layout. After removal of all trees with severe tip moth attack, snow damage or other significant damage, a dominance index was calculated at each age (DIage) for each tree based on the number of standard deviations (SD) from the average of its neighbors. DIage values of 0.1, 0.2, 0.4, 0.6, 0.8 and 1 were assigned if a tree was <-2SD, -2SD to <-1SD, -1SD to <0SD, 0SD to 1SD, >1SD to 2SD, and >2SD, respectively. In addition, an additive score at each age (SC_{age}) was calculated as the sum of previous DI_{age} indexes representing the history of a tree in the dominant or co-dominant classes.

For all dominant trees at year eight ($DI_8 >= 0.5$ or $SC_8 > 4.0$), correlations at sub-sub-plot level (families within replicates) were calculated for indexes (DI_{age}) and scores (SC_{age}) at ages 0 to 6 (DI_{0-6} or SC_{0-6}) with age 8 (DI_8 and SC_8). In order to evaluate the statistical differences among the correlation changes in time and the treatments applied, a split-plot design with repeated measurements analysis (RMA) was used (Gumpertz and Brownie, 1993), but blocks and families were considered as random components.

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RESULTS

Average dominance indexes ranged from 0.52(DI0) to 0.66 (DI8) and showed a reduction in variation with time. Average scores ranged from 0.52(SC0) to 4.95 (SC8) and showed a slight increase in variation with time.

Correlations for DI0-6 with DI8 showed a linear pattern of increasing correlation up to age 5 (Figure 1). This pattern indicated that the probability of dominance prediction from earlier ages increases, as trees get older. In contrast, correlations of DI0-6 with SC8 showed an early increase after age 2 that was maintained until age 5 on an asymptotic trend. A decrease, or lack of increase in correlation after year 5, was observed for both types of parameters and was probably associated with snow damage during that season.

Orthogonal contrasts for linear and quadratic degree polynomials using multivariate repeated measures analysis of DI0-6 with DI8 correlations indicated a strong linear effect ($p<0.01$) of age on TRT and TRT*FAM(PROV), and a strong quadratic effect on TRT (Table1, Figures 1 and 2). The same analyses for DI0-6 with SC8 correlations indicated a strong linear effect ($p<0.01$) of age on TRT and a strong quadratic effect of age on TRT*FAM(PROV) (Table1, Figure 1).

		DIageDI8		**DIageSC8**	
SOURCE	DF	**linear**	**quad**	**linear**	**quad**
Mean	1	**<.0001**	**<.0001**	**<.0001**	**<.0001**
REP	8	0.7283	0.0024	0.2990	0.0268
TRT	1	**<.0001**	**0.0510**	**0.0010**	0.1316
PROV	1	0.5763	0.1480	0.4651	0.9333
REP*TRT	8	0.8404	0.6119	0.9104	0.1644
REP*PROV	8	0.8559	0.1204	0.8572	0.0994
TRT*PROV	1	0.7526	0.8181	0.0704	0.2319
REP*TRT*PROV	8	0.6516	0.6937	0.9792	0.2395
FAMILY(PROV)	8	0.4314	0.4161	**0.0532**	0.3999
REP*FAMILY(PROV)	64	0.3684	**0.0413**	0.8922	0.0505
TRT*FAMILY(PROV)	8	**0.0094**	0.2251	0.4631	**0.0111**

Table 1.- Orthogonal contrasts for linear and quadratic degree polynomials using multivariate repeated measures analysis of $\mathrm{DIageDI_8}$ and $\mathrm{DIageSC_8}$correlations. Linear or quadratic (quad) degree polynomial contrast p-value for the age of the stand and treatment effects.

Analysis of dominance-indexes parameters showed that dominance prediction from earlier ages is feasible, and in all cases increases, as trees get older. Our results also indicate that individual tree dominances at early ages are not good predictors of dominance at age 8, and cumulative history (SC8) may be predicted from age 2.

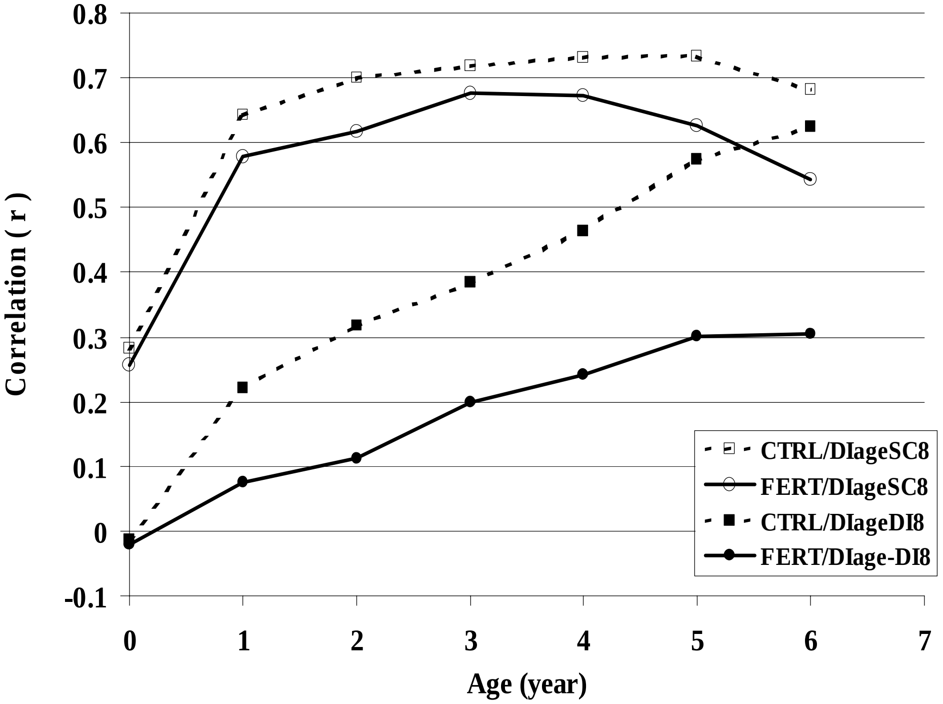

Figure 1.- Correlation of DI from ages 0 to 6 with DI8 and SC8 for each fertilization treatment.

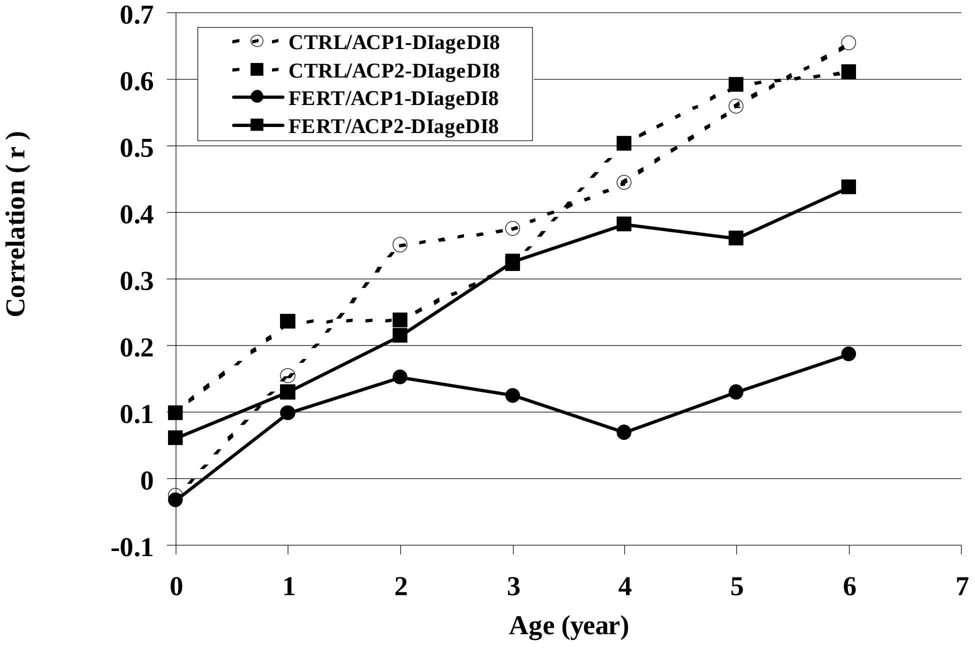

Figure 2.- Correlation of DI from ages 0 to 6 with DI8 for families ACP1 and ACP2.

Strong effects of TRT and no effects of PROV in dominance determination were not surprising considering the large nutritional effects in all other growth parameters of the stand (McKeand et al., 2000; Handest et al., 1999). An interesting result was the fact that lower correlations were obtained for fertilized trees compared to unfertilized trees. For fertilized trees dominance continues to change where no fertilized trees establish and maintain dominance at earlier ages.

Dominance at the family level changed under different nutritional conditions (Figure 2). A significant lower correlation across ages was observed under improved nutrition for ACP1 families compared to ACP2 families. On the other hand both families showed high correlations under no fertilization. Interestingly, only ACP fast growing families showed significant interactions under improved nutrition.

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