COMPARISON OF CONTAINERIZED PROGENY TESTS PLANTED IN SPRING AND FALL

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Abstract.-- Field observations have suggested that spring-planted progeny tests may be slower to develop than fall tests. If this delayed development is not soon outgrown, two potential problems of spring-planted tests must be considered; 1) growth and yield estimates may be biased downward from expectations of fall tests, and 2) family rankings may not be consistent across the two planting times. In this study, both loblolly and slash tests were evaluated to determine if either of the two potential problems appeared. Results suggest that after five years, effects of spring planting have been generally overcome in slash pine. However, there is a trend for spring-planted loblolly pine to show less growth. Performance in both species was also shown to be highly dependent on planting site. Whether or not significant changes occur in family rankings is more difficult to quantify. This study suggests that family x planting time interaction is not a serious concern.

Keywords: *Pinus taeda* L., *P. elliottii* Engelm., containerized seedlings, progeny testing, planting time.

INTRODUCTION

Many tree improvement programs are continuing to use containerized seedlings for the establishment of genetic tests. Barnett (1988) reviewed several of the advantages and disadvantages of containerized seedlings relative to bare-root stock, while van Buijtenen and Lowe (1981) summarized the existing and potential uses of containerized seedlings for establishment of progeny tests. In their presentation, van Buijtenen and Lowe (1981) suggested that only two time periods, early spring and early fall, were considered suitable for planting containerized tests. This restriction was based on such variables as time of expected freezes, soil moisture availability, and conflicting workload schedules.

Progeny tests established during the fall and spring time frames have generally been assumed to provide consistent data for both growth and yield information and family performance rankings. However, data to support these assumptions is lacking. An additional concern is that field observations of spring-planted seedlings often reveal a "champagne glass" appearance, where seedlings fail to break bud and grow as expected during the first summer after planting. Mexal and Carlson (1981) pointed out that this failure is a short term phenomena resulting from a incomplete satisfaction of a chilling requirement. After one winter in the field, the trees can then be expected to grow normally. However, this delayed development could lead to inaccurate conclusions regarding both total yield and family rankings.

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Previous studies involving time of planting have been limited to evaluation of survival and growth. For example, Barnett (1981) presented information for both slash pine (*Pinus elliottii* Engelm.) and loblolly pine (*P. taeda* L.) planted each month from January to September, 1973. His study, while designed to evaluate container types, generally showed better performance for spring-planted seedlings as opposed to fall-planted seedlings for both species. Data presented by Goodwin (1974) showed containerized seedlings of loblolly pine performed better if planted in spring rather than fall. However, in this study, several non-container related problems may have contributed to the poor showing of fall-planted trees. Goodwin et al. (1981) observed no difference in performance between containerized loblolly seedlings planted in April or September.

For a number of years, the Texas Forest Service (TFS) has utilized containerized seedlings of loblolly and slash pine in its testing program, with plantings being established in both spring and fall. This procedure allows for increasing the number of parents which can be tested in a given time frame, when considering a fixed greenhouse production capacity. However, the potential for spring-planted tests to develop slower than fall-planted tests warrants consideration. To further explore the use of containerized seedlings, several previously-established containerized tests were evaluated. The objectives of this evaluation were to; 1) determine if significant growth differences exist between tests established at the two different times (season of planting), and 2) to determine if family by date interaction is of sufficient magnitude to merit concern in the ranking of families for selection purposes.

METHODS

Seedlings for outplanting were produced by the Texas Forest Service at College Station, Texas utilizing the greenhouse production schedule indicated in Table 1. All seedlings were grown in commercially-available 163 cu.cm. containers using a 1:1 mixture of peat and vermiculite. Supplemental heating and lighting were provided the fall-sown seedlings (for spring planting). Tests were field planted as close to the indicated time as possible, although precise timing from year to year was not maintained. Once planted, tests were maintained according to standard procedures, to include periodic mowing, fireline construction etc.

Table 1. General production schedule for containerized seedlings planted in spring and fall.

Activity	Fall-Planted	Spring-Planted
Seed stratification (loblolly)	March	September
Sowing into containers	April	October
Greenhouse management	May-September	November-March
Outplanting	October-November	April-May

A total of 20 progeny tests established by the Texas Forest Service since 1980 were evaluated (Table 2). Of these tests, 8 were planted in the fall and 12 were planted in the spring.

Table 2. Number of containerized tests by location, species and time of planting.

Location	County	Loblolly Fall	Loblolly Spring	Slash Fall	Slash Spring
Magnolia Springs	Jasper	-	-	1	-
Hudson	Angelina	1	-	-	-
Fastrill	Cherokee	2	-	-	-
Pine Valley	San Jacinto	1	1	-	2
San Augustine	San Augustine	1	3	-	2
Siecke	Newton	-	-	1	3
Spurger	Tyler	-	-	1	1
Total		5	4	3	8

Plantings were measured for total height and diameter after five years in the field. Average family volume was also calculated using height and diameter and included dead and missing trees. Survival obtained at the end of the first year was analyzed using the arcsin $\sqrt{\%}$ transformation (Snedecor and Cochran, 1967). It should be emphasized that these tests were established with the objective of evaluating selected material and not the determination of optimum time of planting. Thus, confounding often occurs across families, planting location, year of planting and planting time (fall vs spring).

Three analysis were performed and were designed to; 1) indicate if growth differences could be observed for the two planting times, using as a data base all 20 plantings, 2) evaluate if planting time affects growth or if family x time interaction occurs, using plantings which had specific genetic checklots in common, and 3) to determine if a family x time interaction is present between two plantings with families in common. The first two of these analyses were performed for both loblolly and slash pine, with the third using only two slash pine tests.

RESULTS

Performance by planting date

The first analysis utilized all 20 progeny test plantings, with family means for survival (transformed) and five-year growth variables as input data. Separate analysis were performed for loblolly and slash pine. Loblolly tests planted in the fall were somewhat larger than those planted in the spring (Table 3). Slash tests showed a similar trend, although statistical significance was not reached for any of the variables. There also appeared a trend for first-year survival to be higher for fall tests, but again, no statistical differences were noted.

Table 3. Average survival and growth for loblolly and slash pine tests established in either spring or fall.

Variable	Loblolly Fall	Loblolly Spring	Loblolly Sig.[1]	Slash Fall	Slash Spring	Slash Sig.
1-year survival (%)	92.5	82.7	NS	91.1	87.5	NS
5-year height (m.)	4.2	3.2		4.2	3.2	NS
5-year diameter (cm.)	6.2	3.9		6.4	4.6	NS
5-year volume (cm. dm.)	4.8	1.4		4.7	2.1	NS

1 Denotes statistical significance. NS indicates non-significant at .05 level of probability. * indicates significant at .05 level of probability.

Performance of common checklots

To alleviate confounding encountered by using tests of differing genetic material, plantings which had checklots in common were selected for further analysis. Four loblolly plantings and six slash plantings met these criteria. Only performance of the checklots in these tests was considered with all other families ignored. Analysis used plot means as input data. Three loblolly checklots (North of Sabine, South of 190 and North Louisiana) and four slash checklots (three early testing lots and a Western Gulf Forest Tree Improvement Program source) were included. The majority of the checklots were from bulked wild collections and did not have a genetic identification other than geographic origin. The three slash early testing lots were bulked seeds of families which had passed various stages of an early testing program. Tables 4 and 5 present the results for loblolly and slash, respectively.

Table 4. Results of analysis for five-year performance of containerized loblolly pine tests planted in spring or fall, using common checklots.

Source	df	5-Year Height (m.) M.S.		5-Year Diameter (cm.) M.S.		5-Year Volume (cu. dm.) M.S.	
Time (T)	1	24.92	1.96 NS[1]	105.66	1.45 NS	149.52	2.49 NS
Planting (P) within Time	3	12.69	43.75 **	72.86	72.14 **	60.14	18.50 **
Checklot (C)	2	.86	2.96 NS	3.10	3.07 NS	.56	.17 NS
C x T	2	.52	1.79 NS	2.36	2.34 NS	3.70	1.13 NS
C x P	6	.29	1.38 NS	1.01	1.02 NS	3.25	2.02 NS
Error	171	.21		.99		1.61	

1 Indicates statistical significance. NS indicates non-significant at .05 level of probability. ** indicates significant at .01 level of probability.

Table 5. Results of analysis for five-year performance of containerized slash pine tests planted in spring or fall, using common checklots.

Source	df	5-Year Height (m.) M.S.	F		5-Year Diameter (cm.) M.S.	F		5-Year Volume (cu. dm.) M.S.	F	
Time (T)	1	.07	.01	NS[1]	1.00	.03	NS	.33	.01	NS
Planting (P) within Time	4	5.48	22.83	**	31.64	56.50	**	74.01	31.49	**
Checklot (C)	3	.16	.67	NS	.39	.69	NS	3.10	1.31	NS
C x T	3	.07	.29	NS	.55	.98	NS	.86	.36	NS
C x P	10	.24	1.04	NS	1.56	.68	NS	2.35	1.11	NS
Error	221	.23			.82			2.12		

[1] Indicates statistical significance. NS indicates non-significant at .05 level of probability. ** indicates significant at .01 level of probability.

Both of these analyses suggest that time of planting did not have a significant effect on five-year growth for the eleven tests evaluated. While not presented in the table, first-year survival showed similar results. For both species, differences among the individual plantings were highly significant. Thus, location of planting was much more important than time of planting. Additionally, the lack of checklot x time and checklot x planting interactions indicate that these sources performed rather consistently for the two planting times as well as across the various sites.

Comparison of two slash tests

Two of the slash tests were determined to be suitable for a more direct comparison of both planting time and family x time interaction. These tests (#243 and #244) are both located at the Siecke site in Newton County, Texas. Additionally the two tests have the majority of families in common. Site differences between the two planting are considered minimal. Both of these tests consist of trees from open-pollinated seeds collected from slash plantings in east Texas. Test #243 was outplanted in spring, 1987 and test #244 was planted in fall, 1987. For analysis purposes, families not in common in both tests were not used, which subsequently allowed for 25 families to be included. Input data consisted of plot means. Results of the analysis for five-year data are presented in Table 6. Analysis for survival was also performed but is not presented.

A statistically significant difference is observed for time of planting for five-year data. In a contrast to previous results, the spring planted test (#243) performed better than did the fall test (#244). For example five-year average height was 3.9 m. vs 3.6 m for the spring and fall tests, respectively. Both diameter and volume followed similar trends. While family differences are expected, the lack of a family x time interaction suggests very little change in family rankings across the two tests. No differences in first-year survival were noted as both tests averaged above 96 percent.

Table 6. Results of analysis for five-year performance of containerized slash pine tests #243 (spring) and #244 (fall) planted at the Siecke site.

Source	df	5-Year Height (m.) M.S.	F	5-Year Diameter (cm) M.S.	F	5-Year Volume (cu. dm.) M.S.	F
Time (T)	1	14.36	55.23 **[1]	80.44	96.92 **	77.13	47.03 **
Family (F)	24	.54	2.05 **	1.02	1.24 NS	3.48	2.13 **
F x T	24	.24	.94 NS	.92	1.12 NS	2.11	1.29 NS
Error	460	.26		.83		1.64	

1 Indicates statistical significance. NS indicates non-significant at .05 level of probability. ** indicates significant at .01 level of probability.

SUMMARY

The results of this study do not preclude the possibility that containerized progeny tests planted in the spring may suffer from a delayed development for as much as five years after planting. In one analysis, this effect was found to occur in loblolly plantings, and a trend for slash pine to respond similarly was noted. However, separate analyses using only common checklots in plantings of both species showed no effects for time of planting, but showed large differences among planting locations. When two slash pine tests containing the same material were compared, the spring planted test outperformed the fall test. In all analyses, effect of year of planting could not be evaluated.

Use of both common checklots and a slash comparison analysis with the same families showed no source x planting time interaction. This result is somewhat comforting relative to the efficiency of selection in these tests, as family ranks are expected to be fairly consistent for the two planting times.

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