SEED ORCHARD SEED EVALUATION TESTING (SOSET) AND CONE ANALYSIS SERVICE (CAS) AT THE EASTERN TREE SEED LABORATORY

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Abstract.--A basic summary of the data from the first three years of SOSET and the first two years of CAS is presented. Yields of apparently sound seed from slash and loblolly pine increased by over 200 percent from 1974 to 1976. The amount of insect damage to mature seed was very small in the 1975 and 1976 cone collections. Both of these results are attributed to more intensive management practices.

Immature cone harvesting is cited as a major problem in participating orchards, indicating that substantial financial losses occur because seed is not extracted from the cones. A two part cone harvest is a suggested solution to this problem.

Seed production capacities for loblolly seed orchards appeared to decrease along an east to west gradient. Differences among individual clones within an orchard were large enough to possibly obscure geographic patterns.

A scheme is presented for integrating SOSET and CAS in a manner to efficiently evaluate the seed production of all clones in an orchard. This scheme will be useful for both short term and long term planning.

Additional keywords. Seed production capacity, seed production efficiency, cone harvesting, orchard evaluation.

INTRODUCTION

This report summarizes results obtained from the first three years of Seed Orchard Seed Evaluation Testing (SOSET) and the first two years of Cone Analysis Service (CAS). Both are service programs offered by the Eastern Tree Seed Laboratory to assist seed orchard managers. The main points of discussion deal with improvements in seed yields, categories of seed loss, improvements to be made in management practice and future utilization of these programs.

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METHODS AND MATERIALS

Loblolly (Pinus taeda) and slash pine (P. elliottii) have been the species most frequently submitted and provide the bulk of the material analyzed. Shortleaf (P. echinata), Virginia (P. virginiana), and longleaf (P. palustris) pines have been submitted for testing. Data analysis has been restricted to means and ranges because of irregularity in orchard participation and periodic changes in which clones are submitted.

The procedures used in SOSET are essentially those used for the Seed Orchard Survey (SOS) program (Belcher and Hitt 1973). The CAS procedures and concepts are presented by Lyons (1956), Bramlett (1974), and Karrf alt and Belcher (1977). The most important differentiating characteristics between SOSET and CAS are listed in table 1.

Table 1.--Differentiating characteristics between CAS and SOSET

SOSET	CAS
Clonal bulk samples of 10 to 20 cones	10 to 20 individual cone samples per clone
Analyzes only seed extracted by drying cone	Analyzes all seed produced and aborted ovules
Yields evaluated relative to other yields	Yield evaluated relative to cone's seed production capacity
Categories of seed losses incompletely determined	Categories of seed losses fully determined

RESULTS AND DISCUSSION

SOSET

A steady improvement in seed production was observed in the annual means computed from the SOSET data. Number of seeds per cone for both loblolly and slash nearly doubled during the first three years the program has been offered (table 2). The percentage of apparently sound seed (estimated by x-ray) has also shown strong improvement. In 1974, 29 apparently sound seed per cone were being produced by loblolly and 28 by slash. In 1976, these mean values had increased to 71 and 63, respectively, which amount to increases of 245 percent and 225 percent over the 1974 levels. These production figures can be compared to seed production capacity, estimated by the cone analysis, to

arrive at values for seed production efficiency. Assuming seed production capacities of 150 seeds per cone for loblolly and 163 for slash, seed production efficiencies for loblolly would be 19 percent of capacity in 1974, increasing to 48 percent in 1976. For slash pine this efficiency would be 17 percent in 1974 and 39 percent in 1976. Comparing these results to those of third year data of the SOS (Belcher 1974), we find that the efficiency of loblolly increased from 35 percent to 48 percent and for slash it increased from 18 percent to 39 percent.

The number of insect damaged seeds decline sharply while the yield of good seeds increased. Both of these trends indicate that the efforts toward more intensive orchard management are having a very positive effect on seed production from the orchards.

Table 2.--Annual means for lobloll and slash pine anal zed b SOSET

Measurement	Loblolly			Slash		
	1974	1975	1976	1974	1975	1976
Seeds per cone	56	87	102	54	96	97
% Apparently sound seed	52	71	70	52	65	65
Sound seed per cone	29	62	71	28	62	63
Seed production efficiency	19	41	48	17	38	39
Viability of filled seed	95	95	96	90	94	90
% Insect damage in extracted seed	24	1	1	28	3	2

CAS

Overall, loblolly production averages declined from 1975 to 1976 (table 3). These averages are explainable; however, by losses from the program of some high producing orchards and the gain of some orchards with production problems. Second year ovule abortions were generally very low, averaging only 2 to 3 percent of seed production capacity. A few clones had more than 5 percent second year abortions, none exceeded 10 percent. Also, insect

damage observable in mature seeds averaged only 1 percent for loblolly. Both of these results indicate better management is reducing seed losses caused by insects.

Table 3.--Cone analysis summary for loblolly pine; 1975 & 1976

Measurement	Mean[a]		High Clone[b]		Low Clone[b]	
	1975	1976	1975	1976	1975	1976
	- - - - - - - - Percent - - - - - - - -					
1st year ovule abortion[c]	27	40	48	60	17	18
2nd year ovule abortion[c]	3	2	5	8	1	0
Visible insect damage[c]	1	1	4	7	0	0
Empty seed[c]	13	15	23	9	8	26
Seed production efficiency[c]	55	41	88	79	38	4
Other	0	1	1	4	0	0
Extraction efficiency	82	67	98	99	0	0
Full seed germination	96	95	99	100	92	87
Seedling efficiency[c]	47	31	81	76	0	0
Seed production capacity	145	149	171	204	129	113

a/ Mean value for all clones analyzed.

b/ Highest and lowest clonal means observed.

c/ Values are percent of seed production capacity.

Extraction efficiencies were generally low (table 3). All orchards had average extraction efficiencies below 95 percent, which is the minimum for good management. However, almost all orchards had at least one clone with an extraction efficiency above 97 percent (figure 1). Harvests are apparently being conducted when the earliest maturing clones are ripe, but at a time before late maturing clones are ready. Close attention needs to be given the

cone ripening date for each clone to assure harvest of only mature cones. This practice will reduce losses caused by casehardening of cones while drying.

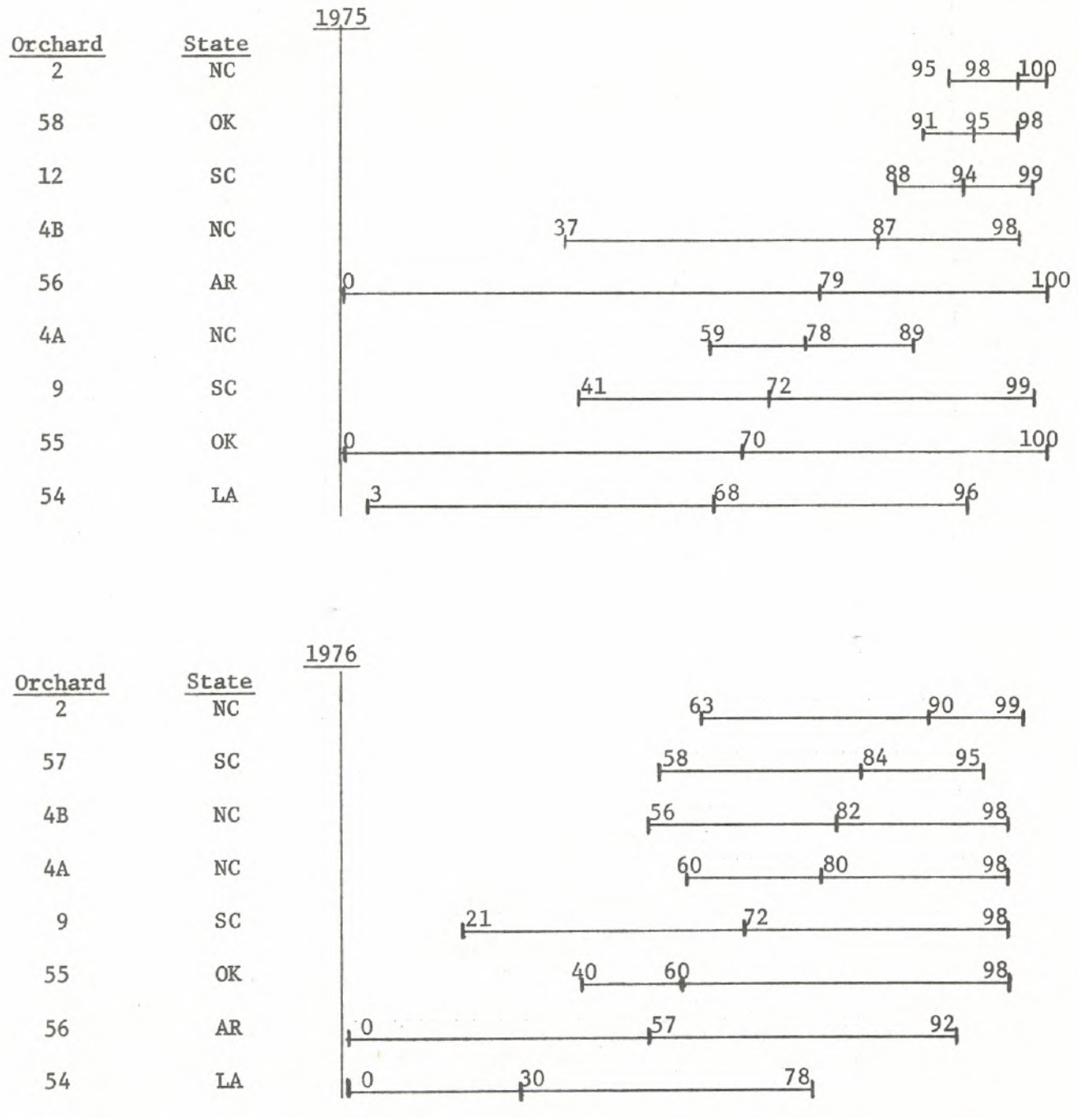

Figure 1.--Loblolly pine extraction efficiencies. Left value is lowest clonal mean in the orchard. Middle value is orchard mean. Right value is highest clonal mean.

Once the earliest ripening clones are ready for harvest, only a short time remains before natural seed fall begins. By leaving late maturing clones to a second pick when they are more ripe, more time would be available for picking all early ripening clones before cones begin opening on the tree and seed is thereby lost. A harvest divided into a picking for early maturing clones and a picking for late maturing clones could, therefore, increase yields from both early and late groups.

The immediate financial consequences of immature cone harvest can be il:_ustrated by a simple example. If only 80 percent of a potential harvest of 1,000 pounds of seed is extracted from harvested cones, 200 pounds of seed are lost. At value on the seed of $100 per pound (Zobel, 1974), this loss would cost $20,000.

Seed production capacities for loblolly seed orchards appear to decrease along a gradient from east to west (figure 2). The highest orchard average in both years was found in an eastern orchard, while the lowest came from a western orchard. However, some western orchards contained clones that had capacities that exceeded the highest clonal averages from some of the eastern orchards. Clonal variation might, therefore, equal or exceed geographic variation. The capacity of each clone to produce should be evaluated. Species or regional means for capacity can serve only as general estimates.

The seed production capacities for other pine species analyzed were: longleaf - 157, slash - 175, shortleaf - 96, Virginia - 84. A detailed discussion on these species is not possible because insufficient data was available on them.

Future Application of SOSET and CAS

Cone analysis provides detailed information, but is restricted in the number of clones to which it can be applied because it is time consuming and costly. SOSET, on the other hand, can be performed relatively quickly and inexpensively, but does not provide as much information as cone analysis. The preferable analysis will depend on the particular problems to be solved or the objectives to be met. A scheme for evaluating and monitoring an orchard for extended and short range planning could be as follows.

An initial step would be a light sampling of all clones in the orchard, primarily to determine seed production capacities by cone analysis. Capacity is a trait under strong genetic control and would not require heavy or repeated sampling for an accurate estimate. Subsequently, or concurrently, a SOSET analysis could be applied to larger samples from each clone to evaluate realized production (seedling efficiency, Karrfalt and Belcher 1977). Poor producing clones could be identified from the SOSET results. These poor clones could then be analyzed more closely by cone analysis to help find ways to improve their performance, or to decide whether or not to replace them with more productive clones (fig. 3). Meanwhile, SOSET can still be applied to monitor any possible changes in production from better clones.

As an alternative to a light cone analysis, seed production capacities could be estimated from the same cone samples used in the SOSET analysis.

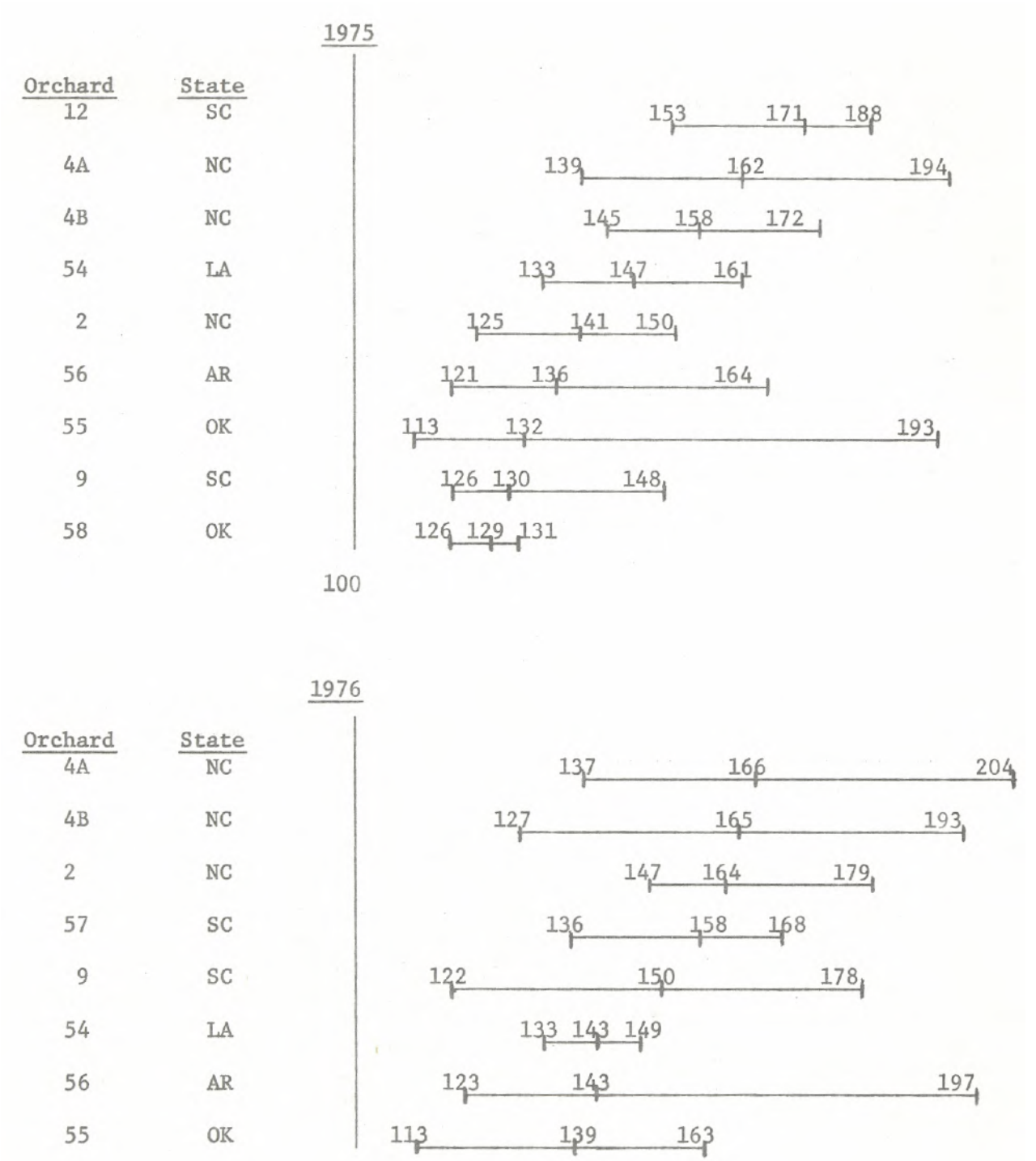

Figure 2--Loblolly pine seed production capacities. Left value is lowest clonal mean in the orchard. Middle value is the orchard mean. Right value is highest.

Figure 3.--Scheme for total orchard evaluation

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