CUSTOMIZE OR COMPROMISE

An Alternative for Loblolly

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Abstract - Within the framework of broad recurrent selection programs, fine-tuning of genotype-site relationships will maximize genetic gain. Interactions evident in progeny, provenance and nursery tests suggest that individual specification of site conditions and cultural practices for many production-scale half-sib families will result in significant growth gains. Segregation of families or groups of families from cone harvest through the regeneration effort can enhance realized genetic gain and, in instances of orchard seed surpluses, permits an after-the-fact roguing of the maternal side of an orchard through preferential planting of the best families. Poorer performers may be used to advantage in other geographic areas, or not harvested.

Additional keywords: *Pinus taeda*, performance index, family segregation, family performance, non-destructive roguing.

INTRODUCTION

> "The fit are those who fit their existing environment and whose descendants will fit future environments."
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> Thoday (1958)

It is difficult to say, at any point in time, which of an array of biological populations is the fittest or best adapted for long-term survival and utility, except in retrospect. And then, of course, it could be too late to do anything about it . . . too late to influence the system, to pick the right starting population, or to apply pressure which pushes the population in the direction of long-term fitness.

So, we do the best job we can of anticipating what future environments will be like and act accordingly, regardless of whether we are dealing with tree breeding, with setting long-term corporate policy, or educating our offspring. That we are doing our level best for the future of southern tree improvement is evident from the papers and the discussions of the past two days. But are we devoting enough attention to our current seed crops and their application to the environments of the present? How have we balanced long-range needs for adaptability to diverse and changing environments with short-term desires for specificity and immediate gain? My answer to the latter question is, "Not well enough," and that answer is based on a little evidence and a lot of intuition that we stand to gain a great deal if we make a concerted effort to know, *intimately*, how our orchard-derived seed and seedling populations behave.

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I anticipate that segments of thoroughly rogued first generation orchards of loblolly pine (*Pinus taeda* L.) will make useful contributions throughout the lives of their second generation successors, but such contributions will be wholly dependent on intimate knowledge of the performance of orchard-derived populations and on the ability to apply it. Both dependencies can be overcome by the segregation of families or groups of families from cone harvest $_2$ o plantation. Heed the poet, and . . . ". . . Stick to the devil you know."2/

STICKING TO THE DEVIL

Table 1 displays performance and inventory information from a hypothetical loblolly pine orchard, and hints at the flexibility which segregation of orchard families can provide. Without carrying family segregation any further than the seed extraction stage, the orchard manager is much better able to predict the growth gains which can be expected from the whole crop or any part of the crop. The maternal contributions of each orchard clone can be established unequivocally and progeny test information weighted accordingly. For sites which are comparable to the appropriate progeny test sites, a family-weighted prediction of growth should be better than one based on an assumption of equal family contributions to a bulked orchard lot.

Family segregation assists in the roguing of an orchard, both genetically and silviculturaily. Accurate records of seed yields by clone help to make the early "silvicultural thinning" decisions and improve later genetic roguing, particularly when several clones have performance records which are close to the orchard's truncation point. For example, in the interest of insuring good overall seed production, Clone 18 or Clone 19 might be retained in our imaginary orchard (Table 1) at the expense of Clone 16. Similarly, the non-productive Clone 4 will doubtless get the axe before Clone 16. Clonal yield histories can result in better roguing decisions.

Extending the family segregation concept to the nursery and regeneration operations can enhance realized gains through preferential planting of the best families. When orchard seed supplies exceed planting requirements, the ability to be selective at the family level amounts to a non-destructive after-the-fact roguing of the maternal side of an orchard. If producing orchards maintain relatively constant per-hectare seed yields through successive roguing cycles, opportunities for such non-destructive roguing will continue to make family segregation attractive, regardless of the physical roguing level. As long as an orchard remains fully stocked from a crown cover standpoint, that condition should prevail.

In a seed surplus situation, family segregation insures that the best genetic material is used first; i.e., seeds of high performance families do not remain in storage in bulked orchard lots while lower performance material proceeds to the plantation. Accountants who deal with inventory finance would label this sytem BIFO, or best in/first out. Applying this procedure to the stock listed in Table 1, it is easy to see that meeting a 1982 sowing requirement of 1500 kilograms with seeds from Clones 1-14 exclusively will best allocate the growth potential of the 1981 seed harvest. If the 1500 kilograms were drawn from

2/ Rudyard Kipling. The Gods of the Copybook Headings.

Table 1 - An example of information available to the orchardist who harvests cones and extracts seeds by clone

Clone	Performance Index [a]	1981 Harvest: Clonal	1981 Harvest: Cumulative
		Kilograms of Seed	
1	66	160	160
2	64	95	255
3	63	140	395
4	61	0	395
5	60	65	460
6	58	220	680
7	57	162	842
8	55	143	985
9	54	87	1072
10	54	47	1119
11	54	76	1195
12	53	68	1263
13	53	184	1447
14	52	53	1500
15	51	110	
16	51	27	1637
17	50	88	1725
18	50	131	1856
19	50	142	1998
20	49	0	1998
21	47	281	2279
22	47	70	2349
23	46	0	2349
24	44	115	2464
25	44	38	2502
26	42	201	2703
27	37	96	2799
Check	36	-	-
28	35	15	2814
29	33	146	2960
30	33	40	3000

[a] Performance Index is a composite, relative ranking of growth, form and fusiform rust resistance, derived from progeny test information pooled over installation years and sites.

a 3000-kilogram bulked orchard lot, half of the high potential seeds would remain in the freezer. How long they would remain there depends largely on the nature of the long-term orchard supply/nursery demand relationship.

The selection pressure which can be applied in non-destructive roguing is also dependent on this supply/demand relationship. With a long-term surplus of seed, unused families become available for use in other geographic areas or on unusual sites, where genotype/environment interactions may enhance their relative performance. Alternatively, in the early, unrogued life of an orchard, these families may be used for direct seeding or simply not harvested. It should be noted that appreciable flexibility in selective planting can be achieved by handling groups of clones; e.g., by dividing the clones of Table 1 into several sub-groups and maintaining the identity of these, but bulking the families within each group. This is an improvement over orchard bulking, but does not permit the detailed evaluation and optimum allocation of orchard seeds which is provided by complete family segregation.

Not only does family segregation accommodate the best in/first out system, but is also permits the assignment of the best families to the best planting sites available. Thus, sites which demand and receive priority for intensive management treatments can also receive the most intensive genetic treatment. Conversely, the best genetic material has the best opportunity to express its superior productive potential.

GETTING TO KNOW THE DEVIL BETTER

Detailed information on performance accumulates during the orchard, nursery, regeneration and plantation management phases of a family block planting system. Coupled with extending and confirming research, these data continually identify unique and useful family characteristics which would go undetected with the bulked seed system. The identification of a family in Weyerhaeuser's North Carolina orchard program which cannot tolerate early lifting and prolonged cold storage, is a good example of between-family variability which probably would not have been picked up had we not been using the family block system. Ignorance of the need for special handling would have contributed to mortality in plantations established from stored bulked seedlings, mortality which would have gone on the record as "unaccountable." Segregation in the field made the diagnosis possible. Segregation in the nursery provides the remedy, as this high performance family is now lifted and moved to the field with no or minimal storage.

Other examples of useful variability among orchard families are being verified and will be used, ultimately , to tree improvement's benefit through family segregation methods. Dierauf has demonstrated that, although one of five tested families did very well in the field, its tendency to germinate slowly put it at a disadvantage in a random (bulked) nursery sowing pattern (T. A. Dierauf, Virginia Division of Forestry, Charlottesville, Virginia). Early sowing and relatively uniform competition from its half-sibs can insure that this top family does not frequent the cull pile. This can be accomplished, in practical fashion, only be segregating that family.

Provenance tests using identifiable families to represent North Carolina orchard stocks are revealing changes in family ranking on some sites in Arkansas and Oklahoma. These rank changes may provide opportunities to use families which are fair performers, and which might he relegated to long freezer storage in North Carolina, west of the Mississippi. Again, this refined allocation cannot be made if the orchard output is bulked. Another family ranks among the leaders under fertilized conditions and seems to do almost as well when it's not fertilized . . . its peers do not. If further study verifies this faculty, routine fertilization can be withheld from the blocks containing only that family. Customize!

Some other advantages of the family block system may prove to be:

Increased crop uniformity at all stages
Field verification of vulnerability/resistance by family
Assignment of rust-resistant families to high risk sites
Earmarking of plantations for specific end products
Verification of progeny test results on a stand basis

The possibilities are endless and, once started, the system seems to be self-improving. Specificity and identity in commercial plantation units encourage observation, because variability among families provides management alternatives.

CONCLUSION

While I, too, advocate that we proceed rapidly with advanced generation orchards as a means of achieving greater benefits from our tree improvement programs, I am convinced that a more intensive examination and utilization of the material we have in hand is in order. Where practical, the segregation of orchard families permits the fine-tuning of genotype-site relationships which will maximize genetic gains. Interactions evident in progeny, provenance, and nursery tests suggest that individual specification of site conditions and cultural practices for many production scale half-sib families will result in significant improvements in growth and form.

Knowledge of the exact contribution of each family to the seed pool can improve the quality of roguing and of growth predictions. Positive identification of the maternal genotype in plantation parcels can confirm progeny test information in a commercial situation.

Non-destructive roguing after orchard harvest improves the allocation of families to plantations by insuring that the best families are planted on the best sites, that the best families are first, and that poorer performers are relegated to storage if seed supplies exceed planting requirements. The customizing of nursery, orchard and plantation management practices to take advantage of, or to overcome, special properties of individual families can provide substantial benefits.

We need to learn a great deal more about the potential of our orchard crops, and then "Stick to the devil we know"!

LITERATURE CITED

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