SEED MOVEMENT IN THE DOUGLAS-FIR REGION
(SYMPOSIUM SUMMARY AND RECOMMENDATIONS)

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Introduction

Five well qualified contributors in this symposium have: (1) explained the exigencies of seed movement and the likely continuance of the practice, (2) developed data showing likely economic effects under indiscriminate seed movement followed by serious maladaptation of planting stock, (3) assessed possibilities for matching climate at seed source and planting site and the value of this process in assuring planting success, (4) scanned the knowledge gained from past seed movement and provenance studies with coastal Douglas-fir, and (5) from similar studies with sympatric or cohabiting western conifers. The final task for the symposium is to summarize and draw pertinent conclusions from these discussions, then to formulate and present recommendations concerning seed movement to this association. Recommendations given here have been reviewed and approved by all symposium members.

Summary

Despite serious gaps in our fundamental knowledge of natural variation--thus in our information on effective and safe limits of seed movement--Mr. Wheat points out that we will undoubtedly continue to plant Douglas-fir seed at some distance from the seed source. Hopefully, a very small proportion of the total seed movement will occur because of ignorance, exigencies of replacing stands lost to fire or other stand accidents, and even inquisitiveness. Less hopefully, in the light of today's effective seed storage practices, the bulk of seed movement will occur because of inadequate planning for the long-range work of artificial reforestation.

Under these practices, we can expect things to go wrong from time to time. Presuming that ill-advised seed movements will be followed by serious maladaptation of planting stock, then as Mr. Staebler has shown we can expect heavy financial losses associated with costs of replanting and delayed harvest. These losses can amount to as much as $65 to $90 per acre.

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Seeking climatically analogous seed-collection and planting-sites is a logical step in preventing most such failures, but as Dr. Irgens Moller points out it is seldom that representative weather records can be found for both the collection and planting sites. He goes on to say that even the possession of both sets of weather records does not assure success. Also, he remarks (somewhat ruefully) on how much we could have learned if we had maintained good records of seed origin for all plantings of the last 20 to 30 years.

As Drs. Haddock and Silen have indicated, natural genetic variation lies at the roots of our problem in Douglas-fir seed movement. Therefore, let us take the time to review what we know, and what we don't know, about this variation. I will commence by quoting Callaham's (1962) concise, yet comprehensive definition of natural variation in forest trees as rephrased by Burley (1965). Burley begins by saying "Probably the most acceptable concept of variation in forest trees is that climate has a continuous variation pattern and tree growth is related to climate. Individuals of a widespread species show continuous variability of inherent climatic adaptation."

Dr. Haddock ably documented this very broad concept of parallel climatic and genetic (or clinal) variability. It simply constitutes "good biological horse sense", and as such is supported by the overall findings of Munger and Morris (1936), Silen (1964, and as reported in this symposium), Ching (1965), and Ching and Bever (1960) concerning growth and other attributes of Douglas-fir of known seed source. These 5 Douglas-fir studies have shown that germination, nursery performance, early height growth, bud bursting and onset of dormancy, plantation survival, and probably volume growth rate (diameter2) all follow general patterns associated with climatic gradients of temperature, moisture, and day-length. Similar clinal variation is recognized in ponderosa pine (Callaham and Liddicoet 1961, Squillace and Silen 1962), white and Engelmann spruce (Roche 1965), Scotch pine and Norway spruce (Langlet 1962), and in a number of other western North American conifers introduced in Europe.

Not surprisingly, most investigators report notable exceptions (sources apparently off-beat in respect to expected performance at the "local" planting site) along the climatic-genetic clines they elucidate. For instance, at age 17 to 19 Munger and Morris (1936, 1942) demonstrated the relatively poor height- and diameter-growth performance of the "local" source (7 miles away and 200 feet above) at the Wind River plantation. Similarly, Ching and Bever (1960) remarked upon aberrant performance in late bud-setting, characteristic of the northernmost of 4 Vancouver Island sources grown in a nursery at Corvallis. Later Ching (1965) showed that at age 6 in the Salem plantation another of the Vancouver Island sources was significantly taller than the "local" source.

Burley goes on to cover part of this problem of aberrant, localized variation by explaining--"Superimposed on this clinal pattern, discontinuities in environmental factors may produce distinct genetic changes justifiably recognized as ecotypes; soil types in particular show abrupt changes." Then, describing still more complex, local situations, he says, "In addition, a clinal pattern with respect to one selection pressure may be superimposed on a clinal pattern with respect to another. Indeed, in the multidimensional interaction of plant and environment, the pattern is more complex and it is easy to visualize the type of situation in which a soil ecotype occurs within an altitudinal cline superimposed on a latitudinal cline."

Thus, we begin to appreciate why the clear, yet broad concepts of continuous, or clinal variation do not always hold, even for local seed movement. We also begin to perceive what it is that we don't know about natural variation.

First we lack the means for identifying genetically-discrete subpopulations (ecotypes, disjunct portions of clines, or merely genetic oddities) that disrupt the otherwise continuous clines found in most natural stands. Conversely, we are unable to distinguish ecological discontinuities, or discrete environmental niches, which may occur in our planting sites.

Second, we have so far failed to mobilize present knowledge and techniques toward the unravelling of complex interactions that may occur under overlapping selection pressures at the seed collection or planting sites.

In an earlier version of his symposium paper, Dr. Silen introduced an "uneasy question" when he asked "How local is local?", in respect to disappointing performance of certain, so-called local sources. This question was aimed at something more than the mere distance between the seed source and planting site. It suggests that the "local" source may be anything but that, in respect to similarity of environment at the source and planting site.

I would hazard a guess that many cases of aberrant performance in "local" sources involve movement of seed between unrecognized but nevertheless distinctly different environments. Particularly suspect in this region would be movement across fairly sharp, but so far undefined climatic breaks, i.e., from temperature inversion areas into cold air drainages, from lee slopes into oceanic wind channels, or from mild to extreme climates of any type. Also suspect would be movements across unrecognized edaphic breaks, as from soils with low moisture retention on south and west slopes to soils with more favorable moisture levels on north and east slopes, or simply from one soil type to another.

Conclusions

Despite the fact that we still do not know how to move seed with assurance of planting success, we have made two long strides in that direction in the last 20 years.

First, we have recognized, and to a large extent defined, broad concepts of parallel climatic and genetic variation occurring in Douglas-fir and other northwestern species. As Dr. Haddock has shown, most of this knowledge has come only in the last 10 years; yet because of this, as Dr. Irgens Moller and Mr. Wheat have indicated, really wide movements of seed have all but ceased. By using this knowledge we can solve a large part of our seed movement problems; possessing it we have reinforced common-sense seed movement schemes like those of Isaac (1949) and Dick (1955).

Second, we have learned that localized, discontinuous variation is also real, and at the heart of the remainder of our day-to-day seed movement problems. Now that we perceive the nature of the residual problems, we can better attack them. We must shift research emphasis toward characterizing the ecology and physiology of (1) disjunct genetic variation (ecotypic or otherwise), and (2) genotype-environment interactions among subpopulations developed under multi-directional selection pressures.

Recommendations

1. For the time being, hold to the maxim "Local seed is safest, and probably best." Don't stretch the concept of "local", especially where steep climatic gradients or soil changes are known or suspected between source and planting site.

2. Where seed must be moved any distance between source and planting site, follow one of the common sense, seed movement schemes based upon parallel climatic and clinal, genetic variation (Isaac 1949, Dick 1955). Record any divergence from the stated seed movement rules, or any crossing of climatic zones. Above all, be ready to accept a few failures because of unrecognized discontinuous variation.

3. Insist upon seed collection practices and records that pinpoint locality (exact distance and direction from permanent landmarks if not elevation, site index, stand quality, etc.) of the source. Subsequently, insist upon planting records that include seed-lot identity and pinpoint exact locality of the planting sites. Whenever possible include several replications of a truly local or at least standard source in each plantation. Schedule survival and follow-up examinations and comparisons with the local source at 5- to 10-year intervals.

4. Before any large, new provenance tests are started, the scientist must find new and better means for characterizing aberrant variation. A team approach involving the forest geneticist, meteorologist, ecologist, and physiologist is strongly recommended for providing fundamental information on:

Occurrence and recognition of discontinuous variation via study of climate, soils, soil moisture, and subordinate vegetation tied in with study of growth responses under controlled environments.

Interactions of subpopulations developed under overlapping clines. Growth chamber studies may be expected to provide early information on selection pressures existing both at seed source and planting site; thus they should greatly increase the efficiency of provenance tests to follow.

It is emphasized that these are only interim recommendations. Part of our Douglas-fir seed movement problem has been solved, but we still have a long way to go.

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