A STUDY OF THE FACTORS INFLUENCING THE PRODUCTION OF FOREST TREE SEED

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INTRODUCTION

IN 1928 the British Columbia Forest Service established a small temporary forest nursery near Victoria as an experimental area for studying nursery practice for trees of the Pacific Coast. Since then several hundred thousand seedlings have been grown and considerable information has been obtained as to seedbed requirements for various tree species. Two years later, a 620-acre tract of land was acquired at Green Timbers on the Pacific Highway five miles South of New Westminster to be used for experimental plantations and a permanent forest nursery. At the present time about seven acres have been cleared and put under cultivation at the nursery site and in the future it is planned to produce planting stock at this place for reforestation in the Southern Coastal area, the species to consist principally of Douglas Fir, Sitka Spruce, Cedar and Hemlock.

Such a planting program will require a considerable and uninterrupted supply of tree seed which will have to be of very high quality in order to keep nursery costs down to a minimum and to obtain young trees of good quality. It has been observed from the experience of European countries, and to some extent in America as well that an apparently young and vigorous plantation may later develop an unhealthy condition; this probably is due to using seed in the nursery beds of unsuitable parentage, the inherent characteristics possibly not showing until the trees are several years old. At the present time very little definite information is available as to the fruiting habits of our commercial trees—what makes a good seed tree, what characteristics are transmitted from the parent stock, at what intervals the trees bear cones, and the effect which climate, soil and other site conditions have on the production of seed. At what age do trees begin to bear seeds of good germination quality? Is there any relation between quantity of seed produced and quality of the seed? What are the main factors influencing seed production? These are questions whose answers should be familiar to the nursery manager in any extensive planting programme. It is supposed that when a tree suffers some mechanical injury, caused by logging, fire, or disease, that a heavy crop of cones is produced the year following the injury, and the tree may continue to bear heavily for several years, until such time as it may take to recover from the injury, or becomes adjusted to it. Is the seed produced during this period of recovery equal in quality to that of healthy trees? Is cone production at the expense of vegetative growth and vigor? Do young or medium-aged trees

bear seed of as good quality as older trees? Answers to such questions as these are of primary and vital importance to all foresters engaged in afforestation problems.

REVIEW OF LITERATURE

The cause and frequency of fruiting in forest trees has as yet been studied only slightly, and in fact worked out thoroughly for only one species, the European Beech. Hartig (4) has shown that in the beech the formation of fruit uses up all the available nutrients stored in the tree, and a seed crop can only be expected again when the storage cells of root and stem have been replenished. For different species of trees this will take periods of different duration which probably vary somewhat between the trees with larger and smaller fruits. It will also depend very largely on the weather, and especially the weather at the time of formation of the fruiting buds. It does not follow, however, that conditions favorable for the formation of fruiting buds will be followed by a good seed year, since conditions at the time of flowering may be very adverse for the fertilization and setting of the cones. The effect of weather upon fruit formation is as yet not clearly known. Lakari (6) states that in Finland a seed year for spruce and pine follows two years after a hot dry summer, but Zimmerman (7) working in Saxony could find no relationship between the weather of the two years preceding and the production of cones. Klebs (5), however, explains that flower production is favored by summer drought, a condition which produces an excess of carbohydrates in the tree as compared with the proportion of carbon nutrients absorbed by the processes of growth and reproduction. This might be one of the reasons why isolated trees left after a logging operation fruit abundantly. The soil becomes drier due to surface evaporation, and the production of carbohydrates is stimulated by the increased light on the tree. Another reason might be that the increased solar radiation on the ground greatly increases the number and activity of the soil organisms, with increase in the production of nitrogenous compounds; this might reasonably be assumed to affect the carbon-nitrogen relation in the storage cells of the trees, which in turn control seed production. The writer has often noticed that slow growing trees often fruit more abundantly than their more vigorous companions, and that the growth of leaders is often reduced during a heavy seed year. Is there any correlation, then, between tree vigor, growth, and cone production; and is cone production at the expense of vegetative growth? Bates (2) puts forth the thesis "that the strength of Norway pine seed and the immediate vigor and hardiness of seedlings developed therefrom vary inversely as the vigor of the parent trees, and that in consequence the most profitable seed collections, from the standpoint of nursery production solely, and without regard for hereditary tendencies which may develop later, are to be made by avoiding

particularly thrifty parent trees, and especially vigorously growing young trees on the best soils. It will generally be found that the seed produced by slow-growing trees is of an entirely different physical quality, better filled and nourished, and superior in every way to that from very vigorous trees."

In seed collection work, it is unquestionably a good policy to collect seed from only good, healthy seed trees, but in so doing we have no guarantee that their offspring will show the same good qualities as the mother trees. All living things are governed by the laws of heredity, and there is no reason why trees should not be controlled by the same laws. This being so, why do we, in seed collecting, select only the mother tree, which has no greater influence upon its seeds than the tree with which it has crossed? This other tree might possibly be a very inferior specimen, of poor form, of slow growth, or diseased. Some of the offsprings from such a union will certainly exhibit many of the poor qualities of the defective progenitor. The problem then is, what characteristics are transmitted from parent to offspring? Experience has shown that, in general, the climatic factors are of primary influence. Seed collected from trees of good quality, growing near sea level in temperate climates, will not give the same good results when sown at higher altitude or further north. However, local climatic and site conditions will have little effect on the offspring since in forest regeneration small local topographical areas may be seeded by trees from other areas and some cross-fertilization from outside trees will take place. For example seed collected from small trees of poor form growing on a rock bluff, or other poor site, will probably give as good seed as their surrounding fellows growing upon good soil, with which they will cross fertilize, and there is as much chance for these poorer sites throughout generations to be restocked by the surrounding trees growing on good sites, as from the trees on the poor sites, so that a race of poor quality trees will not arise. However, if these poor sites are of a sufficiently large area to form a self contained forest, and breeding takes place only amongst the trees they contain, then it is very likely that a race of poorly formed trees may develop. There is considerable difference of opinion as to whether or not trees transmit a predisposition towards disease. Boyce (3) says that "trees infected with fungous and phanerogamic parasites that actually kill or deform the roots, branches, twigs, leaves or the entire tree are certainly diseased and undesirable for seed trees. However, it is questionable if decayed trees with the dead, mechanically supporting heartwood alone affected by a fungus are diseased in the true sense when disease is considered as any disturbance of the normal functions of a living tree." Accordingly, seed from the latter might very well be collected and develop none of the poor qualities of the parent. Diseased trees might be fertilized by pollen from healthy trees, and the resulting seed have none of the characteristic predisposition to weaker resistance to disease of its mother, and a healthy

tree being fertilized by pollen from a diseased tree might bear seed having a predisposition to a lower resistance. The question to be answered then, is a predisposition towards disease hereditary, and if so, when crossed with a healthy tree, is this characteristic present. Bates (1) states that "most endemic diseases, the class of parasitic organisms which has preyed upon trees almost as long as trees have existed, are specific, attacking only one species or a few closely related species. For most of them it is a fair assumption that the tree species has developed some resistance, else in most cases the disease would be of almost universal occurrence. Some individuals of the tree species may be expected to show complete immunity to one or many of the diseases which beset its fellows, even when growing under conditions which give it every opportunity to become infected." From this it would appear advisable to use as seed trees only healthy specimens, from a stand comparably free from disease.

METHODS USED IN THE INVESTIGATION

During the past year the British Columbia Forest Service has undertaken a study at the Cowichan Lake Experiment Station of the factors influencing seed quality and production in order to find out the effect of weather on seed production, the interval between good crop years, the ages at which different species begin to yield seeds of good quality, and the relation between vegetative growth and seed production. A series of seed-tree stations has been established in the neighborhood of the Experiment Station, and at present observations are being made of 65 trees bearing cones, composed of the following species, *Pseudotsuga taxifolia*, *Abies grandis*, *Thuja plicata* and *Tsuga heterophylla*. The heights of the trees were first carefully obtained by use of a transit set up at a permanent station; the leader growth for the current year was also measured. Records were made of the abundance of the cone crop and the cones were counted through the transit telescope on a definite portion of the crown, usually lying between boundaries defined by two recorded vertical angles on the transit. The series of trees was chosen from as many age-classes as possible, varying in age from very young trees to old veterans. Some cones were collected from several trees of each age-class in order to obtain seed for viability tests as an index to the quality of the seed. It seems likely that seed quality is closely related to age, very young trees bearing seed of low viability, whereas an old veteran may yield very good seed but not of sufficiently better quality than that from medium-aged trees to warrant the extra expense incurred in gathering cones from old trees of great height.

Weather records are available for the study-area and a careful check will be made as to the effect of climate on seed production. After the selection and measurement of the seed trees soil samples are to be collected and ana-

lyzed for the characteristics of pH, carbon content, free nitrogen and total nitrogen, as it is thought that some useful information may be obtained from such a study of the relation between plant nutrients and cone production. These samples will be gathered at intervals throughout the growing season, from the different soil horizons. When sampling, care will be taken to do as little damage as possible to the root system of the trees, since it is fully realized that with too frequent and indiscriminate sampling damage might be done to the trees which would produce appreciable physiological results.

All trees will be re-examined at regular intervals, when abundance of cones will be noted, seed collected, viability tests made, and leader growth measured. It is proposed to continue these observations for at least ten years following the commencement of this study.

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