CERTIFICATION OF FOREST TREE SEEDS

by

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Seed certification is making certain, affirming, assuring, and furnishing of a certificate stating that certain things about the particular lot of seed are true (2). It is seed which carries reliable information on exactly where the seed was collected, when it was collected, and how pure and viable it is(10). This practice has been used to advantage in agriculture for some time. It has become so important and so widely accepted that in many states it is necessary for the seed producer to obtain a statement regarding the quality and purity of his seed from a special laboratory employing trained specialists before it can be put on the market.

The wide acceptance of this practice is due to activity by two agencies. It means protection for both consumer and producer. A seed buyer is benefitted in that he no longer runs the risk of paying a high price for what he thought was pure seed of high germinative capacity. Under enforced seed certification laws he knows exactly what he is getting. This protection is not enjoyed by the consumer alone. Reliable seed dealers no longer are obligated to compete with other producers putting inferior seed on the market at a selling value equal to that of better seed. Another important feature is that better crops may be maintained more easily. This is seed certification as applied to agriculture.

The basis for seed source certification lies in the fact that certain types of characteristics are hereditary in plants as well as animals. Darwin's laws of natural selection as improved by DeVries indicate that for a given environment that organism is better able to live and reproduce which is best able to cope with its surroundings. In plants this may mean some special characteristic or equipment which increases its ability to resist insect infestations, to secure nutrients during times of drought, to persist through recurring fires, to survive during periods of extreme cold or heat, or in any other adverse conditions.

Some variations are hereditary while others are not. Johannsen proved this with his experiments with beans. It is usually thought that anything affecting the germ plasm will have its result in the offspring. The germ plasm in turn is affected by prolonged subjection to one type of environment. This is responsible for the development of the various races and strains. One species having existed under some influence which tends to inhibit its growth makes specific adaptation to the condition, as it is only those particular individuals with the special characteristics which are able to survive. After many generations of such conditions, the adaptation becomes hereditary. There is an effort to use this trait for control of chestnut blight. This disease was introduced into this country from Europe. In China the blight has existed for many years and the chestnut there is semi-resistant to it. By bringing the Chinese strain of the chestnut over here, it is possible to combat the blight. However, the imported strain is subject to frost injury, whereas, the original strain was frost hardy.

Strains have been found in Ponderosa pine. "The Race Study of Ponderosa Pine on McDonald Forest" is proof of this. Strains are also found in green ash, Douglas fir, Scotch pine, and Norway pine (6). There seems to be a strong correlation between wide range in altitude or area and racial differences in the same species of all trees studied in Europe. In America the same thing has been found to be true. This is only a natural result or proof of the fact that environmental factors do affect a tree's heredity. It is fairly well established that climate and soil are directly responsible for the production of character (7). Accordingly, the drought resistance of green ash is found to increase from South to North and East to West in the Midwestern states (5). However, climate and soil are not the sole determiners of tree characteristics. As pointed out above in the case of chestnut, disease contact may have something to do with it.

A list of the possible differences between strains and inherited traits would be lengthy indeed. However, a few of the more important ones which might exist and be determined by a seed test and certification might include such things as vigor. In Ponderosa pine a better control on the western pine beetle could be had, as Keen's classification has definitely established a strong correlation between vigor and insect resistance. According to Hasel's article, Champion found that trees from large seeds become dominants in the stand (3).

However, no results are available on Ponderosa pine dominance and seed size. It is pointed out here as a possible application of seed certification to better silviculture.

Another thing which would be desirable to control and may be possible through seed testing would be rot resistance. The rotation of many species is determined chiefly by a pathological rather than financial basis. If in these species there are fungi-resisting races, these might be segregated from the others by some characteristic of the seed, thereby eliminating one of the factors making management of some forests both difficult and unprofitable.

There are many other racial traits which can be substituted for undesirable qualities, as for example, straight boles for crooked, small limbs for large, and straight grain for spiral. Characteristics of this sort, however, may be out of the realm of seed certification and more properly belong on a thesis of stand certification. These features still might be detected in the seed by determination of origin of the seed.

The seed differs in type as to origin. First of all, there is the seed of indigenous trees of natural stands of indigenous races. These stands are the result of natural reproduction and apply to the Douglas fir type in the Pacific Northwest. If features of the existing stand are desirable, this seed should be certified as to origin. This includes information on the climate, as well as elevation and location. The Long-Bell Lumber Company at Longview, Washington, uses a seed classification system which rates on a basis of species, elevation, rainfall, and the number of frost-free days. For this region and species this may be adequate. At least there is work being done on the origin.

Secondly, there is the seed of indigenous trees of planted stands from seed originating near the planting site (2). This type of seed is not as important as the first, as there are not many planted stands from seed in the United States which are furnishing seed at the present time. If the seed for a planted stand now furnishing seed comes from a more remote section, it is classified as another type. In this case it would be desirable to include in the certification the origin of the seed which produced the parent tree. The justification of this lies in the fact that recessive characteristics do not appear in the first generation when two races are crossed. Although desirable, it is only seldom that such information exists particularly in this country. In the future it will no doubt become much more significant as certification becomes more widely accepted. Foreign seed may be classified in the same manner as native seed (2). The importance of all types varies in Europe because the intensive forestry practiced there even in the past warrants it.

The importance of certification of forest tree seeds is easily seen when the results of indiscriminate use of seed are considered. These results were first noticed in Sweden over sixty years ago, however, conditions in Germany are more serious than anywhere else because of the extent of artificial regeneration carried on there during the last part of the nineteenth century. Trees in Germany are more often of bad form and undesirable race than not (1). Over twenty-five per cent of the forest trees there are of such bad form that the government is requiring that they be removed to prevent their propagation (1). When any country removes one quarter of their forest trees, conditions are indeed drastic. The early German forest managers were unaware of races and bought where seed was cheapest. This produced the inferior stand of today.

It may be interesting to note what steps Germany is taking to remedy this situation. Definite regulations have been set up requiring that all stands of bad form must be eliminated. For propagation of certain species it is necessary to certify the seed squrce. Seeds from cones collected in undesirable stands cannot be given away, and infractions of any of these rules are punishable by a fine of 4000 dollars.(1). In addition to this, the owner of the timber must keep accurate account of all seed sold and to whom it is shipped, allow his stand to be inspected, and supervise cone collecting.

Seed for sale must come from a certified stand. Although stand certification is important, it cannot replace accurate and complete seed analysis. This is so because it is not always possible to determine the features of the offspring by the parent tree. First of all, even if the seed does come from a stand of good trees, cross pollination may easily occur with an inferior race and in this manner propagate the poorer type, or secondly, the parent tree of desirable features may be a hybrid with undesirable characteristics being recessive. However, chances for inheritance of poor form and other undesirable features are much greater when the parent trees exhibit these same traits. This is the reason that it is necessary to have a stand examined before seed from it can be used.

All certified forest stands must be straight shafted, not inclined to branchiness in a closed stand, free from damage by men or animals, in good health and vigor, and of satisfactory heredity as far as can be ascertained (1). The stand must be so located that cross pollination with undesirables is not likely to occur (1). None of the stands can be certified unless under the supervision of a forester. Similar conditions exist in other European countries but not to the same extent. However, remedial measures of this nature could have been avoided if knowledge of races in tree species had existed.

In the United States today some of this knowledge does exist, yet we are not giving this bit we have due significance. Up to 1939 the CCC, which is by far the largest organization having to do with artificial regeneration of trees, planted over two billion trees. No doubt part of this stock was certified as to origin and admittedly this is a step in the right direction. Nevertheless, what assurance have we that the resulting trees will be of the right shape, have few limbs, and any other desirable attributes? In planted stands of Scotch pine in Germany small, stunted, limby trees were found growing next to large, vigorous, thrifty ones of the same species (1). There is little foundation for the belief that given a good site, a tree will develop into one like the others growing naturally in the same region. Fortunately, this theory is being questioned, criticized, and unaccepted more and more by foresters of the United States. This attitude is probably developing first of all by reviewing what has happened in countries which planted stock of unknown origin and race. The forestry journals are helping this cause along by giving more discussions of the problem. Secondly, forestry schools are training students in genetics more thoroughly. It is hoped that the favorable publicity and teaching will avert the unfortunate results of indiscriminate seed selection.

However, there is another force acting in the opposite direction and which may be at present more powerful than any of these constructive ones. No doubt there are many seed producers who knowing their product to be of inferior quality put it on the market at a reduced price to get it out of inventory. This seed is bought by a nurseryman because it is cheap and because he is under a limited budget. This situation is possible because there is no law requiring forest seed to be certified before being sold on the market. Though even if this law did exist, it would only help the forester in that instead of guessing about the quality of the seed he buys he knows it is poor. For the present conditions, neither can the seed salesman be blamed too much. He is a business man in a competitive market and is here to satisfy a demand. At present that demand is for cheap seed. If that seed is not sold by the seedsman, his competitors will force him out of business. To remedy this situation, the strict budgeting of nurserymen's funds for purchase of seed should be removed. Also, a seed quality standard for each species should be made compulsory for sale of any seed anywhere in the United States. This should make it easier for the seed salesman as well as the forester.

At this point it may be well to discuss what should be included in a certification of a certain lot of forest tree seed. All seed should have its origin made known to the buyer. This should include the type of stand the seed came from, as well as the proximity of any other stands of trees of same species but of another race. Climatic features of the seed origin should also be included in this report. The important things here are the amount and distribution of rainfall, the mean annual temperature, the number of frost-free days, soil type and depth, as well as the altitude. Seed purity is important to the buyer also. He should know the percentage of other species, and if possible, the race of any seed other than that he is buying. Frequently, the latter may not be discernable in a seed testing procedure. However, it is important and should be included whenever the information is available. Any foreign material should be identified, and its amount by weight for a given volume of seed made known. In this respect it should be said that large seed should be more pure than small seeds, as for example, paper birch, which has often two-thirds of its weight in cone scales. The per cent of impurities is found by dividing the weight of impurities by the weight of the clean seed (9). The number of seeds per pound is also useful to the buyer.

The viability of the seed is important as the variation is great enough occasionally to make one seed bed over-stocked and another without a seedling (9). Toumey says it is "the outstanding factor in determining seed quality" (9). He goes on to state that a heavy seed crop generally produces seed of above average viability, and seed from a light crop of below average viability; also, that young or over mature trees produce a high percentage of blind seed. If this is so, the wrong kind of seed trees are being left. It is usually conceded that the question as to whether a Douglas fir cut-over stand will grow back to Douglas fir, as well as the time required for the process, depends on what kind of a start the seedling gets. If the seed trees are over mature, the seed produced by them may be great, but the resulting trees very few because of the high percentage of blind seed. Consequently, it is questionable if it is wise to leave over mature trees as seed trees.

Viability is also affected by the length of time the seed has been stored. This effect is to reduce viability with increases in storage time (9). There may be an exception to this in species which require an after ripening delay. Even in these species it is not a function of storage which increases the viability so much as actual physiological development of the seed. The manner of storage is also a determining factor in how a seed reacts to growing stimulus. The recommended procedure varies with the species. Most pine seeds and other conifers, as well as black locust and catalpa, are stored dry, while the seeds of other, as beech, chestnut, oak, and walnut are stored damp. In general, the temperature of storage is low, as it lowers respiration and transpiration of the dormant seed, and in so doing decreases the destructive assimilation (8). For the most part, the storage technique is most successful which most nearly parallels conditions as found in nature (8).

Viability also varies with the relative maturity of the seed at time of collection. If seed is collected too early, the resulting germination is low. Whereas, if they are collected shortly after maturity, many will have been blown away and others eaten by rodents. However, there are a few quite reliable indicators of time to collect seed. Some species as Western white pine exude pitch at the end of the cone and the scales turn brown, whereas, in others the most convenient method is to wait until the squirrels begin to collect cones (14). These indicators are of importance to collectors desiring high quality seed.

As well as knowing something about the viability, origin, and purity of the seed, the buyer should also know the general condition of the seed, as for example, the extent and type of damage if any done to the seed in extraction or by any special treatment as scarification to increase germination. Extraction damage may be of two types, first, the mechanical damage, and secondly, heat damage. A certain amount of the mechanical type may not be harmful in some species as they may be in need of scarification anyway. The effect of heat in extraction is of the same nature as heat damage in storage of seed, but not so pronounced.

For any agency to certify seed for purity, germination, or any other factors, it is necessary to test it. Methods of testing vary according to the species of seed and the individual doing the testing. However, certain techniques have become accepted because of their convenience or accuracy. Generally, a test for genuineness is made by comparing the seed with samples of known species. This is done with a hand lens which magnifies eight or ten diameters. Difference in size, color, form, pattern, or surface may indicate that the seed is not that which it is asserted to be. In some species it is nearly impossible to establish a genuineness ratio by examination of external characteristics. Usually in instances of this sort, a cutting test will determine this ratio. Toumey and Korstian say that the color and texture of the inner seed coat, the color and consistency of the seed kernel, and the size and form of the embryo aid in identification when external appearance of the seed is not adequate (8). A cutting test, they say, is necessary for black and scarlet oak. The kernel of black oak is deep yellow, while that of scarlet is nearly white (8). Separation of seed according to races is much more difficult. Consequently, seed should be bought from collectors shown to be reliable by the quality of trees produced from seed they have collected. Even this method of determining seed quality is difficult to use here in America as collectors and nurserymen have not kept records of where seed was collected and to whom it is sold.

Purity of seed refers to the amount of debris such as seed wings, pebbles, twigs, and items of that nature. Since seed is almost exclusively sold by weight, the total weight of these impurities, as compared to the weight of the pure seed, is important. This ratio is determined by first selecting an average sample of the seed being tested. The pure seed is then separated from the rest of the sample with the aid of a hand lens if the seed is small enough to warrant its use. Most coniferous seed is easily cleaned and should, therefore, be practically pure.

The tests for viability of seed are of three types. However, in any one of the three there should be a close correlation between results in the laboratory, and actual conditions in the field. Only too often do seed technicians lose sight of the objective of seed testing and by devious and sundry means try to attain a high germinative percentage. If the same means are capable of being used in the field with the same results the method is all right. However, because in a laboratory where heat and moisture can be controlled for optimum seed germination and in the planting site these factors cannot be controlled, the testing procedure should be standardized and made known to the buyer.

Probably the most inaccurate of all tests is made by examination of the features of the seed. In this method those seeds which are wormy, shriveled, or wrinkled are considered to be not viable. The rest should have a clear bright surface if they are coniferous seed. These remaining seeds are then cut to examine the endosperm and embryos. Of those cut, any which are wormy, rancid, or those having spots in the endosperm or embryo are considered to be poor seed and not capable of germination. The advantage of this test is that it is fast. Its disadvantage is that the test is not reliable. Toumey and Korstian have found that this type of test used on coniferous seed and small-seeded, broad-leaved species gave results which were often fifty per cent higher than those given by a germination test (8). This fact, together with the failure of this test to take into consideration the effect of storage time of the seed on its ability to germinate, make this test one to be avoided.

Still a faster test is described in the reference just cited. They suggest heating a fair sample of seed until it puffs up and finally explodes. The number of those which explode compared to those which do not is representative of the germination percentage (8). This test is justified by the fact that fresh, good seed contain considerable moisture. This moisture, when heated, exerts a pressure on the seed coat, and finally causes it to break. Toumey and Korstian go on to say, however, that true viability can be determined only by a germinating test (8).

Germination tests in a laboratory require more time and equipment, but most authorities seem to believe this test possible of much greater accuracy, and so recommend it. The seed may be placed in soil, on porous clay plates, in sawdust, on blotters, and in many other ways. Soil is generally used when the test is being made in a greenhouse, and the other substrata when it is stimulated in a germination oven. Some seed technicians favor the use of soil but stipulate that it must be sterile. The reason they give for this is that if the soil is not sterilized, the dormant destructive fungi in it will destroy the seedlings or retard their development (8). It is admitted that under artificial conditions as in a seed testing laboratory or greenhouse, the fungi will be stimulated. However, as to whether this is a fair test or not is debatable. In most planting sites, and certainly where direct seeding is being done, these same organisms exist. The buyer of seed is interested, not in how much seed germinates in the laboratory, but in the number that will germinate on his ground.

If sterile soil is used to standardize the results and the seed buyer realizes this and from past experience knows the correlation between the laboratory viability and that in the field, it is a desirable measure, otherwise it is not. This does not apply to test soils containing damping off fungi nor any other fungi in sufficient amounts to classify it as anything but a typical soil in which the species grows.

Soil is the most natural substratum of course. However, other materials are often used. Blotters are used to quite an extent for this purpose by placing the seed between two layers and supporting them above the water so that neither seeds nor blotters come in contact with the water. Moisture is furnished the seed by strips of either blotting paper or flannel which extend down into the water below (8). This method has the advantage of easy observation of germination progress. Porous clay plates are also used as substratum but in general they are considered to bring about the same results as blotting paper. There are many other ways of arriving at a germination approximation. The test of any of them should be in its correlation with average conditions on the planting site when the particular species is normally planted.

Considering a germination test, a purity test, one of genuineness, and as often as possible establishment of origin and race, the cost of certified seed should not be prohibitive. Baldwin estimates that the total cost would range between five and ten per cent of the cost of raising planted stock (2). In Holland the cost is five cents per pound. There certification is on a large scale, which would probably reduce the costs. However, there is no reason why it should not exist to the same extent here in the United States. At present there are more trained foresters than the country can use in the woods. These should be the logical men to develop as forest tree seed analysts. Also, as the idea of certification of forest tree seeds becomes more widely accepted, the demand for such seed and the returns from the service should pay quite a number of them.

At the present time only a few agencies here in the United States are doing any seed certification. The Yale School of Forestry has done some, as have the various forest experiment stations. Some seed is sent to the present agricultural seed testing stations, but only few of these are equipped to handle forest tree seed.

The widespread adoption of certification of forest tree seed can and should take place. As a starting point, trained foresters should be hired by the government to establish standards and investigate some of these questions which are as yet unanswered. There is much yet to be learned about collecting, storage, and sowing of seed. There is still more to be known about tree races. Questions of what is hereditary and what is not are of utmost importance in seed collection. The collector, according to Minckler (6), is left with the following four alternatives: first, to assume all characteristics are due to environment only; second, to assume all are due to environment, except a few which are definitely a result of inheritance; third, he may assume all characteristics are due to heredity and select trees accordingly; or four, he may make a real effort to distinguish between the effects of heredity and environment, and when in doubt, choose heredity. In the past, collectors have worked on the assumption that all characteristics are due to environment. This is extremely dangerous as has been pointed out in this paper. Today, the second assumption is probably used more than any of the others, chiefly because of a lack of information, and it is much simpler. Seed collectors in Europe are using the third assumption. The ideal way is the fourth, that of trying to distinguish between the effects of heredity and environment, and choosing heredity when in doubt.

This ideal cannot be accomplished by seed collectors alone. Neither can the foresters do it alone. There must be cooperation between the government providing research, and seedsmen and foresters providing an earnest interest. Without this cooperation our forests are subject to deterioration; with it our forests may thrive and continue to be an asset to our civilization, rather than a ward and symbol of inefficiency.

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