Mr. Augenstein: (cont'd) of the things that he found out. Now apparently these experiments he started years ago he has been carrying through, and I feel that he is quite an authority on it now, at least he should be, and some of the things in that bulletin, if you fellows haven't seen it, are worth reading. It was little simple things that were wrecking our seed, and for the past several years we have really taken a beating on seed. This past winter, I think, was the worst beating I have taken. I collected around 3000 bushels of cones, Ponderosa and White pine, mostly Ponderosa, and I think about 110 pounds of it was from the Bitter Root area and 700 pounds north of us, on Kootenay, gave a one percent germination test. Yet when we collected the cones, they looked good, seeds looked good, and what went wrong, we don't know. The cones collected between those two gave pretty fair germination percent, so we feel it is something in the way that seed was collected, the type of Fall we had, or something. When I got this bulletin, I think it bears out some of the things that might have happened there, and I was hoping we would get a chance to report on it, which I have.

COLLECTION, EXTRACTION, STORAGE, AND HANDLING OF FOREST TREE SEEDS

by

James W. Augenstein

* *

A continuous supply of good seed is the backbone of a planting program. Without seed we could not raise trees. Therefore, it is essential that tree seeds be collected and handled properly in order to attain the highest viability during the entire storage period.

The seed crop on conifers is very erratic. Up to the present time there is no method for determining when a tree will bear cones. Thus, when the seed supply is low, seed must be collected whenever it is available until sufficient seed is in storage.

According to recent experiments by Philip C. Wakely of the Southern Forest Experiment Station, it is important to handle the cones properly from the time they are collected until the seed is extracted, cleaned and stored if good, viable seed is to be expected. Much of the following information in this report was taken from Mr. Wakely's Occasional Paper No. 123 on "Storing Southern Pine Seed," published in September 1951. It is true that southern pine seed differs in character from the conifer seed in the Northwest. However, it shows the importance of proper handling of all seed.

Collection and Storage of Cones

There are various methods for determining when the seed is mature. One of the most reliable methods is the specific gravity test. When a cone will float in S.A.E. 20 motor oil or in a mixture of 1 part of kerosene to 4 parts of raw linseed oil, it is mature. This method is not accurate if the cones are wormy or if the cones have been picked for several hours. The cones should be tested as soon as picked. Another method is to test the hardness of the endosperm. If the endosperm is solid, it is normally mature. The longer a cone can be left on the tree without losing the seed before picking, the better the seed will store.

Cones should be kept dry and well aerated after collection. They should not be permitted to mold. Mold often indicates heating which will kill the germ. Cones should not remain in sacks for more than 10 days, if at all possible to remove them. They should be collected and spread out in drying racks.

In drying sheds, cones should never be spread more than two cones deep. In the extracting trays or racks, the cones should not be more than one cone deep. This will provide for sufficient air circulation to prevent mold or smothering of the seed and give the cones a chance to dry rapidly.

Drying and Extraction

Fall weather conditions are usually unfavorable for air drying in the Northwest. By the time the seed is ripe, there is too much moisture in the air to open cones. Kilns must be relied upon for drying.

A good kiln is important for efficient extraction. It need not be elaborate but should be designed to require the least amount of handling of the cones. It should have good air circulation and reliable temperature controls. A very slight increase in the temperature over the maximum for that species may kill the entire lot of seed in the kiln.

Proper air circulation is important. The circulation should be rapid and pass around every cone. This will open all of the cones evenly and quickly. The rapidly moving air over the cones tends to keep the cones cooler than the kiln temperature due to the evaporation of the moisture from the cones. Seeds are more easily killed by high temperatures while their moisture content is high.

The maximum temperature for extracting the seed from each species is important. A maximum temperature is needed to open the cones in the shortest possible time. Long exposure to safe temperatures may even be harmful.

Tests should be made at each extractory to determine the safe maximum kiln temperature for each species. Tests made at the Savenac Nursery indicate a maximum temperature of 123 degrees F. is a safe temperature for extracting Ponderosa pine, western white pine, Engelmann spruce, Douglas-fir, and western red cedar from the western Montana and Northern Idaho sources. The maximum kiln temperature for extracting longleaf pine is 115 degrees F., whereas the maximum temperature for jack pine is 170 degrees. The kiln temperature should be measured close to where the hot air first hits the cones.

The humidity in the kiln should be held to a minimum. This not only safeguards the seed but speeds up cone opening. Humidity is decreased mainly by increasing the rate at which the hot air, laden with moisture, is allowed to escape from the kiln.

De-winging the Seed

According to Mr. Wakely, seed keeps better if stored with the wings on. The main objection to this is the extra space involved.

Seeds may be de-winged by hand rubbing or by brushing them off mechanically. Hand rubbing is less likely to injure the seed, but it is time consuming. Occasionally the wings cling so tightly to the seed they cannot be removed by hand.

Mechanical de-wingers are very effective if they are operated with care. There is little danger of injuring the seed with the slow operating brush type de-wingers. The revolving rubber finger type must be used with care. Seed coats may be damaged if they are operated too fast. Standards must be set up for each type of de-winger and species through trial runs and close examination of the seeds. Damaged seed coats may lower the viability of the seed.

Drying Seed

Mr. Wakely finds that seed keep better if dried to a low moisture content. Care should be taken not to get the seed too dry and once the seed is dried to a certain level, the moisture content must be held fairly constant. A fluctuating moisture content will break the dormancy of seed.

Mr. Wakely's tests show that longleaf pine stores best with a moisture content of 6 to 9 percent and seed of other southern pines with a content of 9 to 12 percent. Figures governing the best moisture content for storing conifer seeds of the Northwest are not available to the writer. According to Mr. Wakely's tests and the Woody-Plant Seed Manual, the moisture content of most conifers should be around 10% for optimum storage conditions.

Most extractories are not equipped with the proper equipment for drying seed. In order to make accurate tests, an electric oven is necessary.

Mr. Wakely finds that one simple method he has found to dry seed to a desired moisture content is to expose the seed for several hours or days to some combination of temperature and relative humidity. For example, if the temperature of the air remains at 75 degrees F. and the relative humidity at 55%, the seed will dry to around 10% moisture content.

It has been found that direct sunlight dries seed to about the right moisture content for optimum storage without reducing it too much. This can be done in small cotton sacks or in trays. The sacks must be shaken up frequently. The seed must be placed in airtight containers at night and on cloudy days.

Storing Seed

Mr. Wakely states that storage problems can best be overcome if three main facts are kept in mind:

1. So long as a seed is alive it respires. It consumes the plant food stored within it; it uses oxygen; it liberates carbon dioxide, water and heat. Some respiration is essential to keep the seed alive but too much rapidly uses up the stored food on which seedling growth depends. The rate of respiration increases slowly with increase in storage temperature up to about 41 degrees F. Above this level respiration increases tremendously with increased temperature and seed moisture content. It also increases tremendously with injury to the seed.

2. Seed is in storage from the time the cone ripens until pregermination treatment for sowing. Excessive respiration at any time between ripening and sowing may weaken or kill the seed.

3. Storage succeeds only when all influences that materially affect respiration are kept favorable. These influences include not only storage temperatures and seed moisture content, but also the initial soundness and vitality of the seed. Thus correct collection, extraction, de-winging and correct drying are the foundations of successful storage. Only if these processes are properly carried out will the seed enter storage with the necessary soundness and vitality.

It is not uncommon for a nursery to have a seed investment of $10,000 to $20,000. This investment is worth protecting by providing a good seed storage house. A good seed house should be well insulated, dry and fireproof. The insulation should be sufficient to hold the temperature constant or it may be necessary to install a refrigeration unit to hold the temperature within the proper range. The seed house should be built out of material that will not sweat and cause free moisture inside the storage room.

Mr. Wakely finds that any temperature between 5 and 41 degrees F. is satisfactory for storing sufficiently dry southern pine seed. However, temperatures between 5 and 32 degrees F. will preserve properly dried seed better than do temperatures between 32 and 41 degrees F. Prolonged or frequent increases of temperatures above 41 degrees may be injurious to seed.

The relative humidity within the seed house should be low and constant. If this condition cannot be controlled the seed should be dried and stored in airtight containers.

Seed that is injured will not store well. The chief causes of injury to seed are: too high temperatures, moisture content, letting cones or seed heat or mold, excessive heat during extraction, bruising, cracking or scarifying the seed coats during de-winging or cleaning, and letting the seed lie around too long before ripening and storage.

The seed is a living plant and must be handled as such.

Mr. Augenstein: Other than getting into storage, that is about all I have on my paper. One thing I would like to mention, that we have a large sum tied up in seed. It runs from ten to forty or fifty thousand dollars in nurseries, that is our type where we store seed for the whole region of course, but even ten or twenty thousand dollars worth of seed is certainly worth protecting, and I believe seed has probably received less attention than the trees themselves. We sow seed and think we should get a good germination, and actually we have ruined our seed in storage. I think this paper of Wakely's, if all of you have a chance to read it, is certainly worthwhile. He verified the same thing in regards to temperatures for storing, 55° to 32° F. was one test, and 32 to 41 was another, and 32 to 41, unless you had good control, was probably the better, because if you take it below freezing, he says it should naturally never go above freezing again, and in most nurseries, in Wind River and ours, that are out in the country, it is hard to get refrigeration men to come to fix immediately. We have to stay away from a lot of these mechanical things, and I think the same way with Mt. Shasta. You have to keep in things that you can control yourself.

Mr. Augenstein: Ronald, before we open for questions, would you like to go into the extraction by the use of infra-red light now?

Mr. Adams: We heard indirectly that Ontario Forest Service has an extractor where they were using infra-red lights, so we wrote and requested information on their extractor, and they sent us this rather elaborate bulletin, with some very nice photographs, and it looks like a very simple machine, and I thought I would bring it up here to the meeting to get some comments and ideas on it and see if there might not be some more work that could be done on it. We might even like to work on it ourselves if we were sure it would work out a little better.

They have two continuous belts and they have these little aluminum slats on the belt, and the cones -- there is a hopper there at this end. The cones come in, fall out and are carried along the top of the belt, and another hopper here, or a wetting bath they have, and the cones come down through this wetting bath, that is, to prevent case hardening. Apparently with this process, if they didn't wet the cones, they would get case hardened. From the wetting bath, they come off this belt and then on to the collection plant, and I believe they have screens of some type in these belts here where the seed falls out from the cones.

Now they said that the drawback to this is they can only handle cones, very small cones. They handle Red pine, Jack pine and Scotch pine, and they said they tried it on Ponderosa and apparently they don't develop sufficient heat. The infra-red, by the way, the banks of light are up above each one of these belts, and they develop temperatures within the cones at 170° for Red pine, 160 for Jack pine and 160 for Scotch pine, and I guess those are safe temperatures apparently. Cost of extraction, they compared them with the kiln, they apparently have a kiln also, and they ran around for a large quantity of cones, above 154 bushels on the Red pine 17¢ a bushel and compared with the kiln type, it was 25¢ a bushel, so there is a saving there in the extraction.

The total cost of the device was $2,500 -- $1,500 for the machine and the transformers were $800, and the extracting drum was $200, making a total of $2,500.

Capacity is not too large, I think, for Red pine is 28 bushels in 24 hours, Jack pine 29 bushels in 24 hours; Scotch pine is 26 bushels in 24 hours, so the machine itself has very definite limitations, but I am no engineer and wouldn't know how it could be improved. I suppose they could have larger lights and larger belts and so forth to increase their capacity. They sent a couple of pictures. I will pass these around if you would like to see them.

Mr. Engstrom: What is the time? How long are they supposed to take?

Mr. Augenstein: A very short time. We sent cones back once. We sent White pine and Ponderosa, but they were held up. Carmichael sent - or thought he did - the proper clarification to come across the border, but they were held up and they molded some, only a few sacks. They molded and they had trouble opening them. Once they mold, they are hard to get open, so we didn't get any results back. What they were interested in was to find out the time element to run them through this machine.

Mr. Adams: It gives 20 revolutions a minute.

Mr. Augenstein: But you run a very small amount of cones through there. Of course, other than Jack pine, your Red pine opens fairly easily, doesn't it, Charlie?

Mr. Rindt: If that was travelling 20 revs a minute, that would be a very short time.

Chairman Webster: Are we ready to go ahead on questions?

Mr. Cameron: I believe the time on that is 4 hours.

Chairman Webster: Four hours of actual drying under the lights?

Mr. Augenstein: Possibly they go through more than once then.

Mr. Cameron: The belt itself is travelling very slow.

Mr. Augenstein: Have you fellows checked in on that?

Mr. Cameron: No, I haven't seen the machine.

Mr. Lanquist: I would like to put in my two cents again. I have been looking for that very same thing, the bulletin that you have now, and in the meantime, we sort of made some tests on this deal you are speaking of. We built a little oven and put a thermostat in it and put an infra-red bulb in it and ran a few tests on the Ponderosa pine. I couldn't give you the details now, but we didn't hurt the seed at a temperature of 150 degrees. Then on the basis of that, we made some drawings that the engineer has now in San Francisco, and those drawings are only tentative, but we figure this way, that it is on a belt type 40 feet long and 4 feet wide and if we loaded it twice, by the time it gets to the end of the run, the cones would be dry. That is the idea. Now it is only tentative; we don't know just how it is going to work, but it looks darned good on paper anyway, and the engineer is going to fix it up for us.

Chairman Webster: On this case hardening that you brought out, are they likely to have to dampen those cones before they go through?

Mr. Adams: Apparently so.

Mr. Lanquist: We found that out in our little oven, so we put some fine jets above there so there will be a fine stream, like a fog coming through there once in a while.

Mr. Augenstein: That depends a lot on your type of cone. Jack pine, even in a convection kiln frequently has to be immersed in water in order to get it open, so it was with particular reference to the Jack pine that they refer to there.

Mr. Isaac: Temperatures sound awful high to me, but if they tested them, they ought to know.

Mr. Cameron: Well, may I make a remark. We did look into that type of kiln, but we gave it up for the reason that with infra-red, your temperatures within the seed are very difficult to measure, and of course they are immediately inside out and you might get into very serious effects there with the very slight change in temperature, and we felt that the risk involved was more dangerous than the saving might be in the time of extracting the cones.

Chairman Webster: I will stay with you on that remark. I feel that it is pretty hard to beat a good forced draft system of ventilation in a kiln, like the dry kiln people can put in for you. If you want to go into kiln work, the dry kiln boys have the experience and they can put in any kind of a system you want, control your temperatures, and you know what you are doing every minute of the time all the way through. There is no guess work.

Mr. Adams: The only advantage in this, I believe, would be less manhandling of the cones. You wouldn't have all the trays to handle.

Chairman Webster: You don't have any other handling in the dry kiln type. You put them in one end and they come out the other, and they are completely dried when they come through, so it is a simple process.

Mr. Augenstein: If anybody is interested in building kilns, I think they should look into the Swedish way -- anyway, Norwegian or Swedish -- one of them was over visiting the nursery here and he told me that they had a long tube and blow hot air through that, blow hot air across it, but anyway, in my way of thinking, that is the real way to dry a cone. When you lay a cone there and blow air over it, you are only hitting the surface, but if you are tumbling this cone as it goes, for instance, we get a lot of pitch on our White pine and when it dries, it will just lay there stuck together, and when you pound it, it will start opening right, but if you tumble it, it will break that pitch loose and let it open. We get the same thing in Ponderosa lots of times, and in my way of thinking, that is the real way to dry a cone, and that is tumbling it through this long tube with air blowing through.

Mr. Adams: We have a Rube Goldberg extractor we use. It hasn't too large a capacity. It would be the same as this infra-red extractor, but it is a drum, 4 feet in diameter, 10 feet long, and it has 4 baffle plates on the inside, welded to the side of the drum. It rotates about two revolutions a minute, and we have a core, a 6-inch core down the center slotted, and one end of this core has a blower and a gas jet, and we blow hot air through this core and retate the cones. We don't rotate them continually, but every so often turn them over a little bit, and on Ponderosa that is not too awfully green, we can get the seeds out in about 8 hours.

Mr. Cameron: I wanted to say I can't really contribute anything concrete to what Jim has to say, but we are experimenting with a machine very similar to that and I think it holds considerable merit.

Mr. Augenstein: You are using a long tube, 40, 50, 60 feet long?

Mr. Cameron: Probably by next year we will know something concrete about it.

Mr. Corson: I just want to interject one thing. I wonder if we are not going too far off the end on some of the dry kilns where we have conditions like we have in California. We don't have to actually run them through a dry kiln. We have sun and we should be thinking something along that line where we have weather conditions where we can do natural extraction.

Mr. Augenstein: E. C. Moran, a seed collector in Montana, who does collect a lot of conifer seed from Montana, Northern Idaho, and into Canada, extracts all of it out in the sun. Each farmer, or each farmer's man who collects, he supplies with some canvases. When it is dry he puts them out, and when it rains, takes them in, and he dries all his cones that way. Of course, it is a cheap method and you are limited.

Mr. McDaniel: I wanted to ask, several years ago I received a bulletin on drying cones and extracting the seeds with electrostatic heat. This fellow, after the seed had gone through there 2 weeks, the cones had gone through a pre-curing stage, he would run them through, grade the cones and run them through wringers, sort of like a clothes wringer, and then they went from there into electrostatic heat of 360 degrees F. for a minute and a half, and then they went right out into the shakers and the seed was right there ready to store.

Mr. Augenstein: You don't know what species that was?

Mr. McDaniel: That is all Southern pine cones.

Mr. Augenstein: There is a lot of difference with what a fellow works with. It is Ponderosa pine and White pine.

Mr. McDaniel: I just wanted to ask you if that method had ever been improved upon? It took a few minutes.

Mr. Brown: You haven't mentioned, Jim, about the collection of cones. We found lots of people are interested in collecting cones and when we gave them a cutting test, we found in three cases out of four there were very few seeds in them and they had quite a lot of wormy seeds in them, so I just wanted to interject a word of caution about taking from somebody you don't know. You may get good seed and you may not.

Mr. Augenstein: We do most of our collection through purchases, but we line up the people and it is usually old time collectors, and if we have a new collector, we usually work with him, and we threaten him within an inch of his life that we won't take his cones if they are not good. In fact, we keep them separated.

Chairman Webster: John Cameron, do you concur with what Jim said on moldy cones not producing good seed?

Mr. Cameron: I hesitate greatly in saying what I would want to say about it, because I found with some rather limited tests, I must admit -- but I took some cones, Douglas-fir this is, and subjected them to the most adverse conditions I could. The cones were very, very moist. I piled up about 50 sacks of cones just tight, and let them sit from the collection time until the last of April. Well, those cones were just as moldy as you would imagine they would be.

Chairman Webster: The sacks had fallen apart then, I suppose?

Mr. Cameron: That's right. The same time out of the same lot of cones I put cones on trays so that there was just a single layer of cones of the same lot and extracted them before the end of May so that they didn't sit around so long, and sent them in germination tests. Well, the lot of cones that were stored as perfectly as I could see that they could be stored germinated, I believe it was 82% or something. The seed from the cones that were very moldy, and the heat within that pile was pretty high at times -- I put my hand in there and I wanted to get it back out in a hurry -- that seed germinated over 90%.

Mr. Augenstein: Well, we found just the other thing. Now there are two or three different types of mold. You get that old white mold that is bad. We have tested a lot of cones that are moldy, especially in the squirrel caches; they are moldy, green type mold, and we have had cones sacked up and apparently must have heated a little sometime or other, and we got good seed out of it.

Mr. Cameron: To carry that a little further, we had that in a little discussion at noon, about that very point. I think it is not the mold that is on your cone, even if you get an extremely moldy cone, you don't find very much of that mold is on the seed. If the mold is on the seed coat, once again it has very little, if any, bearing on the germination of your seed. It has to penetrate the seed coat and when your seed has gone through the dry kiln, you will find you are going to kill most of those molds that exist, and I don't believe it is going to have much bearing on the germination of your seed.

Chairman Webster: I wanted to bring that point out, because I knew there was feeling both ways on it, and I thought we should have a little discussion.

Mr. Deffenbacher: I would like to ask another question. Did you find you got more seed from either lot?

Mr. Cameron: The lots weren't comparable, but you will get better recovery from cones that aren't moldy than you will from moldy cones, because the butt and the tip of your cones can't release their seed as well if they are moldy.

Mr. Deffenbacher: Bushel for bushel, the recovery would be more on those that were not moldy than those that were moldy.

Mr. Augenstein: There is just one thing that happened to be in the Spokane paper that was interesting to me -- maybe some of you have seen it -- it is an asphalt coat for mulching lawns after they are sowed which struck me that it might be usable in nurseries. There are two types. One is put out by the Shell Oil Company, and another one was called the Cutback material, asphalt mulch, produced by the Lion Oil Company, that is apparently in the east. This was a test run by Mr. Harold Smith from the University of Illinois. And grass and corn and various things will grow right up through this asphalt coating over the beds. It works from a sixteenth of an inch to a half-inch and it might be a way of keeping excess moisture out of your beds. Shell Oil is where you can write for it. I haven't received any information on it, but it is something that might be valuable for the nurseryman.

Mr. Cameron: I just wanted to say one more thing that isn't really new, but when Jim started out he said we pay a lot of attention to our storage of seed. We haven't paid a great deal of attention to our collection and extraction. I think that one of the things that is most frequently overlooked is in the de-winging of seed, no matter what species it may be, that you are very liable to damage the seed coat, and if it is even a very slight dent in the seed coat, you are going to affect your seed, not for any sowing that year, but for sowing after it has been stored for some years, and we had an experience along that line that showed it very definitely to us. It takes a very slight dent in your seed coat to affect your seed in storage. Apparently it displaces the embryo, and perhaps a hole through the seed coat where it might affect the transfer of gases, but it is a point that I think has been overlooked considerably.

Chairman Webster: Thanks, Jim and Ronald Adams for doing a good job here.

Mr. Finnis: I remember reading about two years ago in Swedish Research Notes, they called de-wingers murderous weapons, and I have often wondered in doing some of these staining tests, when you get a seed which to all outward appearances looks perfectly normal, and you cut it open and it is quite sound, quite normal, but it just doesn't take the stain and therefore we presume that it is dead, whether maybe it hasn't been killed by bruising in the extraction process, possibly the de-winging process.

Chairman Webster: That is a good point which has been brought out here. Now we are going to pass on to our next subject, which is last but not least, "Short Cuts in the Nursery - From Seed to Seedlings Packed for Shipment," and Vern McDaniel from the Oregon State Board of Forestry is going to present the topic.

Mr. McDaniel: I think this is last and also least, boys. This working partner of mine, Mr. Ladd down there, commonly known as Charlie, contacted me on this confounded thing and he sent it in unbeknownst to me, on this topic. All you fellows have short cuts probably better than these, and then Mike here had the nerve to write and ask me if I would talk on a thing like this, and due to certain conditions in our nursery we have been forced, like all you fellows, to do a certain amount of little types of work, special training of a man, and such as this in order to get our work done and to save cost. My paper, which I will take all afternoon to read -- I am going to read it because if I get off on a tangent here, I am liable to be here till six o'clock, and you fellows want to get going.

SHORT-CUTS IN THE NURSERY
FROM SEED TO SEEDLINGS PACKED FOR SHIPMENT

by

Vern McDaniel

* *

Short cuts in the forest nursery. Just what does this expression mean? To me it means getting a better job done in a shorter time at a minimum cost. That cost per thousand is the one that always haunts the nurseryman. Even a few cents per thousand amounts to a substantial saving when the nursery raises several million trees annually. The hopes and dreams of every nurseryman are to produce the best tree possible, the tree that will give the maximum survival for field plantings, at the least possible costs.