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4-1-1987

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Recommended Citation

Karrfalt, R. P., "The Conditioning of Seed In Argicultural Seed Plants" (1987). *Proceedings of the Short Course for Seedsmen*. 471.

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THE CONDITIONING OF TREE SEED IN AGRICULTURAL SEED PLANTS

Robert P. Karrfalt¹

Introduction

The amount of tree seed conditioned in the United States has been increasing steadily in the last 10 years. This has been because of increasing demand for wood in the United States and a demand in other countries for seed of trees native to the United States. The amount of seed produced is expected to continue to increase at least for another five to seven years because of increasing need for wood fiber, a greater emphasis on genetic improvement which almost necessitates artificial planting, and the Conservation Reserve Program. The Conservation Reserve Program might prove to be one of the largest single factors influencing tree seed production because it calls for planting trees on 3.4 to 5 millions acres of highly erodible crop land during the next 5 years. The CRP alone will require an additional 166 tons of tree seed over the 5 year period. Although 166 tons of seed may seem small by some agricultural standards, the value is at least moderately high. Tree seed currently is being traded at \$50 to \$100 per pound. Therefore, there might be some opportunity for an agricultural seed conditioning plant to find some additional revenue from conditioning some of the increase in tree seed production. Even for those seed conditioners not interested in conditioning tree seed, some knowledge of forestry might well prove useful and interesting because forestry is coming to occupy a growing place in American agriculture. An example of this growing prominence is, that in the state of Georgia, pine is the most important single agricultural crop contributing 8.6 billion dollars to the state's economy every year.

Tree Seed Collection Systems

The majority of tree seed collection requires the collection of fruits. With most of the tree seed being from conifers this means cone collection. The cones are collected from the ground after shaking them from the trees with tree shakers or by picking the cones after reaching the top of the tree with ladders or bucket trucks. The cones are then moved in burlap sacks or in 20 bushel containers to the

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holding area where they often need some period of additional ripening. The proper time of harvest of cones is dependent on the species, the genetics of the individual tree, the weather and the properties of the growing site.

However, for some species the seed is collected directly from netting spread beneath the trees. The net collection systems offer many advantages for species that require climbing to cut cones free. It is safer because the workers are not working high off the ground. Harvesting cones at maturity is not a problem because the seed falls when the cone is mature. A large amount of work and fuel is saved because only the seed needs to be transported to the conditioning plant, dried, and conditioned. The draw backs are that collection is dependent on enough dry fall weather to cause the cones to open, birds and rodents can feed on the seed as it lays in the open, and many other tree and weed species fall on the net with the crop seed.

Components Of The Tree Seed Conditioning Plant

Many items in the tree seed conditioning plant will be the same as are found in an agricultural seed plant. Agricultural machinery has traditionally been adapted to forestry use. Only in the last 10 years have the equipment manufacturers produced equipment specifically with forestry in mind. The initial steps in conditioning tree seed are the most different from conditioning agricultural seed.

Drying Cones

The cones that are collected must be dried in a kiln that allows for the expansion of the cone scales. The most commonly used types are tray systems, tumbler dryers and drying wagons. Trays are the most common and the trays are either moved by hand, on rolling racks, or by fork lift. The drying wagon is a direct adaptation from agriculture. This is the standard drying wagon used for peanuts, soybeans and other crops, except that shelves have been installed to separate the layers of cones and give them the room they need to expand. If a cone cannot expand as it dries, it will not be able to release its seed. The tumbler drier is used to both tumble the seed from the cone as well as dry the cone. This is an expensive type of drier and is used only in relatively special circumstances where the tumbling action is needed as the cone is dried.

Cone Tumblers

After drying in trays or wagons, the cones must be tumbled to extract the seed. Tumblers are usually cylinders made of expanded or perforated metal or heavy gauge wire. This cylinder turns around a

central axle and the cones are tumbled like clothing in a cloths drier. Some tumblers are batch operated while most are continuous flow.

Seed Dewinging

Most conifer seed has a wing on it that must be removed before it can be conditioned into a high quality seed lot. Seed plants of the 1950's used dewinging machines that were rather harsh in their action but the degree of dewinging was not required to be high and a higher amount of mechanical injury was acceptable. The Crippen EP26 popcorn polisher was a widely used favorite for dewinging pine and spruce. An experienced, careful operator was able to dewing and not damage the seed. However, the less experienced or somewhat careless operator would easily obtain damaged seed. The high potential to damage seed coupled along with a need to fully remove the seed wing resulted in the development of equipment specifically for tree seed.

Crippen manufactures equipment designed to remove the wing in two stages. The first machine removes the largest portion of the wing by lightly rubbing the seed with paddles in a back-and-forth motion. The second machine removes the tightly attached portion of the wing from around the seed by the same action after adding a small amount of water. The addition of water causes the wing to release. Minimal or no drying is required with these dewingers because the least amount of water is applied. These dewingers and any that rub the seed mechanically require a scalping prior to dewinging in order to remove any large debris that would cause the seed to be crushed as it is rubbed.

South Pine, an American Company, and Hillehog, a Swedish Company, both make wet dewinging machines that tumble the seed as it is sprayed with a fine mist of water. The tumbling action and the natural release of the wing when moistened are enough to separate the wing from the seed. An air jet blows the wings away into a collection pan. These types of dewingers require the use of a seed drier because of the addition of extra moisture. The drying is brief because the moisture is on the surface of the seed. The wet dewinging procedure is easily, though not as neatly, accomplished by using slightly modified cement and mortar mixers.

The modern dewinging procedures have been combined with basic cleaning by adding aspiration or blowing air so that the seed is relatively clean following dewinging. Only a small amount of trash needs to be removed at this point and it is usually removed while sizing or upgrading the seed lot.

Sizing

Sizing is the next step following dewinging. Tree seed has a high amount of variability in seed size because of the large amount of genetic variation among trees. Tree species under cultivation are still essentially wild plants and demonstrate the variability of wild plants. In all likelihood forest trees will never have the uniformity of seed size that agricultural crops have. The sizing is done usually with round hole screens and the lot is divided into three and sometimes four fractions. Once divided into sublots of more uniform seed size, the empty and partially filled seed can be removed without loss of many of the smaller seed. Sizing would not be necessary for basic cleaning but is essential before the upgrading steps.

Upgrading

X-ray is a very useful tool for determining how much seed to remove in upgrading with air or with the gravity table. Empty seed are the most common seed that need to be removed. These result from the feeding of seed bugs on the cones before harvest. Because the seed coat accounts for as much as 60% of the weight of the pine seed, a large empty seed can easily have the same weight as the smaller filled seed. This is the reason for sizing the seed before attempting to remove the empty seed. Cracking the seed with a hammer or cutting it with a knife are also effective procedures to use to determine the percentage of empty seed. The equipment costs much less but is slower and destructive of some good seed. Other types of non-viable seed are more difficult to detect by cracking or cutting the seed. X-ray is far superior for detecting partially filled seed that is caused by seed bug feeding or fungus infection and for detecting seed filled with insect excrement or insect larvae.

Air is very successful in removing the empty seed. The air-screen machine or an aspirator is used for this task. It is adjusted in the same way as it would be for an agricultural seed. Larger and larger amounts of air are applied until a few good seed are blown off with the empty seed. Water flotation is also occasionally used on very small volumes. Water is not suitable for all species and some other fluids or mixtures have been used.

The gravity table is also a good way to remove empty seed although it is not as often used. A gravity table usually is the only practical way, however, to remove stones, partially filled seed, and cone particles that are about the same size as the seed. Seed lots that are collected from nets or extracted from cones that are gathered off the ground can contain many small stones and dirt particles. Generally a small gravity table is required because tree seed lots are often in a range of 10 to 200 pounds, and the necessary complete deck coverage can not be achieved on large machines.

Seed Moisture Control and Seed Storage

Maintaining proper seed moisture is as important with tree seed as it is with agricultural seed. Seed at a moisture content above 10% and at warm temperatures for more than one day can lead to deterioration. The best rule is always keep extracted seed below 10% moisture content until it is time to prepare it for planting. The easiest way to control moisture in the seed is to keep it in a sealed container. The moisture-proof fiber drum is one of the most common containers used. Ambient temperatures as high as 75°F are acceptable for storage for a few months, but storage at freezing temperatures are required for storage beyond a few months. The moisture content of the seed is determined by electronic meters but only a few have charts made for tree seed and these are usually developed by the USDA-Forest Service.

Conditioning Plant Design

Seed conditioning plants built in the 50's and early 60's were designed to do large bulk lots of seed and it was logical to construct them for continuous flow. In the 70's and 80's smaller seed lots became more common and batch operated plants became more important. Modern plants are now batch operated or have an option to run seed in the batch mode. Reasons given for using the batch procedure are simpler design, easier clean out, and better control of lot quality and integrity.

Testing Tree Seed

Tree seed testing is somewhat unique compared to agricultural seed. Only a brief description is given here to give an impression of what is done. Purity is conducted in the same way as for agricultural seed but the problem of weed seed is comparatively not very great. A seed weight test must be done to determine the number of seeds per pound because tree seed varies greatly among seedlots in seed weight. Germination is the strikingly different test. Tree seed almost always needs light, more space because of the light requirement, and often one to several months of prechilling to break dormancy.

The laboratories testing tree seed were few and all official laboratories as recently as 10 years ago. Some in-house testing was done by a few companies and agencies at that time also. Now there are two commercial laboratories and six or more laboratories operated by larger forestry corporations.

Tree Seed Conditioning in an Agricultural Seed Plant

Could an agricultural seedplant condition tree seed? The answer is definitely yes but with limitations. A full conditioning operation could be done only if the plant contained the additional equipment needed for tree seed. This would be the cone kiln, the cone tumbler, and the dewingers. Also specialized experience would have to be developed. Currently in the southern United States there are three firms that do a large volume of contract conditioning work that have this specialized experience. A third factor, to which the agricultural seed plant would have to adjust, is spillage. I have seen small amounts of seed spilled on the floor of agricultural seed plants that seems insignificant. But to the owner of tree seed any spillage and loss is unacceptable because of the small lot size and the value of the seed. Finally the agricultural plant might not be able to accommodate the small size of tree seedlots.

What are the most likely opportunities for an agricultural plant to work with forest tree seed? Drying seed would be a likely activity, especially for a seed orchard where the seed is collected from netting. The seed might be very wet when collected and needs to be dried quickly to avoid loss of viability. The seed could then be sent to a plant that specializes in tree seed. Additionally a basic cleaning could be done without much experience in tree seed. The net collected seed will have a purity of only about 50% when collected. Removal of this large volume of trash would make shipment to the tree seed plant much easier and less costly. Far fewer containers of seed would need to be prepared and the shipping weight reduced.

Removal of stones and dirt with a gravity table would be another likely service. Often the tree seed plants do not have gravity tables, but the seed lots would benefit from the removal of the stones. Only a few stones are needed to have major effect on purity. The removal of partially filled seed could be another service done with the gravity but would require assistance from someone with an x-ray unit to guide the conditioning.

Summary

There are some similarities between agricultural seed conditioning and forest tree seed conditioning such as the use of air-screen machines, gravity tables, and seed dryers. The differences between the two operations include cone kilns, cone tumblers, and seed dewinging equipment. The agricultural seed conditioner who wishes to expand his work into forestry would find the most likely opportunities in drying seed, basic cleaning, and gravity table work.