Seedbed Mulching with Stabilized Sawdust[1]

John R. Scholtes[2] and Thomas D. Landis[3]

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Abstract.-- Discusses the development of a sowing "system" which uses sawdust as the covering for freshly sown seed. Contains a discussion of equipment modifications, material specifications, application techniques, results, and cautions.

MULCHING - BENEFITS AND PROBLEMS

The use of various types of materials to mulch freshly-sown seedbeds is not a new practice. Sand, sawdust, hydromulch, straw, marsh hay, hardwood leaves, pine straw, peat, burlap, thinly-woven cotton, both woven and unwoven poly materials and even plastic sheeting have been used to cover newly sown beds. (Stoeckeler and Jones 1957, Armson and Sadreika 1979). These materials have been used to produce a beneficial environment for seed germination by: controlling erosion from wind and water, preventing soil puddling and crusting, controlling frost heaving, reducing evaporative moisture loss, reducing soil splash, eliminating wicking of saline salts to the soil surface and minimizing surface soil temperature fluctuation. (Stoeckeler and Jones 1957, Armson and Sadrieka 1979, Duryea and Landis 1984)

The general literature dealing with nursery soil management, while mentioning the positive aspects of mulching, actually seems to delve more into the problems which can be associated with the use of mulch materials. Mulches can be expensive to collect or purchase and apply, and some require removal before they cause heat buildup. Others are unstable and blow or wash off the seedbed. Organic mulches can be contaminated with weed seeds or pathogens and may also induce nitrogen deficiency.

Many years of personal experience with mulches and soil amendments have taught that all of the positive as well as the negative statements above can be true. One mus t be extremely careful when introducing any material into a nursery site.

Seedbed mulches, like any soil amendment, affect the physical, chemical, and biological properties of the soil. Therefore, certain tests are required before any potential mulch material is introduced into a nursery. These include: 1) mechanical analysis to determine particle size and distribution; 2) chemical analysis to test for harmful salts and phytotoxic substances; and 3) biological analysis to look for unwanted and potentially damaging pathogens, seeds, rhizomes, etc.

The addition of a mulch over a seedbed is an amendment to the surface of that seedbed. The key here is the word "amendment". This material will change the condition of the soil and the seedbed. The nursery manager must take those changes into consideration when working with mulched seedbeds. Cultivation of the seedbed surface would destroy the mulch. The rate of application of pesticides, especially herbicides, may need to be adjusted. Irrigation for soil moisture and soil surface temperature control will definitely have to change. And the nursery survival factor will need to be adjusted higher to reflect better survival if the mulched seedbeds are properly sown and managed.

PREVIOUS EXPERIENCES WITH MULCHES

A popular seedbed mulch used at USDA Forest Service Nurseries in the west during the 1960's and 1970's was sand. In the late 1960's, the Coeur de Alene Nursery developed a sand spreader which mulched the entire surface of the seedbed with a uniform thickness of sand. During the early 1970's, two of these spreaders were obtained and used by the Lucky Peak Nursery near Boise, Idaho. Also during the early 1970's, the Mt. Sopris Nursery at Carbondale, Colorado was using a seed drill mounted sand spreader which distributed sand over the individual seedrows. These seedbed mulching "systems" all worked but they also had drawbacks.

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[2]John R. Scholtes is Nursery Manager, USDA Forest Service, J. Herbert Stone Nursery, 2606 Old Stage Road, Central Point, Oregon 97502.

[3]Thomas D. Landis Is Western Nursery Specialist, USDA Forest Service, State and Private Forestry, P.O. Box 3623, Portland, Oregon 97208.

The Coeur de Alene sand spreader mulched the seedbed nicely but required large amounts of clean, relatively dry sand to cover the entire surface. Obtaining clean sand and drying it became a monumental task each spring. Loading and application was slow and the loaded spreader was difficult to maneuver around the nursery and down the seedbed paths.

The Mt. Sopris mulcher required much smaller amounts of sand but the sand had to be perfectly dry and clean to obtain a reasonable flow through the small metering holes and drop tubes. Drying and screening sand and storing it in five gallon containers was a full time spring project for two to three persons.

Over the years, all these nurseries have changed seedbed mulching equipment and even materials. The Coeur de Alene Nursery has gone to hydromulching over a soil cover. The Lucky Peak Nursery has changed to mulching individual seedrows with a commercially packaged sand material.

During the mid 1970's, the authors tested several sowing and mulching systems at the Mt. Sopris Nursery. Two different seed drills were used. The Love-Oyjord[R] utilized disc openers which opened an approximately 0.25 inch wide furrow. The seed was dropped into the furrow. The seed was either covered with soil using concave-shaped packing wheels which pressed the soil back into place or it was left uncovered by removing the packing wheels.

The second seed drill was custom-made and utilized a banded roller. Metal bands were spot welded around the roller, and left impressions for the seedbed rows; the seed was dropped into these impressions. A second banded roller followed the seed drop tubes to firm the seed down into the soil in the bottom of the impression (fig. 1).

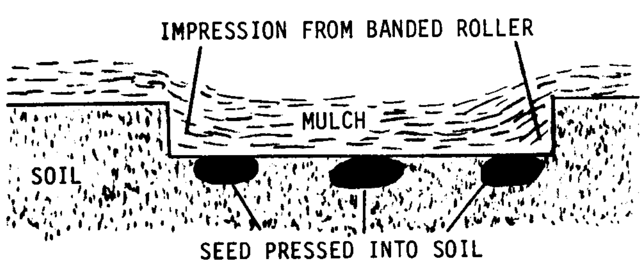

Figure 1.--The placement of seed into a seedrow using a banded roller. Notice that the seed is "firmed" or pressed down into the soil at the bottom of the impression. This is necessary because the mulch material placed over the seedbed will dry out rapidly. However, the soil surface beneath the mulch will remain moist providing a steady supply of moisture for the seed to germinate and the germinant to emerge from the seedbed as a vigorous seedling.

Several combinations of mulching materials were included in the Mt. Sopris trials. They included: covering with soil, sand, two rates of hydromulch, fresh sawdust held in place with hydromulch, and fresh sawdust held in place by staking 60% shade cloth over the seedbed (the cloth was removed at the start of germination). The results of one of these mulch trials has been published (Landis and others 1984).

Of all these trials, the sawdust/shadecloth and sawdust/hydromulch combinations proved superior. The sawdust/hydromulch combination was selected for further operational trials because of the labor of handling the shadecloth. This seed covering system eventually became the standard for operational sowing at Mt. Sopris Nursery.

The authors observed that covering seed with a sawdust mulch which was held into place with hydromulch ("stabilized mulch") had many beneficial effects upon the seedling crop and management of the soil, especially during the germination period:

1. Soil moisture around the seed is more uniform and stable. The mulch dries fairly quickly but moisture in the surface soil will not move into the mulch because of the textural differences between these materials. Another factor that reduces evaporative losses from a mulched seedbed is the insulation provided by the mulch, which lowers surface soil temperatures.

2. Salt accumulation on the soil surface is almost totally eliminated. The mulch slows upward capillary water movement ("wicking") through the soil profile and thus reduces the surface accumulation of soluble salts. High levels of salts at the soil surface bind soil particles into a crust, which can reduce air exchange, increase surface temperature, and reduce water infiltration rates. Also, total soluble salt levels on the soil surface can reach the point of becoming toxic to new germinants.

3. Irrigation requirements are reduced. Reduced evaporative loss from the soil surface significantly reduces the need to add moisture to the soil profile. Except during the germination period and irrigation for cooling or incorporating chemicals, general irrigation can be reduced by as much as 50% during the first year.

4. Improved seed performance because germination and early survival are substantially improved. Seed usage at the Mt. Sopris Nursery was lowered by an average of 20%. Although also affected by other management factors, seedbed mulching played a major role.

5. Improved seedling vigor and root growth. Little comparative data was taken but general observations were that seedlings grown in a mulched seedbed were larger, appeared healthier, and developed larger, more fibrous root systems than those in unmulched areas.

THE NEED AT J. HERBERT STONE NURSERY

These positive experiences with seed mulches were brought by the senior author to the J. Herbert Stone Nursery JHSN). In the spring of 1986, the sowing practices at JHSN followed standard procedures for covering with soil. The nursery was using two Love-Oyjord seed drills for the majority of the conifer seed. A home-made seeder ("Stone Drill") was used to sow larger seed, such as Abies spp., which could not be sown and covered to the proper depth using the narrow disk openers of the Love-Oyjord drill.

The Stone drill was modeled after the Wind River Nursery seeder and had a shoe-type row opener which created an opening ,just over one inch wide. Although the Stone drill did an acceptable ,job, it required almost perfectly formed and surfaced seedbeds to allow covering the wide seedrow with the proper depth of soil. The surface of the seedbed had to be pulverized in order to prepare a suitable surface for sowing. The Love-Oyjord drill was also easier to calibrate and operate.

To get away from these problems with the Stone drill, the JHSN nursery staff decided to modify the Love-Oyjord seeder to hand all types of conifer seed. At the same time, the seed drill would be modified to work with a seed mulch.

SELECTION OF A MULCH MATERIAL

Aware that many different materials could be used as seedbed mulches, potential mulches that were locally available at JHSN were evaluated. In order to capture the full range of benefits, the decision was made to mulch the entire seedbed surface. Even thouh a suitable source of sand was available locally, the cost of procurement and application made this a very costly alternative. The same was true of hydromulch. The most economical material available was fresh sawdust, and so the decision was made to try sawdust as a seedbed mulch at JHSN. This decision was implemented in four phases: 1) Development of sowing equipment, 2) Procurement of suitable quality sawdust, 3) Uniform sawdust application, and 4) Stabilization of the mulch.

1. Development of sowing equipment

One of the Love-Oyjord seed drills was extensively modified to allow sowing the larger seed into wide drill rows and pressing the seed into the soil. Items that were changed or modified are listed below:

a. The smooth drum was replaced with a banded roller: a 1.50 inch wide by 0.38 inch deep steel strap was spot welded around the roller to press indentations into the seedbed surface and form the seedrows (fig. 1).

b. Large drop tubes of clear flexible plastic with an inside diameter of 1.38 inches were fit over the original boots of the seeder (The boots connect the drop tubes to the seed spinner or distribution head).

c. The disc openers were replaced with angled pieces of 1.50 inch muffler pipe bent at the local muffler shop to drop the seed into the rows with minimal bouncing of the seed out of the impressions.

e. The concave soil packing wheels were replaced with flat semi-pneumatic rubber wheels which were 1.50 inches wide to fit down the seedrow impressions and press the seed into good contact with the soil.

f. A seed hopper with a large tube was obtained to allow the large seed to flow into the seedwheel.

g. Larger gauges were made to allow the hopper tube to be adjusted to as high as one inch above the seedwheel.

h. The seedwheel was modified by cutting out every other lamelli to allow the seed to drop more freely into the spinner.

i. The funnel between the seed wheel and the spinner was enlarged leaving as large an opening as possible.

,j. The chain driver for the seed spinner was replaced with a hydraulic motor drive to allow very slow ground speeds as needed to handle larger Abies spp., while still maintaining approximately 800-1200 RPM on the Spinner.

Other "nice-to-have" modifications were also added to the seed drill. These include:

k. A heavy duty digital counter which can withstand more use than the mechanical counters.

l. The seat was offset towards the drive side allowing more room to get on and off the seeder from the left side (facing the rear of the seeder).

m. A step has been built onto the frame halving the distance to the ground.

n. A plexiglass "view window" has been placed into the cover over the gears.

o. The gears have been clearly numbered in the cover.

p. Green and amber lights have been mounted on the tractor with switches on the drill so the drill operator can signal when to stop and go.

q. An insulated box for seed has been built on the front of the seeder.

These modifications have improved safety, operation convenience, and seed care.

2. Procurement of suitable quality sawdust

There are several sources of sawdust available in Southeastern Oregon so prices are competitive. Sawdust must be of the proper size and not contain harmful materials (table 1). Past experience at JHSN had shown that poor quality sawdust can create soil conditions which are detrimental to seedling growth and can cause long-term nutrition problems. Wood from some species of trees can contain phytotoxic chemicals, and sawdust (especially "aged" sawdust)-from some sources can contain high levels of soluble salts.

Table 1.--Physical and chemical standards developed for sawdust supply contracts at JHSN:

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1. Physical Properties

    A. Particle Size - Must pass through a 2 cm mesh screen. Not more than 45 percent (by weight) will be fine enough to pass through a 2.0 mm mesh screen.

    B. Purity - No more than five percent by weight of foreign material will be allowed.

2. Chemical Properties

    A. Salinity - The electrical conductivity must not exceed 0.5 mmhos/cm. Total bases must not exceed 15 meq/100 grams of sawdust; of these, calcium levels must not exceed 12 meq and sodium levels must not exceed 0.8 meq.

    B. Phytotoxic Materials - Cedar or redwood sawdust are unacceptable.

During procurement, sawdust should never be stockpiled or dumped onto any portion of the nursery seedbed area because leachates from sawdust piles can be washed into the soil. Furthermore, piles can never be completely removed nor can they be uniformly spread. The tires of hauling, loading and spreading equipment will also work undesirably large quantities of mulch material into the soil in the stockpile area. Leachate concentrations and excess mulch material can cause nutrition and possibly other problems in subsequent crops. At the very least, this practice will result in a soil which has been "amended" into an hodge-podge which will be difficult to manage. It is difficult to resist the temptation of reducing application costs by cutting corners but the material must be stored off the production area and applied in a uniform manner to the fields.

3. Uniform Sawdust Application

After a suitable source of sawdust has been procured, the next concern is how to apply the desired depth of sawdust to the seedbed. A general rule of thumb is to cover the seed to a depth of 1.5 to 2 times the seed width. If the mulch layer is too deep it could physically inhibit germination or keep the soil too cool for maximum seedling emergence. Too shallow a layer would not provide adequate protection for the seed. An old adage is that "you have to leave a little seed showing to be sure that you are not sowing too deep". In reality, this is saying "we do not have suitable equipment or control needed to cover seed to the proper depth, so it is better to sow too shallow than too deep". Obviously, any seed drying under the direct rays of the sun is not likely to germinate. Perhaps one of the most valuable benefits of mulching is getting all the seed covered to a suitable depth.

The type of manure spreading mechanism used to spread sawdust at Mt. Sopris Nursery could not be located. A paddle-type manure spreader was modified and remodified many times in an attempt to get uniform covering over the seed. We were able to get a suitable covering for the larger-seeded species which can push through around an inch of mulch if necessary, and so this spreader was used for those species only. We did not wish to risk covering the smaller-seeded species with this unit although a few trials were promising.

A thorough market survey did not yield mulch spreading equipment which would handle the required minimum of 12 cu yds of material and distribute it uniformly. A contract was developed for someone to design and build a unit which would meet our specifications. After having no takers on this contract, we contacted a leading nursery materials handling manufacturer and obtained working drawings of basic materials handling methods. Following these drawings, we set up a few bench tests to determine our needs for belt speeds, opening heights, etc.

Using information gained through those tests, we have radically modified a manure spreader which has successfully applied a uniform layer of mulch over our seedbeds (fig. 2). Some of the major modifications are listed below:

a. Tapered internal walls to bring the bottom of the box down to a width only slightly wider than the seedbed.

b. A special type of conveyer chain in the bottom replaces the standard draper bars.

c. The conveyer runs on a special bottom layer of smooth plastic to reduce friction.

d. An adjustable tailgate has been fabricated into the spreader to allow for infinite adjustment of the opening above the conveyer.

e. The standard gearbox had to be replaced with a heavy duty box which could stand the drag of the conveyer.

f. A slip clutch was added to protect the gearbox and other drive mechanisms.

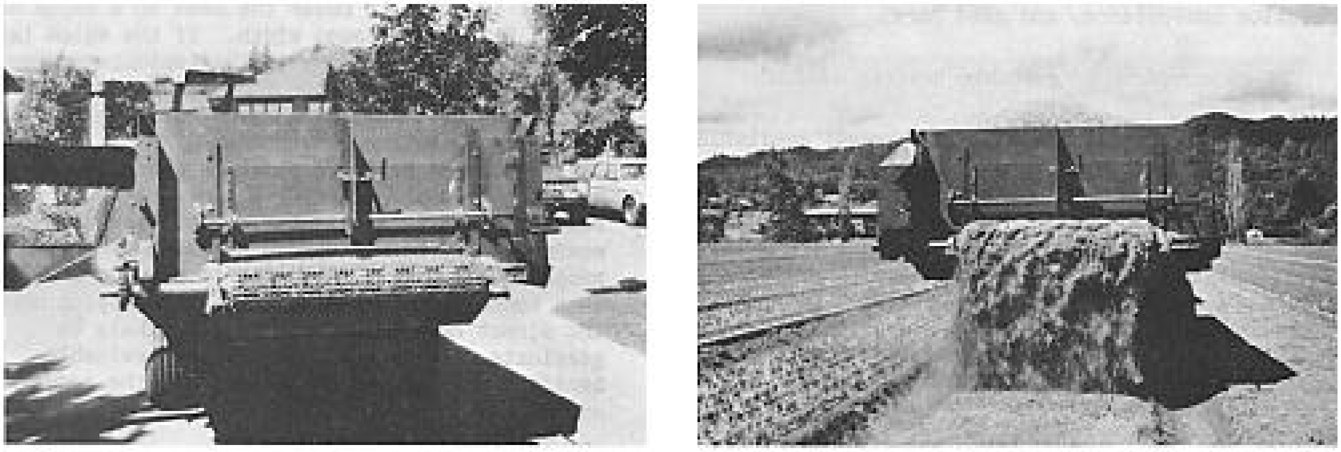

Figure 2.--A commercially-available manure spreader was modified with a mesh conveyor chain, a smooth plastic deck, and an adjustable tailgate (A); these modifications, plus the proper tractor speed, apply a consistent, uniform depth of sawdust mulch over the sown seedbed (B).

g. Several wide cross braces were added across the bed to buffer the downward weight of the material in the spreader box upon the conveyer.

h. A special undercarriage was built to fit the seedbed paths.

4. Stabilization of the Mulch

Once the sawdust mulch has been applied, the final problem is to keep it in place. Several different types of chemical "stickers" are commercially available. As previously discussed, hydromulch worked very effectively at the Mt. Sopris Nursery. This method of tacking down the sawdust was and still is an excellent option. However, lacking a hydromulch unit and recalling that this process was somewhat slow and labor intensive to mix and spread, led to the search for some other suitable material.

A brochure on a new material called Geotech^R had recently been received from the Borden Chemical Corporation. This material was listed as a co-polymer resin and was advertised as having been used to bond sandy soils in southeastern nurseries. A call to the Auburn Nursery Cooperative yielded lots of information about the use of Geotech^R on sandy soils but no information was available about using this material to bond sawdust. Another source had worked with unpigmented latex at the rate of one part latex to 50 parts water on sandy soil but again had no experience with sawdust. Neither source was optimistic about the effectiveness of either material on sawdust.

The decision was made to take the needed risk and extensively test Geotech^R on seedbeds, along with a spot test of latex and water. The Geotech^R was minimally effective, and held most of the sawdust on our seedbeds most of the time. It must be emphasized that Geotech^R forms only a rather weak bond between the particles of sawdust. Heavy winds, especially those associated with spring thunder storms, will loosen and blow the surface sawdust off the seedbeds. During the past three seasons in which we have used this bonding agent, we have experienced some blowing of the sawdust off parts of the sown area. This has not affected the germination of the seed because the sawdust in the actual seedrow depressions made by the drill has never been lost. This leaves adequate cover over the seed for germination. What is lost, however, is the benefit of having the entire bed surface mulched. In most cases, we have gone back in and remulched the affected seedbeds as soon as we could get back onto the area.

Only the general lack of wind in the Rogue River Valley which lowers the risk of catastrophic loss of covering during germination justifies the continued use of Geotech^R at JHSN nursery. A much more dependable bonding agent for the sawdust covering in an area of more wind would be hydromulch.

We are still searching for a better bonding material. One other brand of co-polymer resin was tested this last spring but it had so much large particle material in each of two separate shipments that we could not use it through our sprayer. We have also tried a material used for dust control on roads known as Lignite. This material seriously depressed both rate and total germination.

CONCLUSION

We have four years experience using a stabilized sawdust mulch at JHSN. We have developed the equipment and processes needed to grow seedlings with mulch. Most of the equipment has been modified several times. The change over to using mulch has not been easy but we believe that the payoff has been worth the effort. For instance, we now sow all our seed with ,just one type of drill which is easy to calibrate and use. Seedbed preparation is faster and we believe easier on the soil. A few small clods, twigs, slightly uneven surfaces are no longer problems. We have also seen payoffs in the seedlings. The first year we sowed Abies with mulch cover, we increased the anticipated survival by 10% and we still came up with surplus seedlings. The disadvantage of course was that we also had overly dense seedbeds. We are still working with our sowing factors and we are definitely sowing less seed per thousand seedlings shipped.

Seedlings are also growing faster than anticipated. This can be both "good" and "bad" from a managers view but having the capability of producing larger seedlings faster allows more flexibility in managing future crops. Root systems are also better developed with more branching of secondary permanent roots were up near the surface of the ground than had been observed before.

This last spring, we converted our second seed drill to utilize this mulching process. We have saved the original drill parts ",just in case" but we really doubt that we would ever go back to trying to cover with soil.

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