THREE ROCKS -- FOR BETTER PLANTING SURVIVAL

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When I was in Spain a year ago I saw thousands and thousands of hectares of new pine plantation with 80 to 90 percent survival in regions receiving an average annual precipitation of only 12 to 16 inches. Most of the precipitation came during the nongrowing season, with the summers long, completely dry, and scorching hot. Yet the Spanish foresters were achieving this survival without supplemental watering after planting.

How? Several things were combining to account for this, but one of them is so simple and cheap to do and so easy for American tree planters to adopt that I commend it to the attention of all who are planting on rock strewn sites.

The last act the Spanish tree planting laborer does is to place the three largest rocks that come readily to hand around and as close to the newly planted tree as possible. This simple act, I am sure, contributes a lot to the amazing survival of the plantations that I saw.

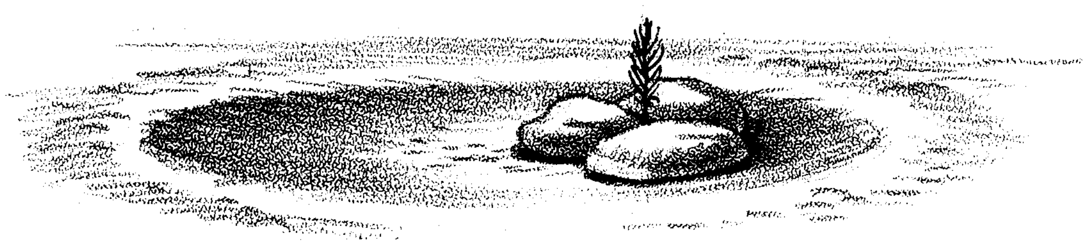

Figure 1. - Newly planted trees with three stones placed to conserve moisture.

These rocks accomplish several things.

1. They reduce loss of soil moisture by surface evaporation. Give this a moment's thought -- the soil under a freshly turned stone in a field or forest is always moist, or at least less dried out than the surrounding barren or grassy surface, even during a drought. The rock has conserved the moisture that was in the soil. A tree with its roots under the rocks would benefit from that moisture which would otherwise have been uselessly lost by evaporation prior to the tree's needing it.

2. They create a permanently cultivated area around the tree. Obviously no weeds will grow under the rocks, hence there will be no competing vegetation at the tree to use soil moisture that will be needed by the tree.

3. The rocks reflect heat that would otherwise be absorbed by the soil. This again reduces the rate of moisture loss.

4. The rocks protect the tree from total destruction by browsing of deer, rabbits, and cattle. They may save enough of the stem to sustain life until the following year when a new bud can develop to start the tree on a new bid for life.

5. The rocks may reduce or prevent frost heaving.

6. Depending upon their thickness, the rocks shade the base of the tree and reduce to at least a little extent the deleterious effect of sun and wind.

7. The rocks act as a support for weak-stemmed trees.

8. The rocks serve as a marker of the spot in which a tree was planted, hence will simplify survival examinations.

The Spaniards place the rocks as close to the stem as they can -- actually touching it if possible. The growing tree apparently has no difficulty in pushing the rocks away as it increases in diameter. And I saw no evidence of stem damage due to heat absorbed by the rocks from a fierce summer sun.

The question might be asked as to why the use of three rocks instead of two or four or five. Actually the number "three" has no magical significance -- the basic idea is to pave as large an area closely adjacent to the tree as is practical with a minimum of added labor. A ring of three rocks can be placed more continuously and closer to the stem than can two or four rocks of that size. Four or more rocks in a ring will often leave an uncovered island in their center in which weeds will prosper from the moisture stored under the rocks.

Another question that might be asked is this -- that if covering a small area with three rocks is good would not covering a larger area be even better? Would it not be desirable to pave a large diameter area around the tree with numerous rocks or cover it with a sheet of tarpaper, pliofilm, or foil? Perhaps so, perhaps not, but at any rate it would certainly cost more than the simple placement of 3 rocks in a few seconds of time. Whether or not the added benefit of more rocks or an impervious sheet would justify the additional cost is a matter for local determination for each planting site. The advantage of using only the three largest rocks handy to the laborer at the tree is that this is something readily done at minimum added cost, and without added problems of procurement, transportation to the site, or burdening the laborer with additional objects to carry.

This is a simple thing to do when rocks are readily available. It won't cost much.
Why not try it sometime ?

BETTER SURVIVAL WITH OVERSIZE HOLE DIGGING

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Another practice which I think accounts in large measure for the excellent survival in the plantations of Spain is one of digging holes several times larger and deeper than required to accommodate the little tree itself. Specifically, their technique is this -

At some convenient time after the close of a field planting season a crew of laborers with mattocks digs holes for the trees to be planted the following spring. These holes are 12 to 16 inches cube in size, and are checked for adequacy by a foreman carrying a wire cube of the required dimensions. Another crew then follows as convenient and fills the holes, discarding the larger stones if enough soil can be found to nearly fill the hole, without them. During either this filling or the planting operation itself a basin, hereinafter called by its Spanish name of "casilla, " 39 inches or more in diameter and about 6 inches deep is dug around but 6 to 8 inches off center of the hole. On sloping sites the workmen dig into the hill and build up the downhill edge to form the casilla that will trap and hold water until it can be absorbed into j the subsoil (fig. 1).

Such casillas with their deeply dug holes will intercept and hold until absorbed all except the most torrential downpours. Thus the trees receive the benefit of all the water that falls; no water runs uselessly to the stream beds and the sea. During the ensuing months the soil in the filled holes settles and absorbs moisture. Because the casilla is off center from the hole, the tree when finally planted stands a little way up the slopes so that if a pool of water collects the tree itself will not be flooded.

When the trees are planted their roots encounter a loosened and moistened zone into which they can elongate quickly rather than a dry, hard subsoil that might confine them to a shallow top layer. By the time the drought begins the trees are established with deep roots and nearly all of them survive the fierce, rainless summer. What a different situation than when the roots are placed in a hole barely big enough to accommodate them so that they must push themselves into solid, undisturbed subsoil, and when scanty rains run off the slope before they can penetrate to the roots. No wonder the trees grow in Spain. Would they not do as well in America on our dry western slopes if planted in the same manner?

Admittedly this kind of site preparation requires a tremendous amount of hand labor and because of the wages paid American laborers the cost would be great indeed. In fact it might be difficult to employ as many laborers as this would require on a really large planting project.

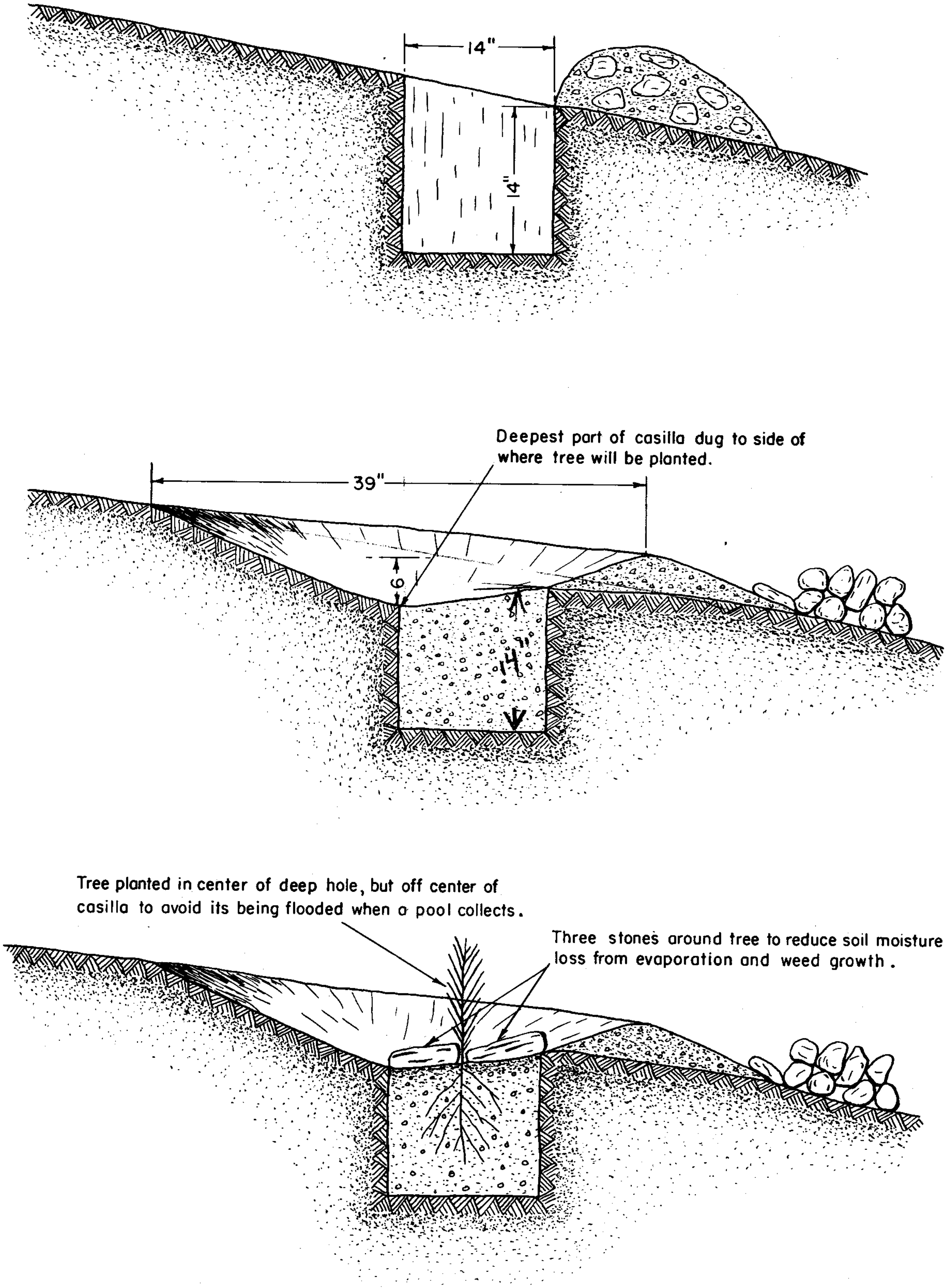

Figure 1. - Hole and casilla prepared for planting.

Choice must be made between. added survival at high cost and less survival at a lower cost. Possibly the technique can be expected only on small jobs with unusual landowner interest and demand for excellent survival. To get it into common use will require a machine that will replace most of the hand labor.

A machine to do this has now been built by the U. S. Forest Service and is being field tested. In brief, it is nothing more than a large diameter rotatable bit hanging from a powered posthole digger carried on arms behind a tractor. It plows up a big deep area without removing much soil from the hole.

The digger is driven from the power takeoff of the tractor. It is raised and lowered hydraulically from the three-point suspension hitch of the tractor. At work the tractor comes to a full stop, lowers the bit and drills the hole, raises the bit, and goes forward to the site of the next hole.

The hole prepared by the present machine has at the top a 36-inch-diameter circle within which all the brush and herbaceous vegetation and roots are chopped up and the soil is thoroughly plowed by the rotating blade and disks. Beneath this scarified area there is a second hole 9 inches deep and 9 inches in diameter, and beneath that another one tapering to a point in 9 inches more (figs. 2 and 3).

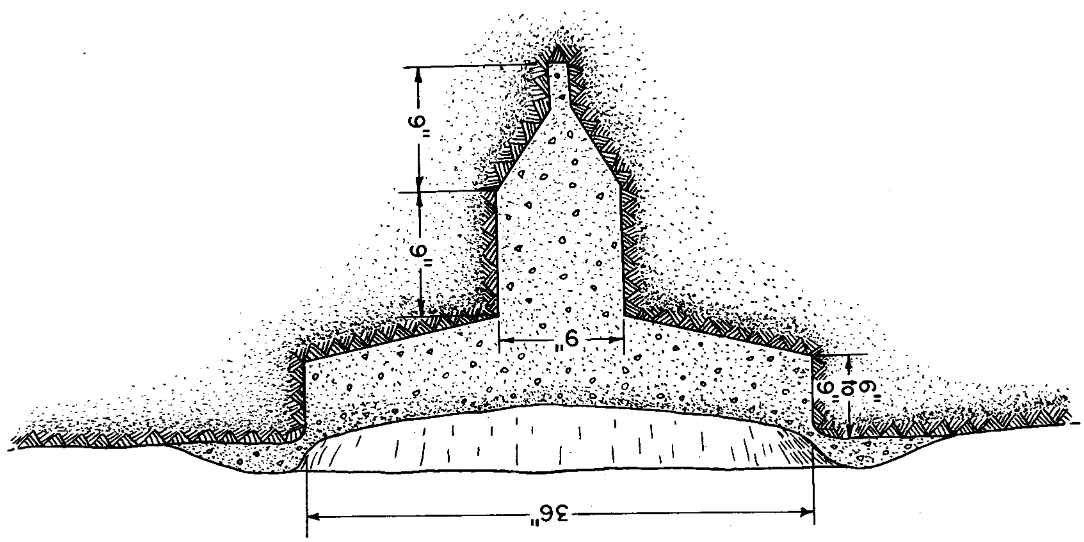

Figure 2 - Cross section of machine made hole.

Figure 3. - Three views of machine for digging special planting hole.

The size hole, of course, is determined by the diameter of the bit. Since the bit is not of complex design, any well equipped machine shop can make it to drill holes of whatever size the local site conditions require.

Whether the bit leaves most of the loosened soil in the hole or ejects it depends upon the design of the bit and the speed of rotation. If rotated slowly, the bit removes only a little soil and piles it in a berm around the periphery of the hole. An excellent casilla with its center depressed several inches from the original ground level results. At planting time a laborer could easily give final shape to the casilla with just a few strokes of his planting hoe or mattock, and open a hole for the tree in the deeply stirred soil.

If there is merit in the idea of a casilla to hold surface runoff until it can soak down to the bottommost roots, and the idea of a deeply plowed subsoil to facilitate deep root penetration during growth, then this machine has much to recommend it to people willing to give new devices a trial.

On appropriate sites a sufficiently powerful tractor could also be fitted with a bulldozer blade in front. Thus for little added cost it could clear a way through continuous brush, or flatten a terrace, as it proceeded across the terrain digging holes.

The machine is not intended to keep ahead of a gang of laborers. Field tests thus far do not promise a speed of more than 40 or 50 holes per hour, and probably less on many site-s. One workman could easily plant trees much faster than the machine can prepare holes for them. Neither is the machine intended for use only during the planting season. The mere cost of owning and depreciating such a machine and its tractor requires that it operate steadily. The machine was developed with the idea that it would be kept at work all during the field season, plowing holes and leaving them to settle and absorb water during subsequent months. It is felt that an overwinter wait to let the loosened, aerated soil settle back into place will be beneficial to the newly planted tree.

Admittedly there are sites so steep that this machine will not operate in safety upon them, or so rocky that it will have difficulty in finding spots where its drill can enter to acceptable depth. For such sites no machine yet devised is as good as a determined man with a mattock.

Also, there are brushy sites so densely covered with stems of large diameter that this machine would be helpless. On such sites a 36 inch diameter circle, even if the machine were able to clear one, would be insufficient space for the tree to survive in. Such brush fields require the total elimination of all existing vegetation by bulldozing with heavy machinery. The machine might be useful after clearing but not before.

But there are millions of acres of other sites where the machine would be well worth while. The adaptability of the machine to any given site is something for the local planting administrator to determine.

Working drawings and specifications for construction of the machine are available. Address requests to:

Equipment Development Center U.
S. Forest Service Arcadia,
California

or to

Chief
Forest Service, U. S. D. A.
Washington 25, D. C.

Letters reporting the experiences of people making and using the machine will be appreciated. From the knowledge of how the machine performed under a variety of conditions, we will be able to evolve a better, more versatile machine. Send such letters to:

Chief
Forest Service, U. S. D. A.
Washington 25, D. C.

SOIL MOISTURE CONDITIONS AFTER CHEMICALLY KILLING MANZANITA BRUSH IN CENTRAL OREGON 1 /

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Selective herbicides are being used on an increasing scale to kill undesirable plants in the Pacific Northwest. On Forest lands, chemical control affords one of the most promising means for preparing for reforestation areas now occupied by brush or weeds. 2/

In central Oregon, trials of chemical control in brush fields of a nonsprouting species of manzanita (Arctostaphylos parryana var, pinetorum) have been singularly successful. 3/ Here, the next step is to reestablish a stand of ponderosa pine through planting or seeding. Of immediate interest in this problem of artificial regeneration is the effect of brush control and brush removal on physical site factors. One of the factors most often critical in the establishment of ponderosa pine seedlings -- soil moisture -- was singled out for attention in this exploratory study.

METHOD

Within a large brush field on the Deschutes National Forest in central Oregon, dense manzanita on several large plots had been killed by aerial spraying in July 1954. 3/ On some of the brush-killed areas, the dead plants had been subsequently pulled and removed to improve access for seeding or planting and to reduce fire hazard. Thus, three very different conditions of ground cover were available for the study of soil moisture: green brush; dead brush; and cleared (brush killed and removed).

1 / Reprinted from Research Note No. 156, December 1957, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

2/ Dahms, Walter G., and James, George A. Brush control on forest lands. U. S. Forest Serv,, Pacific Northwest Forest and Range Expt. Sta. Res. Paper 13, 81 pp., illus. 1955.

3/ Dahms, Walter G. Chemical brush control on central Oregon ponderosa pine lands. U. S. Forest Serv. Pacific Northwest Forest and Range Expt. Sta. Res. Note 109, 5pp. 1955.

Three plots, each 80 feet square, were established in each of the three ground-cover conditions. All plots occupied a position of similar aspect, elevation, and soil. Five sampling points were randomly selected on each of the plots. At each point, soil moisture samples were taken at depths of 10-14 inches and 20-24 inches on 5 different dates: May 24, June 27, July 29, September 8, and September 29. Moisture content, expressed as percent by weight, was determined after ovendrying.

Surface soil on this area is a loamy coarse sand grading to a pumicy loamy coarse sand. At a depth of about 24 inches, the soil is a rich brown, fine sandy loam immediately overlying basalt rock.

RESULTS

At the beginning of the study in late May, the soil was well charged with moisture (fig. 1) with no significant difference in moisture content between the three plots nor between the 2 depths sampled.

By June 27, soil moisture on the "dead brush" and "cleared" plots had decreased slightly, but with no significant difference between the two. Soil moisture beneath green brush, on the other hand, had decreased at both depths to a content significantly lower than that of the other two ground-cover conditions.

By July 29, soil moisture in the dead brush and cleared plots had scarcely altered from the previous month's level, whereas it had again decreased significantly under the green brush cover. The same trend in soil moisture continued through September 8.

The only precipitation during the study was a rainfall of about 0. 25 inch during the period between September 14 and 24. This addition was reflected on September 28 in a slight increase in soil moisture for all samples except those for the 20- to 24-inch depth beneath green brush. However, relative soil moisture under the three ground-cover conditions was the same as for the period prior to the rain. Dead brush and cleared plots showed no difference in moisture content while soil moisture beneath green brush remained significantly lower.

At no time during the study did soil moisture on either of the nonvegetated plots fall appreciably below the moisture equivalent. Beneath green brush, however, moisture at the 10- 14-inch depth declined more than twice as much, percentage wise, as in the nonvegetated plots. At the 20- to 24-inch depth, moisture decline under green brush was almost three times that of the nonvegetated plots

The first permanent-wilting percentage, approximated by 15 atmosphere-tension determinations, was neared in early September at the 10- to 14-inch depth and somewhat earlier at the 20- to 24-inch depth. Critical moisture levels were probably reached much earlier in the season because of immobility of soil water at low levels of moisture content.

Conservation of soil moisture is especially important in the ponderosa pine region where the moisture is derived mostly from snowmelt and stored in the soil for use during the summer. When vegetation is removed, transpiration is eliminated' as a source of moisture loss and evaporation becomes the primary controlling factor. In coarse-textured pumicy soils of the study area evaporation is evidently minimized by a dust mulch at the soil surface. As a net result of these factors, the killing of the manzanita cover with chemicals greatly reduced the loss of soil moisture during the summer drought. The amount of moisture saved was about the same, whether the dead brush was removed or left standing.

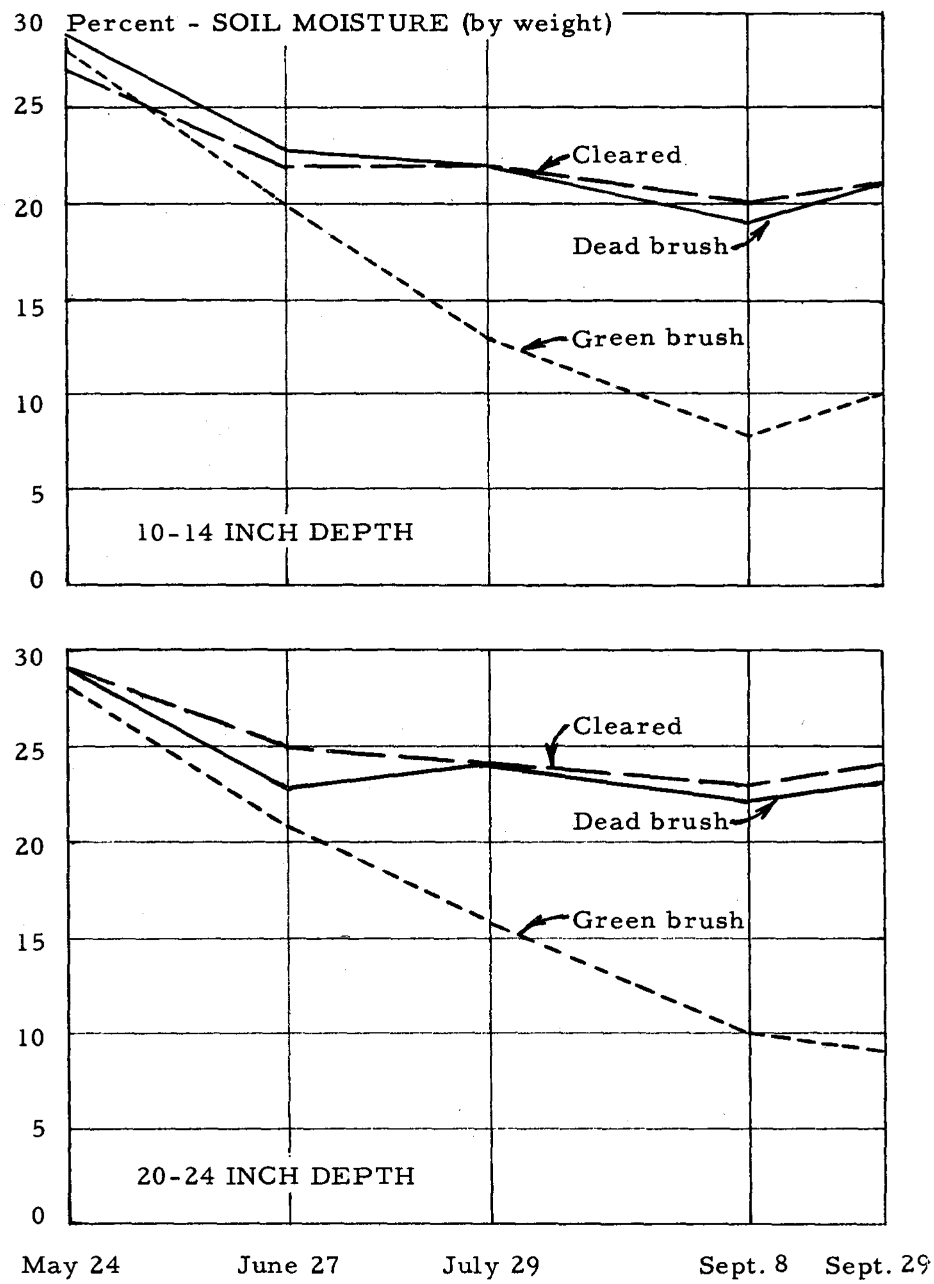

Figure 1. - Trend of soil moisture at depths of 10-14 and 20-24 inches.

MODIFICATIONS OF A LOWTHER TREE PLANTER FOR BETTER QUALITY PLANTING AND SURVIVAL

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The addition of a set of scalper plows to a standard model Lowther tree planter has increased the survival and growth of planted pine seedlings on the Kisatchie National Forest in central Louisiana. These scalpers have been in use for the past three planting seasons. In order to permit the plow beam to be raised, an arch was built into the frame of the planter. Figure 1 shows the right-hand scalper plow and the arch in the side of the frame. Another scalper plow is located on the left-hand side of the rolling coulter.

The initial cost of the scalper plows was $75. Replacement points cost about $34 per set. In general, a set of plows will last through one planting season, but this varies with soil type and amount of use. The cost of the plows, however, is a minor item when prorated on a basis of per thousand trees planted.

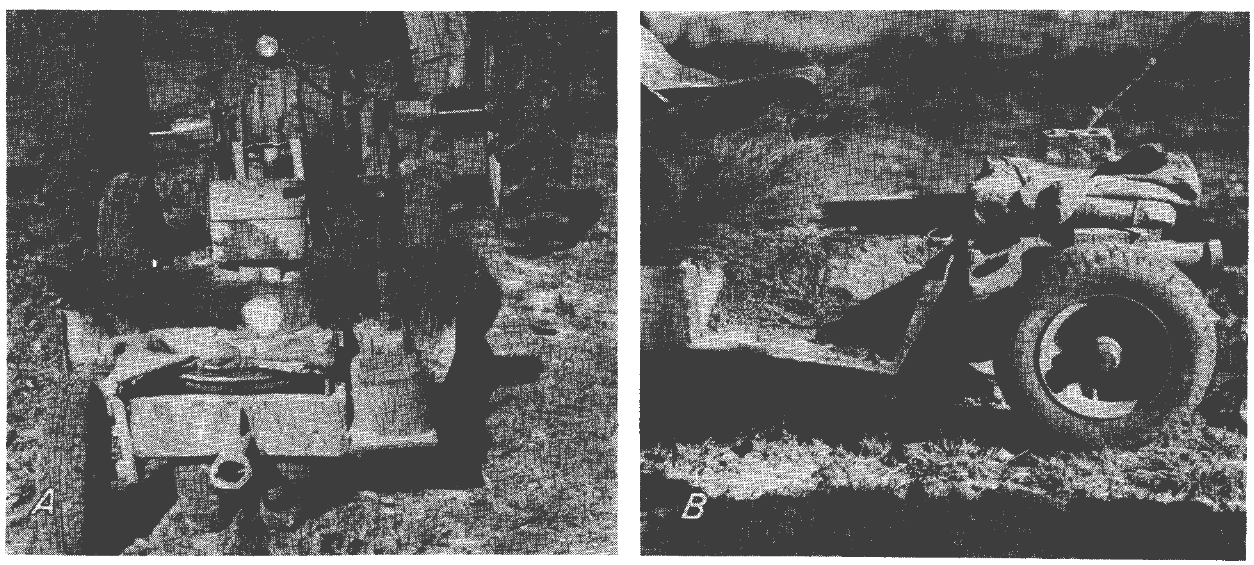
The planting sites had a heavy grass cover and in some areas, scrub oaks. Sites were generally flat with an occasional gentle slope. Where erosion is a problem, contour planting is recommended. Silting has been only minor, because the bottom of the scalped area is flat.

Figure 1. A side view of a standard model Lowther tree planter, showing arch built into frame to provide clearance for wing of scalper plow attached to plow beam.

The scalpers clear a swath about 15 inches wide. The cleared area is not so wide as to preclude successful controlled burning in longleaf pine plantations to reduce infections of brown-spot needle blight. The depth of the scalped strip is adjustable. We ran the plows about 2 inches deep, which removed most of the grass roots. The reduction of root competition is considered to be a significant factor in seedling survival, particularly during the summers.

These scalper plows materially aided the man who was doing planting in that trash was pushed aside; this lessened danger of injury. Getting longleaf seedlings set at the proper depth was easier when scalpers were used. Depth of planting is a critical factor for this species. A better planting job was also obtained when planting slash and loblolly pine seedlings.

In certain soil types and under certain soil moisture conditions, the planter packing wheels cut in and buried themselves. When this happened a poor job of planting resulted. To correct excess pressure on the packing wheels, a modification of the planter was made on a machine belonging to the Nebo Oil Company of Jena, La. , by adding another wheel opposite the packing wheels (fig. 2). The height of this wheel is adjustable, and under ordinary planting conditions it just barely touches the ground. When the packing wheels hit a soft spot and tend to dig in the extra wheel acts to take pressure off of them. Because we, used scalper plows, we set this extra wheel out so that it ran in the track of the main planter wheels. This putt it outside the sod furrow thrown out by the scalper plows.



-Figure 2. A, Auxiliary wheel attached to rear end of planting machine to absorb extra pressure when packing wheels hit soft ground; B, side view of auxiliary wheel.

Another modification made by Nebo is an adjustable screw stop welded to the main plow beam just ahead of the coulter (fig. 3). In certain soils, the coulter and trencher have a tendency to run too deep, which puts an extra load on the tractor and planter. When the trencher is in the ground at planting depth, the end of the adjustable stop bolt rests on the planter crossbar brace, thus holding the trencher at the desired depth.

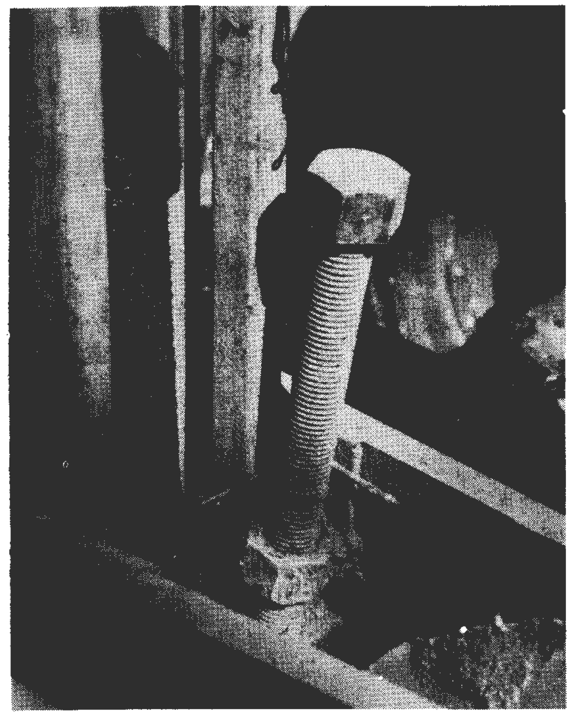


Figure 3. A large bolt with the nut part welded to the side of the plow beam just ahead of the coulter and directly over the frame crossbar brace. With the plow in the ground at the proper depth, the bolt is adjusted until the end hits the crossbar brace. This prevents the plow from running deeper than the desired depth.

A SPACING AID FOR MACHINE PLANTING

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An experimental 70-acre plantation, in which the trees were set out at exact spacings, was established at the Petawawa Forest Experiment Station near Pembroke, Ontario. Owing to the size of the project, it was decided to plant by machine. The rows could be laid out at the proper interval without difficulty, but some means of controlling spacing within the rows was required. Since the operator's job was too exacting for him to watch a visible indicator, an audible signal was required. For this purpose, a mechanism which signaled the machine operator at appropriate intervals was developed.

The mechanism was used with wheels of various sizes to obtain spacings from 4 by 4 feet to 14 by 14 feet. Where the distance between rows was controlled also, the average error did not exceed + 0. 2 feet.

The wooden wheel was cut from one-inch plywood with a bandsaw. The bell was a telephone extension type. The rest of the assembly was constructed

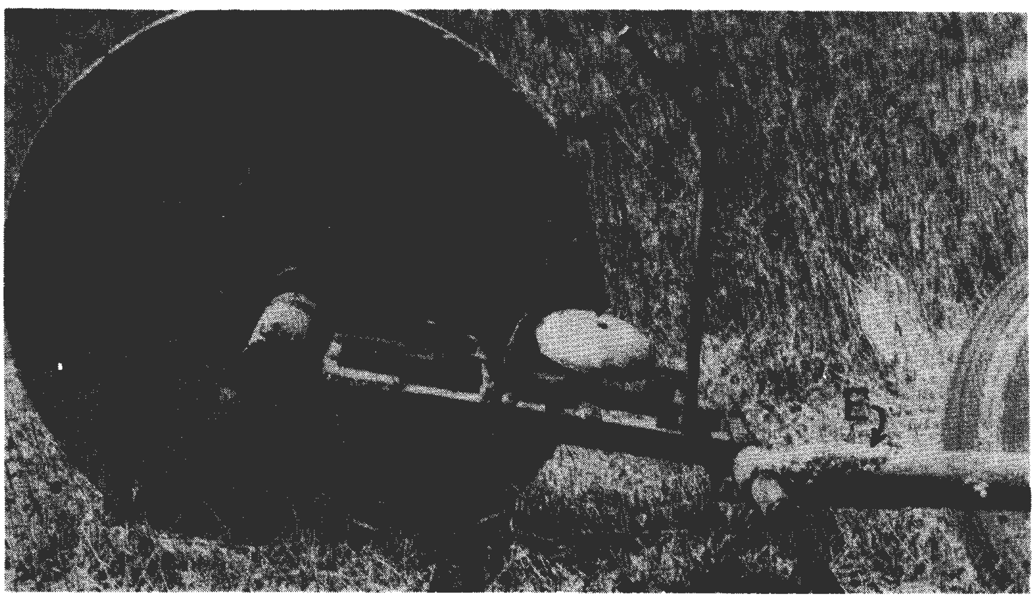

Figure 1. The device included a wooden wheel (A) whose circumference equaled the desired spacing distance. With every revolution of the wheel, a steel peg (B) fixed to its side tripped a spring-loaded striker (C), which rang a bell (D). The whole assembly was fixed to the planting machine by a sleeve attachment (E), and trailed behind it, with the wheel turning freely on bearings (F). A handle (G) was provided to raise the assembly
off the ground, so that the wheel would not be damaged by dragging sideways on turns between rows.

18

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from readily available materials at very little cost. Figure 2 shows the details of the mechanism.

Precise spacing is not often necessary. However, a means of obtaining good control may be required for research purposes, or when changing from one spacing to another, or when planting with inexperienced operators. For such occasions the spacing mechanism is an effective, inexpensive regulator.

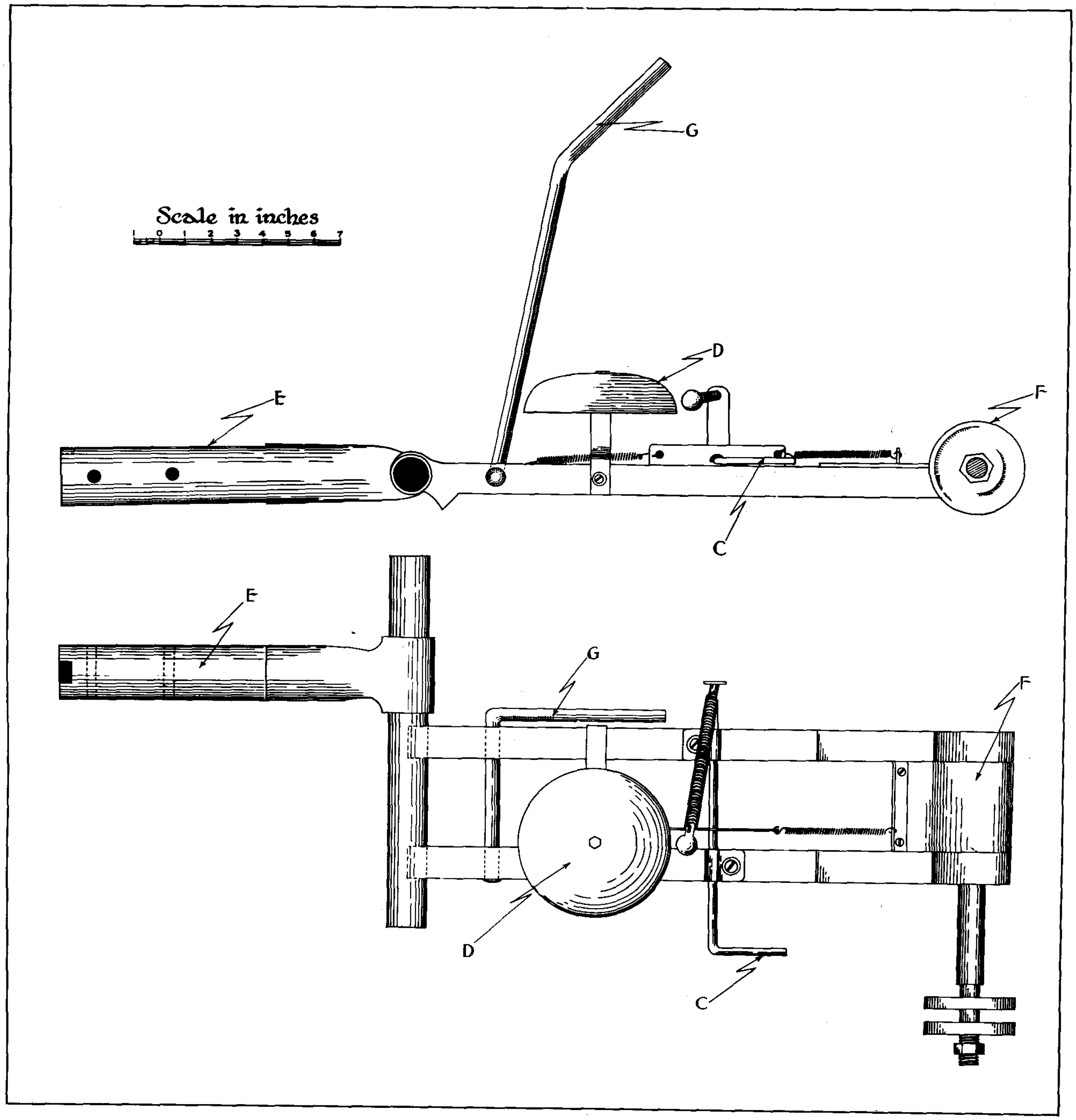

Figure 2. Details of construction of signaling device (see fig. 1 for lettered legend.

DIRECT SEEDING: A FAST, RELIABLE METHOD OF REGENERATING LONGLEAF PINE 1/

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The urgency to plant cutover areas of upland forest has in recent years created. a demand for pine seedlings that far exceeds the capacity of our nurseries and has prompted foresters and landowners to think seriously of direct seeding as a means of getting their land back into production. In the Gulf States the primary interest has been in direct seeding longleaf pine, while in the Southeast there is wide interest in developing techniques for direct seeding slash pine. Today I will discuss recent developments in the art of longleaf seeding -with particular reference to those techniques which a forester, launching his first seeding trial, should be most concerned about.

First, perhaps, we should discuss the question, why direct seeding longleaf? Aside from costs and other considerations, those who are direct seeding longleaf today believe they cannot plant this species successfully. The record of nursery production, in Louisiana at least, testifies to the prevalence of this belief. For lack of demand, the State nurseries have not produced a longleaf seedling for several years.

While we at the Alexandria Research Center do not think that planting longleaf is necessarily impractical, we do think that direct seeding offers several advantages. For this reason we have invested nearly 10 years of research effort in the multitude of biological problems associated with direct seeding.

Four reasons can be cited for using this method of regenerating longleaf.
First, it is fast, requiring a minimum of labor. Fifteen years ago one man with a planting bar could, if his back held out, plant an acre of pine seedlings a day. Now, with a planting machine, he can put in 5 to 6 acres per working day. With direct seeding, a skilled pilot in a light airplane can sow 180 acres per hour. On several occasions in the past 2 years 1, 000 acres have been seeded from the air in 1 day. The second reason for seeding is that it's cheaper. While the cost has fluctuated widely with the cost of seed, it has not exceeded $10 per acre. Planting costs for longleaf seedlings have ranged up to $15 per acre. In years when seed is plentiful and cheap, direct seeding costs can be held to about $6 per acre. This includes the cost of seed, seed treatment and sowing.

1/ Paper read March 1, 1957, at meeting of the Texas Chapter, Society of American Foresters, at Nacogdoches, Texas

The third reason for seeding -- and this one applies particularly to longleaf -- is that it provides denser stands than are practical with planting. Yearling stands averaging over 2,000 seedlings per acre are possible in favorable seasons. A dense seedling catch has a margin for losses during the grass stage, and assures a well-stocked stand later on. Finally, direct seeding is a technique that can be expanded rapidly to take advantage of bumper seed crops.

This final reason prompted our early trials in longleaf seeding at Alexandria. It appeared, in 1947, that if we were ever to make progress in regenerating the 2 million acres of open longleaf land in our territory (which includes two counties in Texas) we would have to think in terms of 1, 000- to 10, 000-acre projects. At that time we did not know how to store longleaf seed for the lean years, so we wanted a method that could utilize the vast amount of seed produced in good years. Longleaf's characteristic of rapid germination also seemed especially adapted to direct seeding.

Our early tests, on small plots, were made to determine basic requirements such as site treatment, time and rate of seeding, etc. We were also testing the theory that birds are the principal obstacle during the fall months.

The early trials were successful, and were followed by a 1, 200-acre venture by the Kisatchie National Forest in 1948. This operation succeeded on areas where fresh seed was used. It encouraged other trials in succeeding years, some of which failed because of bird depredations. The first large seeding operation by a private landowner was by Crosby Chemicals at De Ridder in 1952, when the company started its unique method of tractor seeding on disked strips. Birds were a serious problem on that 900-acre tract, and it was questionable then if bird protection by patrolling was practical for large areas.

The following year preliminary field trials were installed to test Morkit, a German-made bird repellent whose active ingredient was an anthraquinone compound. Results were so encouraging that the Hillyer-Deutsch-Edwards Lumber Company at Oakdale, La. , agreed to try Morkit on 180 acres the following year. This test proved conclusively that birds can be repelled with a chemical seed coating.. Although Morkit is no longer available, other chemicals have proved to be as good or better. The problems in longleaf seeding seem to be minor now in contrast to the threat of complete loss by birds that faced us only a few years ago. Solving the bird problem has modified some of the recommendations that we formerly thought necessary for successful seeding.

RECOMMENDED METHODS

Site Preparation

Of several site treatments that can be used, a light grass rough provides the best surface environment for germinating longleaf seed. It was recommended originally because of the concealment it provides against birds -- especially against migratory species, which are attracted to burned or disked areas. However, a light rough also benefits germination, especially when rainfall is light during the early part of the germination period. A case in point was a 1954 test in which Morkit-treated seed was sown on a light rough and on a burn. The rough produced 4, 200 seedlings per acre and the burn 2, 800. Most of the difference was due to germination failures on the burned area during a rainless period that lasted for 19 days after seeding. The development of a reliable bird repellent now makes it possible to seed on a burn, and in some cases that may be desirable or unavoidable, as on areas burned by wildfire. Certainly where the choice of site treatment is between a fresh burn and a rough that is older than 1 year, the burn is to be preferred. On a burn, seeding should be deferred until late November or early December, when frequent rains can be expected.

Intensive site preparation by disking has been tested for several years, and at least one landowner is using this method on an operational scale. On the difficult sites that foresters are now including in their regeneration plans, intensive treatment appears to be essential. For longleaf seeding, the greatest value of disking is its insurance against serious drought losses in the first year. However, the Crosby Chemicals Company has demonstrated that its method of double disking increases the early growth of longleaf where the brown spot needle blight is not heavy. The company now has 3-year-old seedlings out of the grass stage and 2 to 4 feet high. This cannot be done by seeding on unprepared sites, and few planted stands ever attain this rate of early growth.

The principal disadvantage of seeding on disked soil is the effect of climatic extremes during germination. Disked soils, like burned ones, dry out quickly when rainfall is scant, and at the other extreme disking interferes with surface drainage and the sites tend to flood when rainfall is excessive. Landowners interested in seeding longleaf should start with broadcast seeding on a light rough, then adopt the disking treatment if it appears essential for survival on their sites.

Seed

Fresh seed was prescribed in our earlier recommendations for longleaf seeding. This prescription resulted mainly from some unsuccessful trials with stored seed and from the experience of nurserymen who were having difficulty in storing longleaf seed for as long as 1 year.

To exploit longleaf's periodic seed crops fully, a successful storage technique is needed. We have several tests of seed storage under way, and seed research has been intensified elsewhere in the South, too. This past season nearly 5, 000 pounds of properly stored 1-year-old seed were used for direct seeding in Louisiana. Preliminary observations in January 1957 indicated that the stored seed germinated as well under field conditions as did fresh seed from the 1956 crop. Additional work is needed to determine the effect of seed year, collection date, extraction methods, etc. on keeping qualities. But progress has been made, and it appears now that fresh seed is not essential, provided the seed used has been properly stored.

Rate and Date of Seeding

Two other recommendations, made before we had effective repellents, need reexamination in the light of recent developments.

Now that seed losses can be controlled, you may ask, why not reduce the amount of seed per acre? That is a good possibility, but until we can demonstrate that we have excessive seedlings from 3 pounds of seed per acre we should continue to use that amount. There are other limiting factors besides the creatures that fly, walk, or crawl. Adverse weather during germination or in the first summer can reduce stocking, and as more of the poorer sites are seeded, higher initial stocking will be needed to insure a stand.

It was formerly considered essential to seed as early in November as possible. This recommendation was dictated by the migration and feeding habits of birds. It permitted germination before bird pressure became severe. Now, later seeding is possible and often desirable, because in late November and early December we normally have the best weather for germination.

Seed Treatment

Chemical formulations are now available that will either repel or eliminate most animals, afoot or awing, that have an appetite for pine seed. With longleaf we are mainly concerned with birds and for them a repellent is most desirable.. The best repellents we have at the present time are sublimed anthraquinone, Arasan-75, and Arasan. Other anthraquinones are effective, but are not so widely available. The Arasan compounds have some rodent repellency and, therefore, may be superior to the anthraquinones. Arasan-75 and Arasan should be applied to longleaf seed at the rate of 15 percent by weight (15 pounds per 100 pounds of seed). Sublimed anthraquinone, which is far less irritating to the eyes and skin than Arasan, should be applied in a 25 percent dosage. All these repellents are applied as an overcoating after the seed is immersed in a 25 percent mixture of asphalt emulsion in water. The asphalt emulsion serves as a sticker, and the most effective one tested so far is a product manufactured by Flintkote, called C-13-HPC.

A continuing program of testing repellents is under way at Alexandria in cooperation with the Denver laboratory of the U. S. Fish and Wildlife Service.

The laboratory has assigned a man to Alexandria to work on the problem of controlling bird depredations in forest regeneration. He is also working, with others in his Service, on the rodent hazard, which in the South is most acute during the spring months when we are seeding slash or loblolly pine.

Seeding

Several methods of distributing seed can be used. The choice depends on the size of the seeding project, site treatment, topography, and in some cases the seed treatment. For small or irregular areas, seeding with hand-operated or tractor-mounted Cyclone seeders works well. Hand seeders are inexpensive, and can be used for a labor cost of approximately 50 cents per acre. They require a man to walk a half mile for each acre seeded, which limits their use on large areas. Seed treated with irritating or toxic chemicals cannot be used in them because the operator is constantly exposed to the chemical dust.

Seeding on disked strips can be done by hand or with tractor-mounted seeders. Strip seeding requires more than getting the right amount of seed on the disked soil. The seed must be firmed into a stable part of the strip. Therefore, strip seeding requires machines built for that purpose -- such as those Crosby has been using successfully for the past 5 years.

During the past 2 seasons airplane seeding has been developed to the point where it is as accurate as any other method. Several earlier trials were disappointing because of inaccuracies in the sowing rate. In 1955, Louisiana Flyers, Inc. , at Lake Charles, La. , agreed to try a modification of the conventional seed distributor on a light plane. This modification changed the long narrow opening in the seed hopper to 3 smaller rectangular openings that -permitted longleaf seed to flow out at a uniform rate. Since then this firm has seeded several thousand acres with high accuracy. The work also demonstrated that seeding can be done rapidly with a light plane capable of carrying about 120 pounds of seed.

Especially with a light plane it is desirable to have a landing strip available on or near the area for greatest efficiency. Several landowners have graded dirt strips in the center of the area to be seeded, and the cost is largely defrayed by a lower charge for seeding. The cost of aerial seeding during the past season ranged between $0.50 and $0.88 per acre, depending on the size of the project and the proximity of a landing strip. (These costs are for seeding only, and do not include supervision or the labor required to load and flag the plane.)

Evaluation

The success or failure of a seeding project is relatively easy to determine. Stocking can be estimated from a regular milacre-plot inventory made during March or April of the first season. A reexamination after the first summer is also necessary to measure the extent of summer mortality.

Finding the cause for failure is often a difficult task. Although birds have been the principal problem in longleaf seeding, other biological agents will cause trouble in certain areas. Unusual numbers of town ants, raccoons, or rabbits can reduce stocking severely. Climatic conditions or poor seed quality may be responsible for some failures. Therefore, we urge foresters who are seeding to examine their areas frequently during the germination period, and to install special observation plots where they can detect any unusual damage to seed or seedlings.

It is timely here to mention the effects of grazing, At present the interest in seeding has outstripped the landowner's willingness to fence. Consequently, some seeding has been done under open range conditions and we are watching these areas with interest. Grazing damage caused the failure of several large seeding projects in the past. The best seeded longleaf stands today are on areas that were protected from grazing at least for the first few years. Usually, grazing damage occurs slowly over an entire season, and may easily go unnoticed until heavy losses have been sustained. Therefore, we can only point to the contrast between grazed and ungrazed areas as the best argument for protecting seeded areas from grazing until height growth starts.

CONCLUSION

Through the combined efforts of research foresters, biologists, and landowners, direct seeding has been developed into a reliable means of regenerating longleaf pine. Although some of the difficult problems are behind us, others remain. Rodents, for example, have been discounted as of minor importance in fall seeding. We are learning, however, that their populations build up rapidly during the winter. In recent tests, serious seedling losses were incurred during a short period in January. We are not sure that rodents were responsible. If they were, some method of control must be worked out for us to get optimum stocking from our seed supply.

The demand for longleaf seed will probably exceed the supply for several years to come. We feel sure, however, that if direct seeding creates a steady demand for seed, collectors will have the incentive to set up the facilities needed for handling cones and seed in large quantities.

SURVIVAL AND GROWTH OF 2-0 LONGLEAF AND LOBLOLLY SEEDLINGS IN THE FIELD

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Will 2-0 southern pine seedlings survive better or grow faster than 1-0 seedlings? This is a question that has been considered by many people connected with forest regeneration. In order to partially clarify this question, the Forestry Department of the Agricultural Experiment Station, Alabama Polytechnic Institute in cooperation with the U. S. Forest Service at Marianna, Fla. , and the St. Regis Paper Company, Pensacola, Fla., made experimental outplantings during the 1953-54 planting season of 2-0 and 1-0 longleaf and loblolly seedlings. There is little information concerning the behavior of 2-0 southern pine stock, but it seems possible that certain second year developments could improve survival or growth. Longleaf will develop a larger root collar, which is indicative of its ability to survive. Food reserves of both species could become greater over a 2-year period: thereby, promoting survival and early growth.

The 5 treatments selected for comparisons were: 2-0 longleaf, root and top pruned; 2-0 longleaf, top pruned only; 1-0 longleaf, normal stock; 2-0 loblolly, root and top pruned; 1-0 loblolly, normal stock. The 2-0 longleaf and 2-0 loblolly seedlings used in the experiment were grown in the State Nursery at Auburn, Ala. , during the 1952 and 1953 growing seasons. Some of both species were root pruned near the end of the 1952-53 winter.. It was thought that this root pruning would produce more fibrous and compact root systems. All 2-0 stock was top pruned in the spring of 1953 to retard height and diameter growth and to facilitate planting.

Since planted longleaf does not ordinarily begin height growth until the root collar reaches a diameter of approximately one inch, observations were made on the number of longleaf seedlings making height growth in the nursery beds. Some seedlings began height growth during the second year in the nursery, even though the average diameter at the root collar was 0. 377 inch for 1-0 longleaf, 0.464 inch for root and top pruned 2-0 longleaf, and 0.653 inch for top pruned 2-0 longleaf. The percentage of longleaf seedlings making height growth in each treatment was 0. 10, 0.06, and 0.08, respectively Even though some roots of the 2-0 seedlings had been pruned in the nursery beds, it was necessary to prune all 2-0 seedling roots again after lifting.

Soil texture of the areas planted ranged from sands at Marianna and Pensacola, Fla. , and Autauga, Ala. , to a sandy loam at Fayette, Ala. , and a stiff clay at Auburn, Ala. All planting was done by hand during the 1953-54 planting season.

The 5 treatments were arranged in a latin square design at each of the 5 sites. Each plot within the latin square was planted with 10 rows of 10 seedlings each at a spacing of 2 by 2 feet. Close spacings with no isolation strip were used because plans called for discontinuing the experiment before the seedlings began competing among themselves.

At all locations, height growth of each seedling and survival percentages for each plot were determined annually for the first three growing seasons. Growth and survival data were taken during August of 1957 for the Autauga and Auburn sites. Survival percentages alone were determined for the Pensacola site. Although the results cited in this paper are those obtained in August of 1957 from the Auburn, Autauga, and Pensacola plantings, the same results could be obtained from the 1956 measurements taken at Marianna, Fla. and Fayette, Ala.

Generally, all 2-0 stock gave poorer survival than 1-0 stock; however, there was little difference between the 2-0 and 1-0 loblolly. In the Autauga plantings, the survival of 2-0 loblolly stock was greater than the 1-0 loblolly by 3.8 percent (table 1). Only on the Auburn site was the survival difference for loblolly large. In no instance did 2-0 longleaf do as well as 1-0 longleaf. Height growth followed much the same pattern as survival for loblolly. Again, the height growth at Autauga was slightly greater for 2-0 loblolly than for 1-0 loblolly. In two instances the 2-0 longleaf showed greater height growth than 1-0 longleaf but neither of these was significantly greater. Another aspect of the experiment was to compare the three longleaf treatments in respect to their ability to~ stimulate early height growth. The results indicate that 2-0 stock that has not been root pruned may give earlier height growth; but, again the differences are not significant.

According to the above results, there is no basis for planting 2-0 longleaf and loblolly stock on a commercial scale. None of the 2-0 treated stock survived or grew better with any degree of consistency than the 1. 0 stock. Of even greater importance is the fact that not even in an isolated instance did 2-0 stock perform well enough to justify the additional expense. Of course, the results of this experiment are applicable only within the scope of the experiment; however, they are conclusive enough to indicate that the same results would be found within the greater part of the species range.

Table 1. Survival and growth data for 2-0 and 1-0 longleaf and loblolly pines

Treatment	Auburn	Autauga	Pensacola	Average
SURVIVAL	Percent	Percent	Percent	Percent
2-0 longleaf root and top pruned	9.4	9.0	4.8	7.7
2-0 longleaf top pruned	12.8	18.4	4.0	11.7
1-0 longleaf	46.0	42.6	13.8	34.1
2-0 loblolly root & top pruned	59.0	24.6	30.8	38.1
1-0 loblolly	87.4	20.8	31.0	46.4
AVERAGE HEIGHT	Feet	Feet	Feet	Feet
2-0 longleaf root and top pruned	0.86	0.91	-	0.88
2-0 longleaf top pruned	1.04	1.18	-	1.11
1-0 longleaf	.87	1.24	-	1.06
2-0 loblolly root & top pruned	6.96	4.10	-	5.53
1-0 loblolly	7.29	3.79	-	5.54
SURVIVING LONGLEAF OUT OF GRASS STAGE	Percent	Percent	Percent	Percent
2-0 longleaf root & top pruned	60.06	53.40	-	56.73
2-0 longleaf top pruned	69.56	68.00	-	68.78
1-0 longleaf	51.79	72.60	-	62.19
2-0 loblolly root & top pruned	-	-	-	-
1-0 loblolly	-	-	-	-

MALEIC HYDRAZIDE FAILS TO CONTROL FERTILIZED BERMUDAGRASS

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A recent study near Oxford, Miss., used large quantities of commercial fertilizers in an attempt to improve survival and stimulate height growth of loblolly pine (*Pinus taeda*) seedlings planted on adverse sites. Since excessive weed competition was probable, a growth inhibiter, maleic hydrazide (1, 2-dihydropyridazine-3, 6-dione) was applied to the weeds -- predominantly Bermudagrass (*Cynodon dactylon*). Maleic hydrazide arrests plant cell division for 4 to 6 weeks, but does not affect cell enlargement.

In the presence of the heavy concentrations of commercial fertilizers, however, the maleic hydrazide had no apparent influence on the Bermudagrass, whose growth appeared well in excess of what might be expected from cell enlargement alone.

Three blocks of 6 plots each were laid out on a severely sheet-eroded shallow loessial soil. Plots were 36 by 42 feet in size. All blocks were burned to remove the grass cover, and were planted in February 1955 with 1-year-old loblolly pine nursery seedlings at a spacing of 6 by 6 feet. In various treatment combinations, N was applied at the rate of 300 pounds per acre, P at 200 pounds, and K at 100 pounds. Fertilizing was done in March.

The Bermudagrass surrounding the treated seedlings began rapid and luxuriant growth. By May, when the grass was more than 6 inches tall, maleic hydrazide was dissolved in water at the rate of 1 pound of powder (48 percent by weight of active ingredient) per 10 gallons of water, and was applied to the grass in a 4-foot circle around each seedling with a pressure sprayer of the kind used in gardens. One pound of powder was used for slightly less than one-tenth acre., a concentration a little in excess of manufacturers' recommendations for use on lawns. During the spraying, the seedlings were covered with paper cones. This protection probably was unnecessary, as maleic hydrazine does not appear to affect woody plants. One month after the hydrazide was applied, the grass around each seedling was clipped.

Despite the spraying and clipping, the Bermudagrass grew at an unabated pace. By late May, the plots gave the appearance of evenly spaced mounds of dark green grass with only an occasional seedling visible. In many places the seedlings were overtopped and bent to the ground by the weight of grass. Mounds of grass reached heights of 2 feet, while individual stems occasionally exceeded 3 feet in length. In late summer many, seedlings died of this smothering. On the unfertilized check plots grass growth was negligible. At no time during the year were the check seedlings overtopped.

DIURON FOR WEED CONTROL IN NEW WINDBREAK PLANTINGS 1 /

Walter T. Bagley and Karl A. Loerch 2/

Herbicides have been used successfully to control weeds in many agricultural crops. Research has indicated that some of these chemicals can be used in tree plantations under certain conditions with good weed control and with no apparent ill effects to the trees. Ferrell 3 / found that CMU was the most effective weed killer tested in South Dakota when applied at the rate of 20 pounds per acre of active ingredient on 1 year old windbreaks. No damage was reported on the 8 tree species under test.

The purpose of this study was to determine the effect of diuron (Karmex DW) applied at various rates on the survival and growth of newly planted trees and on weed control in new plantations.

Materials and Methods

Fifty trees each of 7 species, graded for uniformity in caliper and height were planted in late April 1956, at each of 4 locations: Lincoln, North Platte, Mitchell, and Alliance. The Lincoln soil is a deep silty clay loam and the soils at the 3 western locations are deep, very fine sandy loams and silt loams. Each species was divided into 10 plots, 20 feet long by 1.5 feet wide, of 5 trees each. Five treatments, each in 2 randomized blocks, were assigned to each species. Machine cultivation controlled the weeds outside of the treatment plots. Treatments consisted of:

1. Hoe. A check plot cultivated by hand.
2. None. A check plot which received no cultivation or chemical treatment.
3. 10 - Diuron at 10 pounds per acre of 80 percent commodity.
4. 20 - Diuron at 20 pounds per acre of 80 percent commodity.
5. 40 - Diuron at 40 pounds per acre of 80 percent commodity.

1 / Published with the approval of the Director as Paper No. 798, Journal Series, Nebraska Agricultural Experiment Station, Lincoln, Nebraska.

2/ Assistant Forester, Nebraska Agricultural Experiment Station, and Extension Forester, University of Nebraska, respectively.

3/ Ferrell, E. K. Chemical Weed Control in Shelterbelts. Proc. 11th Annual North Central Weed Control Conference 1954: pp 117-119.

The equivalent of 80 gallons per acre of water was used in spraying the 1.5foot band of diuron on the tree row immediately after planting. At Lincoln a 2-year-old plantation of ponderosa pine was also treated with diuron at the same rates of application as above.

Results and Discussion

Tree Survival and Growth

Within a month after planting chlorosis appeared in varying amounts on Russian olive, Siberian elm, and hackberry. Necrosis of affected leaves followed. By late June Russian olive suffered high mortality at all chemical treatment levels. Siberian elm and hackberry were severely injured by late June or early July at the 20- and 40-pound per acre rates, and most of them failed to recover (table 1). Under the lowest chemical treatment the survival of these 2 species was only slightly lower than the 2 check treatments.

On the 40-pound treatment mottling and yellowing of the midribs on the green ash leaves appeared about one month after planting followed by necrosis of some of those most seriously affected. New leaves appeared, growth continued, and by mid-July few symptoms of injury remained. Very little injury was noted at the 10- and 20-pound rates. Survival of the green ash was exceptionally high except on the "hoe" and "none" treatments at Mitchell which had 20 and 30 percent survival respectively while under the chemical treatments it was 70, 100, and 100 percent at 10, 20, and 40 pounds per acre respectively. These results can probably be explained in part by the exceptionally dry season (table 2).

The tips of the leaflets of honeylocust yellowed about 2 months after treatment on 42 percent of the trees in the 20- and 40-pound plots. No symptoms of injury remained at the end of the growing season and growth was excellent compared to the 2 check plots.

Chlorosis appeared on eastern redcedar in mid-July. On the 40-pound plots symptoms of injury remained at the end of the growing season on 72 percent of the surviving trees but only 18 percent of the redcedar in the 10- and 20pound treatments were chlorotic.

Injury was difficult to assess on ponderosa pine but by the end of the season probable symptoms of chemical injury were evident on 63 percent of the trees in the plots treated at 40 pounds per acre. At all 4 locations poor vigor and little growth of most of the pines in the "none" treatment indicated severe damage by shading and deficient soil moisture. The light rainfall was probably responsible for the complete failure of the pine at Mitchell. The 2-year-old ponderosa pine planting at Lincoln exhibited no ill effects at the end of the growing season under the 3 chemical treatments.

Species	Hoe		No treatment		Diuron per acre					
					10 lbs.		20 lbs.		40 lbs.	
	Height growth	Survival	Height growth	Survival	Height growth	Survival	Height growth	Survival	Height growth	Survival
	Ft.	Pct.	Ft.	Pct.	Ft.	Pct.	Ft.	Pct.	Ft.	Pct.
Eastern Redcedar (*Juniperus virginiana*)	--	55	--	68	--	60	--	60	--	45
Ponderosa Pine (*Pinus ponderosa*)	--	62	--	60	--	57	--	40	--	40
Green Ash (*Fraxinus pennsylvanica*)	1.2	80	0.9	80	1.4	93	1.3	95	1.5	95
Honeylocust (*Gleditsia triacanthos*)	2.2	100	1.2	95	2.4	100	2.5	100	2.9	93
Hackberry (*Celtis occidentalis*)	1.1	63	.7	73	1.2	55	1.0	15	1.2	5
Siberian Elm (*Ulmus pumila*)	1.4	70	1.1	73	1.2	53	1.2	13	2.5	5
Russian Olive (*Elaeagnus angustifolia*)	1.7	73	.9	43	1.2	40	1.2	15	--	0

Table 1. Average survival and height growth of seven species at the end of first growing season at 4 locations, by type of treatment.

Table 2. Comparison of total precipitation with storms totaling over 0.5 inch at 4 locations, from late April planting date to October 15, 1956

Location	Total precipitation	Storms totaling over 0.5 inch			
	Inches	Number	Inches	First	Last
Mitchell	5.38	4	4.23	April 30	July 4
North Platte	11.19	5	6.61	May 27	August 3
Alliance	9.63	7	7.99	May 14	August 20
Lincoln	15.56	9	13.00	May 29	September 5

The vigor and growth of all surviving trees were greater on plots where weeds were controlled in varying degrees than on the weedy check plots except when chemical injury was severe and persistent. At all 4 locations the growth of green ash and honeylocust in the "hoe" treatments was exceeded by the growth in plots under chemical weed control. Since the hand cultivated check plots allowed some weed growth between the 3 or 4 cultivations during the season probably less soil moisture was available for tree growth than in plots where weeds were chemically controlled.

Variations between locations in the rainfall pattern and total precipitation is indicated in table 2. Storms resulting in less than 0.50 inch precipitation would have little effect on tree growth and survival or downward movement of the chemical below the immediate surface. However, at all 4 locations light showers were adequate to carry, the diuron into the soil far enough to give immediate results in weed control.

Weed Control

A wide variety of weed species were encountered at the 4 locations across the State. Some of the more common are as follows: Kochia (Kochia scoparia), pigweed (Amaranthus sp.), Russian thistle (Salsola pestifer), foxtail (Setaria sp.),annual bromes (Bromus sp.), stinkgrass (Eragrostis ciliansis), crabgrass (Digitaria sanguinalis), witchgrass (Fanicum capillare), smartweed (Polygonum pennsylvanica), sunflower (Helianthus annus) sandbur (Cenchrus pauciflorus), bladder ketmia (Hibuscus trionum), puncture vine (Tribulus terrestris), groundcherry (Physalis heterophylla), buffalo-bur (Solanum rostratum), and barnyard grass (Echinochloa crusgalli).

Diuron at 20 and 40 pounds per acre gave nearly perfect weed control all season. Occasional plants found in these plots near the end of the season included ground cherry, barnyard grass, pigweed, foxtail, smartweed, and crabgrass. A few more individuals of the above species were found in the 10-pound treatments, and they appeared as early in the season as the first week in July. Also appearing in the lightest chemical treatment were witchgrass, Russian thistle, puncture vine, stinkgrass, and volunteer soybeans (Lincoln). Weed cover was always light and never attained much height on any of the chemically treated plots, and some species, notably kochia never appeared.

Summary

The effect of 10, 20, and 40 pounds per acre of diuron on tree survival and growth and on weed control was studied. Russian olive was easily injured while Siberian elm and hackberry, though easily injured, showed some ability to recover at low concentrations. The two conifers, eastern redcedar and ponderosa pine, were moderately resistant to chemical injury. Honeylocust and green ash were highly resistant to permanent injury at all levels of concentration. Weed control was excellent at 20 and 40 pounds per acre and satisfactory at 10 pounds. In spite of a wide variation in rainfall pattern from eastern to western Nebraska during the 1956 growing season the results of all treatments were similar on medium textured and moderately heavy soils.

SEEDLING STORAGE BINS

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The bin pictured below has been found useful by Georgia State nurseries for storing bundled seedlings.