THE EFFECT OF SEEDBED DENSITY ON SEEDLING PRODUCTION AT THE GEORGIA FOREST NURSERIES

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As demand for pine seedling stock increases, State Foresters are confronted with the problem of developing additional nurseries. Because of high investment in buildings and equipment, the other alternative is to utilize existing facilities intensively. This can be accomplished either by growing seedlings successively on the same land or increasing seedbed density.

This study seeks the maximum seedbed density at which slash and loblolly can be produced.

Literature Review

Wakeley 2/ states that the maximum density at which loblolly seedlings can be grown is 50 to 55 per square foot and that slash pine grown at densities of more than 30 per square foot may be decreased in size. He further states that 80 percent of the living seedlings at digging time should be plantable. TVA Nurseries 3/ grow loblolly pine at 36 to 40 seedlings per square foot and expect 30 to 32 of these to be plantable. Muntz, 4/ in 1944, reported growing slash pine seedlings at densities of from 10 to 50 per square foot with and without compost in the soil. On the basis of his studies, he recommended a seedbed density of 30 per square foot.

1/ The Georgia Forestry Commission furnished all manual and technical assistance and provided suitable seedbed facilities. The author is employed under a cooperative agreement with the Georgia Forestry Commission

2/ Wakeley, Philip C. 1954. Planting the southern pines. U.S. Dept. Agr. Forest Service. Agr. Monog. No. 18, 233 pp. , illus.

3/ Tennessee Valley Authority. 1954. Operations manual for TVA forest nurseries. TVA Div. of Forestry Relations .

4/ Muntz, H. H. 1944. Effects of compost and stand density upon longleaf and slash pine nursery stock. Jour. Forestry .42(2): 114-118.

Experimental Methods

Some beds of loblolly and slash seedlings sown by the standard methods at each of the four Georgia Nurseries were divided into 5-foot plots and thinned in May of 1955 to densities of 20, 25, 30, 35, and 40 seedlings per square foot. Two replicates each of slash and loblolly were established at three of the four nurseries, and four replicates of slash at the other nursery.

During the week of November 21, seedlings from a 3-square foot portion of each plot were dug. Each group was graded and the number of plantable seedlings recorded. These were further divided into those with stem diameter of 3/16 inch or more at the ground level (Wakeley grade #1). They were also sorted into three classes of root development- -good, medium, and poor. A further subdivision on the basis of top length separated those between 9 and 15 inches tall. One hundred seedlings from each plot were planted in the State forest at Waycross. (Survival and growth data on these seedlings will be taken in 1957.)

Results

Table 1 shows the effect of seedbed density on the number of seedlings in the various grades.

Table 1.--Effect of seedbed density on slash and loblolly pine seedling quality at the Georgia nurseries

SLASH

Density after thinning	Living at digging	Plantable	3/16-in. stem	Top length 9 to 15 in.	With good roots
	Number of seedlings per square foot				
20	19	18	10	14	10
25	25	23	10	15	12
30	28	26	10	20	13
35	37	32	12	23	17
40	40	35	11	28	20

LOBLOLLY

20	19	18	8	15	12
25	24	21	7	18	14
30	33	28	10	22	16
35	32	27	6	17	13
40	36	33	8	26	21

The total number of plantable seedlings increased with seedbed density up to the 40-per-square-foot level. This indicates that under Georgia conditions both slash and loblolly seedlings were produced more profitably at a density of 40 per square foot than at any lower density. Examination of the figures shows that the proportion of seedlings with 3/16-inch stem diameter was not decreased with an increase in seedbed density. Eight to ten grade 1 seedlings were produced per square foot at the lowest density and this could not be increased by using additional seed. If #1 seedlings were the only grade desired, optimum seedbed density would be ten. Fifty-seven percent of the seedlings were rated as having good roots and seventy-six percent were between 9 and 15 inches tall. These percentages remained reasonably constant at all densities. There is no evidence from root development or top length to justify using a density of less than 40 per square foot.

Muntz's data for seedlings in beds treated with compost are in reasonable agreement with that reported here. If his figures for percent marketable are converted to marketable seedlings per square foot, the comparison is as follows:

Density	Plantable seedlings (after Muntz)	Plantable seedlings (current study)
20	20	18
30	28	26
40	33	35

The fertility level of Georgia Nurseries is probably comparable with that of his plots treated with compost.

Summary

More plantable seedlings of slash and loblolly pine can be produced at a seedbed density of 40 per square foot than at lower densities under Georgia conditions. Number of seedlings with stem diameter of 3/16 inches or more was not changed by varying densities. By this means, 1,161, 600 seedlings can be grown per acre instead of the 871, 200 which would be produced at a 30-seedling-per-square foot density. 5/

5/ These calculations are based on the fact that seedbeds 4 feet wide are separated by 2-foot alleys, so that 1 acre of nursery contains 29, 040 square feet of seedbed.

MULCHING CONIFEROUS TRANSPLANT BEDS WITH SAWDUST

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Mulching coniferous transplant beds with sawdust is a fairly common practice in many nurseries. It may, therefore, be of interest to review the results from some of the work done by the staff of the Syracuse Experiment Station of the State University of New York College of Forestry.

Mulching was developed primarily in a effort to learn whether conifers could be transplanted in the fall without heavy losses from heaving during the following winter under the soil and climatic conditions of Syracuse, New York. As is true in most nurseries, the work that should be done during the spring is greater than the station staff can manage, consequently the possibility that some of the work of transplanting could be done in the fall was attractive. Past experience had shown that the mortality from heaving during the winter was usually high for fall transplants.

Fall transplanting of conifers and mulching with fresh sawdust was started in September of 1949. The soil of the nursery block was Palmyra sandy loam. Seedlings (either 2-0 or 3-0) were used with a 1 1/4 inch deep mulch spread by hand. The sawdust was approximately two-thirds hardwoods and one-third softwoods and was obtained from a local sawmill.

A tally of trees during September of 1950 provided the following data for 45 of mulched transplant bed row and 45' of unmulched row.

TABLE I

Percent of Fall Transplanted Trees Heaved During First Winter

Row	Species	Percent of Trees Heaved	
		Sawdust Mulch	No Mulch
1	Colorado Blue Spruce	1%	24%
2	Colorado Blue Spruce	1/2%	27%
3	White Spruce	0%	13%
4	White Spruce	2%	20%
5	Norway Spruce	1/2%	26%
6	Norway Spruce	0%	9%
7	Norway Spruce	0%	4%
8	Norway Spruce	0%	48%
9	Norway Spruce	0%	10%

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An attempt was also made to determine whether the mulch was beneficial for the growth of the trees. During the growing season a slight yellowing of the needles was noted on the mulched area but growth was not visibly affected. Heights of the transplanted trees (from samples taken at random from the mulched and unmulched areas) provided the following comparative heights:

TABLE II

Comparative Heights of Fall Transplanted Trees After One Growing Season

	Average Height	
	Mulched	Not Mulched
White Spruce (3-1)	10.1"	8.7"
Norway Spruce (3-1)	12.8"	11.5"
Norway Spruce (2-1)	9.6"	9.3"
Colorado Blue Spruce (3-1)	6.5"	5.5"

In the late summer of 1952 a somewhat more extensive transplanting and mulching project was set up. Six blocks, each approximately 40 feet long and 20 feet wide were laid out in a row across the transplant area. White spruce and Norway spruce seedlings of the same age were transplanted through the six blocks, and a 1 1/4 inch mulch of sawdust was applied to blocks numbered 1, 3 and 5. A tally made in July of 1953, following one winter, provided the following data pertaining to heaving losses:

TABLE III

Proportion of Transplanted Trees Heaved During First Winter

	Norway Spruce			White Spruce		
	Total (Live Trees Unheaved & Heaved)	No. Trees Heaved	% of Total Heaved	Total (Live Trees Unheaved & Heaved)	No Trees Heaved	% of Total Heaved
Unmulched	4262	809	18.98	3450	986	28.58
Mulched	4668	71	1.52	4691	186	3.97

The effect of the mulching is clearly shown in reducing losses from heaving. In addition to taking the above data, an attempt was made to measure the difference in amount of time required to hand weed the two areas. In one instance six hours and thirty-four minutes were required to weed the unmulched blocks as compared with two hours and six minutes to weed the mulched blocks. The weeds were firmly held by the soil in the untreated areas and many broke away from their root systems when an attempt was made to pull them. The weeds in the sawdust treated areas were pulled out with less effort and with the roots attached.

In the summer of 1954 comparative heights were obtained for the mulched and unmulched blocks. The following data were obtained:

TABLE IV

Average Heights of Transplanted Trees After Two Growing Seasons

	Norway Spruce		White Spruce	
Block'	Mulched	Unmulched	Mulched	Unmulched
1	10.4"		8.5"	
2		8.6"		7.4"
3	9.3"		8.1"	
4		8.8"		7.8"
5	8.8"		7.8"	
6		8.1"		7.2"

For each species the height of the trees on the mulched blocks was as high or higher than the height of the trees on the unmulched blocks. The evidence is conclusive that the mulching resulted in somewhat greater height growth at the end of two growing seasons.

Another attempt was made to determine the effect of sawdust mulch of various depths on survival and height growth of transplants. Samples of approximately 300 trees of each of several species were transplanted for each of three depths of mulch and no mulch. Unfortunately, mortality was high for the entire planting, apparently from causes but partly related to the mulching. Differences in mortality between the mulched and unmulched blocks were not consistent and no conclusions could be drawn, consequently, they are not reported here.

The effect of the mulch on height growth seemed to be rather clear and consistent. The table shown on the following page presents these data.

TABLE V

Effect of Depth of Mulch on Height of Transplants

SPECIES	No Mulch			3/4" Mulch			1 1/4" Mulch			2" Mulch		
	Hts. in in. 1953	Hts. in in. 1954	Hts. in in. 1955	Hts. in in. 1953	Hts. in in. 1954	Hts. in in. 1955	Hts. in in. 1953	Hts. in in. 1954	Hts. in in. 1955	Hts. in in. 1953	Hts. in in. 1954	Hts. in in. 1955
Norway Spruce	4.01	7.95	11.70	4.02	10.20	14.25	4.01	9.40	14.80	4.19	9.75	15.95
Hemlock	2.92	5.20	8.30	3.04	6.95	11.45	3.84	9.50	13.35	3.19	7.40	10.85
Douglas Fir (1)	2.27	3.67	5.05	2.39	5.95	8.95	2.51	7.55	10.40	2.66	6.25	7.55
Douglas Fir (2)	1.96	4.80	7.20	2.04	5.15	7.70	1.95	5.30	8.05	2.25	5.20	7.05
Douglas Fir (3)	1.93	5.10	7.50	2.21	6.20	9.30	2.15	5.55	8.15	2.04	5.50	7.95
White Pine	3.08	7.57	---	2.75	7.17	---	3.52	8.22	---	2.98	6.32	---

(1), (2), (3) represent three rows of Douglas fir of same age and seed source.

Comparisons among the samples for each species show greater heights and height growth for all depths of mulch (except Douglas fir (2) 2" mulch and white pine 3/4" and 2" mulch) than for no mulch. Heights for 2" mulch after three growing seasons were less for hemlock and Douglas fir than for 1 1/4" mulch. The 2" depth sawdust mulch proved to be too deep for some of the smaller transplants and retarded their development. It can be observed in the table that Norway spruce was taller after one growing season in the transplant bed than the other species used, consequently, the deeper mulch did not prove to be detrimental. In general, the 1 1/4" depth of mulch appeared to be most effective.

Summary

A series of mulching experiments carried on by the staff of the Syracuse Experiment Station of the State University of New York College of Forestry in which sawdust was applied to coniferous transplant beds showed the following:

1. That a 1 1/4" depth of sawdust placed on fall transplant beds effectively controlled heaving during the following winter for the species tested.

2. For the species tested the mulched transplants grew more rapidly in height, with few exception, than the unmulched transplants

3. The evidence suggests that a mulch 1 1/4" deep was more effective in increasing height growth than-depths of 3/4" or 2".

AGITATOR TYPE SAWDUST SPREADER FOR USE ON DUMP TRUCKS

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The Georgia Forestry Commission's nurseries use considerable quantities of sawdust as a soil improver or conditioner, but getting this sawdust applied evenly over the area has been a great problem. At first we merely dumped the sawdust in piles directly upon the area and then scattered them by hand. However, this was not satisfactory because it required too much hand labor and, unless closely supervised, the spreading was sometimes uneven enough to cause yellow spots when the seed beds were established. We then tried spreading the sawdust with a manure spreader. This gave an even enough distribution but was costly because of the great amount of labor required to transfer the sawdust from the truck to the spreader.

A solution to the problem was found by devising a special tail gate for use on nursery dump trucks. It is so designed that it can be removed with a minimum of effort when the truck is needed for other work. With this attachment it is possible to load the truck in the woods, drive to the nursery and spread the sawdust to almost any desired depth. No hand labor is required other than adjusting the opening of the gate to control the rate or depth of spread.

The sawdust spreader shown herein was made in the Georgia Forestry Commission's Macon shop. Any good machine shop should be able to make a similar machine. Cost data were not complete at the writing of this article but it is believed to be around $150. 00. Construction details are shown in Fig. 1 through 5.

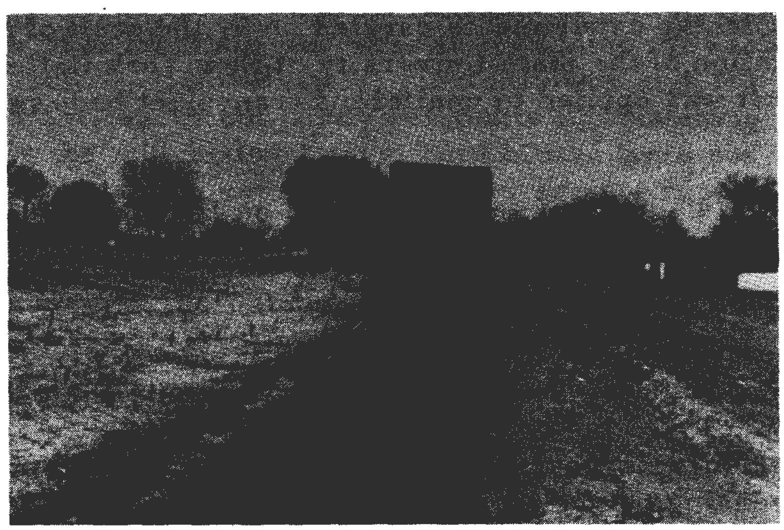

Figure 1. Nursery dump truck showing beginning of run to spread sawdust with agitator type tail gate attachment.

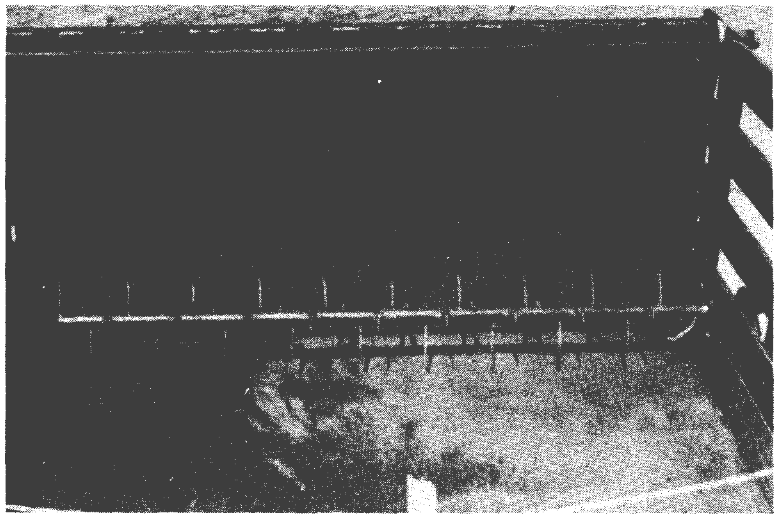

Figure 2. Front view of tail gate showing agitator mechanism.

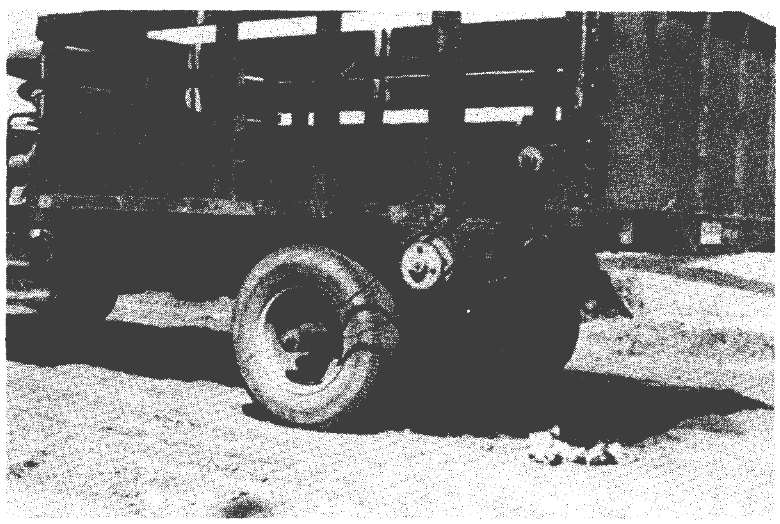

Figure 3. Side view of sawdust spreading attachment showing tail gate, agitator drive mechanism and adjustment crank for control of spread.

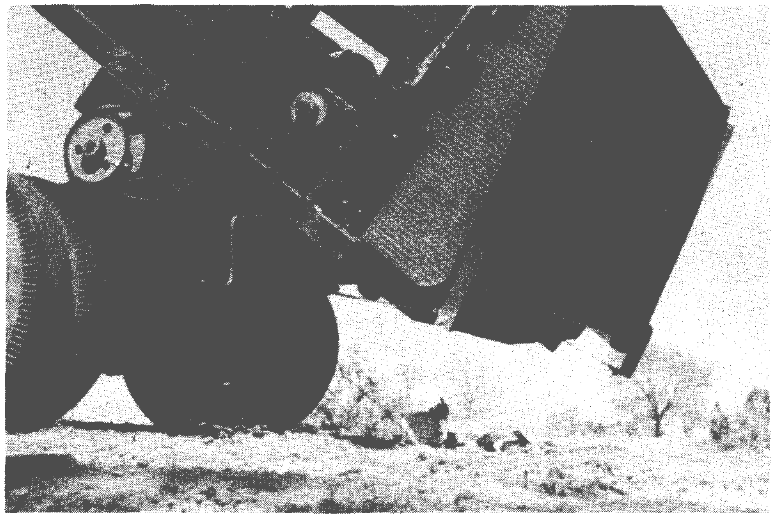

Figure 4. Side view of tail gate, showing cables used to control width of gate opening.

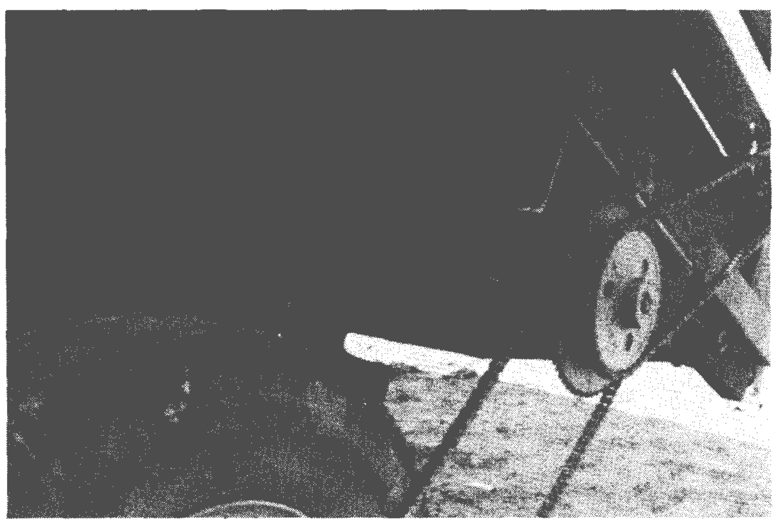

Figure 5. Side view of dump body showing installation of agitator drive mechanism.

SHELTERING THE. SEEDBED

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The sheltering of seedbeds can prove to be a costly, labor consuming item.

The accepted practice here in the Prairie Provinces is to box the beds in with a framework of screens 10' long and 1' high made of a 2 x 2 framework and screen wire. These are placed end to end around the beds, and are supported by nailing or wiring to flat stakes driven into the ground. This framework supports the lath shelter (snow fencing) that is then unrolled over the bed. Setting the screens, up and then removing them is very costly in time, labor and materials and the screens themselves are costly, for they must be made of treated wood or else be kept well painted to preserve them from rot. A much more simple method, and one which is practiced in England, is described below.

Cut round stakes about 2'6" long and of a 3" minimum top and point them. Starting at one end of the bed lay them out in pairs (one each side) 15' apart. Drive them down into the ground, trying to maintain the same height above the bed surface for the sake of the 'finish' of the job. About 6' beyond the ends of the bed drive in a retaining stake at an angle of 45 degrees to act as an anchor for the galvanized wire which is stretched along the top of the stakes. This retaining stake should be sunk to within 1" of its top. (The use of a proper stake-maul instead of a sledge hammer will reduce the splitting of the stakes during driving.)

Fix the wire to the first retaining stake and lead it over the tops of the stakes in the line, fastening it loosely with staples on each stake top. Strain and fasten at the other end of the bed. Go along the line of the stakes, hammering the staples home. The aim should be to fasten each 15' section so that there is no 'creep'.

Having reached the point where you have a line of stakes on each side of the bed with a taut strand of galvanized wire stretched along them, place crosspieces of 1" x 1 1/2" x 4' wooden strips across the bed between each pair of stakes and nail to stake top. Now, draw a third strand of galvanized wire down the middle of these cross-pieces. You now have three strands of wire on which to roll and unroll the lath shelters.

The advantages of this method are cheapness, a better circulation of air in the seedbeds, and a saving of time in covering the bed. The disadvantages are that in the event of a sand storm, beds my get silted up (this can be avoided by putting a row of snow fence at intervals of about ten beds), and it does not look as neat as the boxed-in bed.

DIRECT-SEEDING THE SOUTHERN PINES 1/

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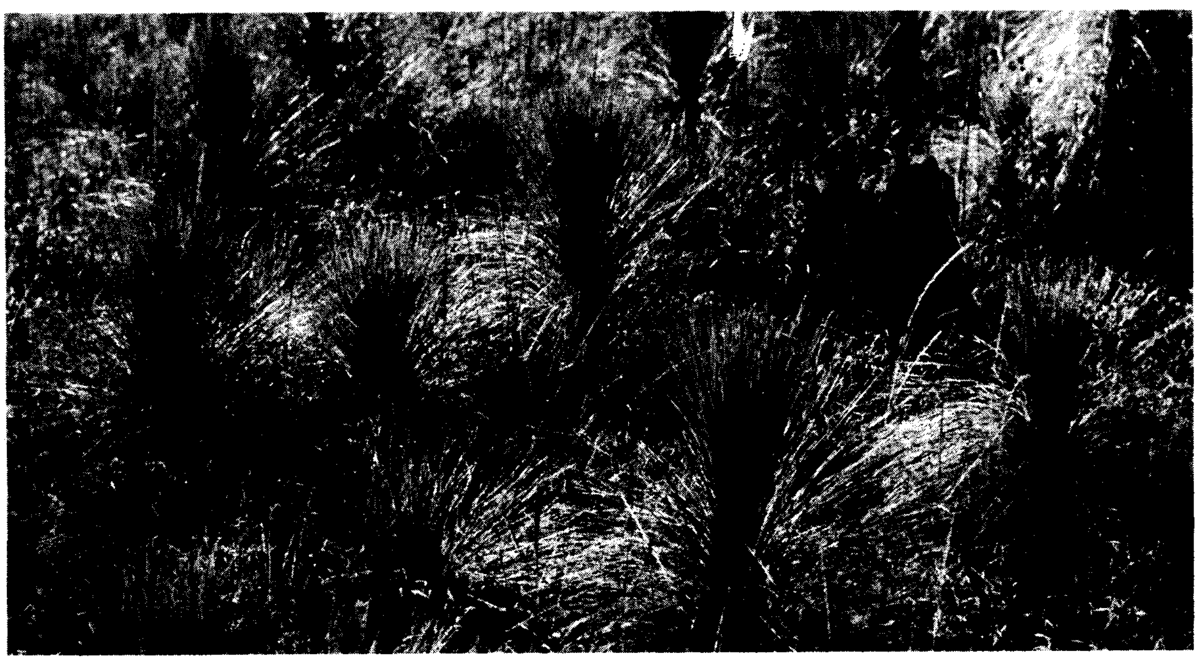
Nothing would be more gratifying to me today than to be able to tell you how to direct-seed each of the southern pine species. Unfortunately this is not yet possible although we firmly believe the answers are close at hand. I will tell you, however, our present prescription for seeding longleaf pine and will briefly summarize our progress with loblolly and slash pine.

First let me quickly review why direct seeding is so important. Basically it promises a quick, cheap substitute for planting. But there are other potential advantages that are not generally recognized. Successful methods of direct seeding should give more trees per acre than can be economically planted. This suggests that seeded stands can be made to produce higher quality trees than are normally grown in plantations. High initial stocking also offers assurance that acceptable stands will be achieved even when drouth kills many of the individual seedlings.

1/ This paper was read at the meeting of the Association of Southern Agricultural Workers, Atlanta, Georgia, February 6, 1956.



A vigorous 5-year old longleaf seedling stand established by direct seeding on a one-year old grass rough.

Direct seeding can be the means of bringing back longleaf pine. This valuable species is difficult to plant successfully. In Louisiana, where there are 1. 6 million acres of barren, cutover longleaf land, less than 100 acres were planted to longleaf during each year of the past 5. In contrast, about 8, 000 acres of longleaf were direct-seeded last November alone--the equivalent of planting more than 12 million seedlings.

The Southern Forest Experiment Station's research center at Alexandria, Louisiana, began direct-seeding research in 1947. Since 1951 it has been the center's major project. The work has been facilitated by cooperation from the Louisiana Forestry Commission, the U. S. Fish and Wildlife Service, the Kisatchie National Forest, and several private landowners.

Longleaf Pine

Time of Sowing

With longleaf pine, one of the most important factors is to sow in the fall as soon as soil moisture is adequate for prompt germination and when maximum air temperatures are below 80 degrees F. To put it another way, seeding must be done after the fall drouth is broken. Usually two inches of rain is enough. In central and southern Louisiana, fall rains may begin anytime from late October to late November. Any delay in sowing after ample rain has fallen is dangerous because seedeating birds and animals are more numerous in December, while their natural foods become less abundant. In addition, progressively lower temperatures delay germination, thereby leaving the seed exposed longer than is necessary. Premature sowing--as in early October--is equally hazardous because high temperatures may cause seed deterioration or faulty germination.

Seedbed Preparation

On most sites, seeding should be done in a light grass rough, obtained by burning in the spring of the year in which the sowing is to be done. Burning destroys the accumulation of dead grass and enables the pine seed to reach mineral soil; it also reduces the rodent population. If burning is done before April or May, however, the regrowth of grass will be heavy and will form a favorable habitat for rodents. Burns in late summer or early fall should also be avoided, for fresh burns are highly attractive to birds.

On dry, sandy sites, it may be desirable to follow the spring burn with a disking in late summer. Disking has many pros and cons, and no flat recommendations can be made. Its chief advantage is that, by reducing competition from grass, it may improve pine survival and growth the first year after seeding. Double-disking is usually necessary, either as two separate operations or by using tandem disks. If disking is confined to strips 8 feet wide and 6 to 8 feet apart, costs can be held to about $2.50 per acre.

Disking also has several disadvantages. Disked strips are attractive to both birds and rabbits, and are subject to silting and flooding. The top few inches of soil on the strips dry out very quickly. Thus, in a dry winter, germination may be prevented or prolonged. The new grass on the disked strips is highly attractive to cattle, which may trample the young pines. If only the strips are seeded, there is also a strong possibility that early pulpwood yields will be decreased.

Predator Control

Until recently, seed-eating birds have been the greatest single obstacle to successful fall seeding of longleaf pine in Louisiana. Large flocks of migrants begin to arrive in November and, with the aid of resident birds, can cause heavy seed losses and even failure in a short time. Meadowlarks, several species of sparrows, juncos, and robins have been the most troublesome. Blackbirds have not taken much seed from light roughs,. but they are attracted to fresh burns and disked sites.

In the past, patrolling was the only practical method of reducing seed losses to birds. A one-man shotgun patrol, assigned to each 200 acres for at least 8 hours a day through the 5-week germination period, costs $1.25 to $1.75 per acre. Even this expensive measure has not always been effective.

Now there is a chemical bird repellent called Morkit 2/ which is put on the seed. Morkit gave such spectacular results in. field tests in 1953 and 1954 that Louisiana landowners used it in 1955 to protect almost 10 tons of longleaf seed. It is a German product containing anthraquinone, a compound used in the manufacture of dyes, laxatives, and photographic materials. This grey powder is cheap and easy to apply. One pound costs $0.40, and treats 4 pounds of longleaf seed.

Asphalt emulsion, a roofing compound, is used to make the Morkit stick to the seed. Some asphalt compounds are unsatisfactory; the most effective one used so far is C13-HPC, manufactured by the Flintkote Company. The asphalt is diluted with water--one part asphalt to 3 parts water, by volume. The seed is dipped in this mixture, stirred for a minute or two, drained momentarily, and then put in a rotating drum containing Morkit. Two men

2 / For information on Morkit, a chemical bird repellent, see "Not for the Birds," by W. F. Mann, Jr. and H. J. Derr, U. S. Dept. Agr. Tree Planters' Notes.No. 20, 3-6 pps. , ills. June 1955.

can treat 1, 000 pounds of seed daily, with only two steel drums and a fine meshed heavy wire basket for equipment. The total cost for treating longleaf seed--including labor and materials-- is about 15 cents per pound.

The asphalt-Morkit treatment has no noticeable effect on the viability or the rate of germination. It does not appear harmful to humans or animals. It does not kill birds--they just won't eat seed coated with it. (Even with Morkit, however, it appears best to avoid seeding fresh burns--there is no point to inviting trouble.)

Good as it is on birds, Morkit is no protection against the numerous animals and insects that relish pine seed or newly germinated seedlings. Fortunately, only a few of these other predators do enough damage to warrant control measures.

Rodents and shrews are voracious seed eaters, but in Louisiana they have not been numerous enough to endanger fall seeding on a light rough. Apparently, burning 5 or 6 months in advance of seeding helps to check them. So far, they have been relatively scarce in November and early December, but have increased in late winter and spring. They eat some newly germinated seedlings in December and January, but by and large the best way to minimize rodent losses is to seed as early in the fall as the weather permits.

Reports, particularly from the southeastern States, indicate that losses to rodents may be more severe in other regions than they have been in Louisiana. Where trouble is anticipated, some estimate of the rodent population should be made before seeding is attempted.

Town ants and hogs will destroy seed and seedlings. They must be eliminated from the area before sowing, just as would be done in advance of planting.

Rabbits, racoons, and opossums will also eat large quantities of seed, but ordinarily they cause only minor, local damage. An example of a high rabbit population, which almost caused failure in a 275-acre trial seeding, was encountered two years ago. Soon after the seed was sown, severe rabbit damage was found over the entire area. Hunting was started immediately, under a special permit, and 120 rabbits were killed. Not all rabbits were controlled at that, as light damage continued through January. This type of damage often can be prevented by a careful pre sowing examination of the area, at night as well as in the daytime, to determine how numerous the animals are.

Millipedes, small ants, and other insects have been observed eating seed and seedlings. These losses have never exceeded 5 percent, so control measures do not seem necessary.

Livestock, while not in the predator category, should be excluded from the seeded area until height growth starts because they trample and browse seedlings. Disked strips and fresh burns are particularly attractive to livestock.

Rate of Seeding

The minimum recommended sowing rate for longleaf is 10, 000 viable seeds per acre. With fresh, cleaned, and dewinged seed, this means 3 pounds of untreated seed or about 3. 8 pounds of Morkit-coated seed per acre. Fresh seed is preferred, but stored seed can be used if proper precautions are taken. Stored seed should be secured from competent sources and the germination percent should be determined by sand-flat tests before sowing is done. If viability is less than 70 percent, the seeding rate should be proportionately increased. It is important to remember, also, that even fresh seed spoils quickly under improper handling.

Methods of Sowing

On a light grass rough, seed can be broadcast by airplane or by hand-operated grass seeders. Airplanes can seed large areas fast, with a minimum of labor. The main drawback is the difficulty in skipping over small areas not requiring seeding. Planes for distributing fertilizer have been used successfully in seeding longleaf. To permit the seed to flow freely, the opening in the seed hopper, must be modified from a long, narrow slit to several larger openings. This is easily accomplished by placing a plate with rectangular openings in the bottom of the hopper. Airplane seeding was done last fall at a total cost of $0. 60 an acre, including about $0.10 per acre for flagging the flight strips.

Hand-operated "cyclone" grass seeders are well adapted for seeding areas up to 300 or 400 acres in size. An unskilled crew can be quickly trained to distribute seed uniformly over the area. One man can sow about 20 acres in an 8-hour day.

Disked strips can be seeded by hand at the rate of 20 gross acres per man-day. One Louisiana company seeds them with a tractor-mounted seeder which covers 40 acres per day.

Inspections of Seeded Areas

A careful examination of the seeded area should be made each week throughout the germination period. These inspections can be facilitated by establishing 50 well-distributed, staked and numbered observation plots, each sown with about 50 extra seed. The plots should be very small, and the seed should be placed right around the stake. So that field germination can be determined, some seed on each plot should be covered with a small cone of wire screen for protection from larger predators.

A systematic seedling count should be made about 12 months after seeding. Longleaf seedlings are difficult to see and areas classed as "failures" are sometimes revealed as "successful" by such inventories.

Costs

The cost of direct-seeding longleaf pine depends on the price of seed, the type of seedbed preparation, and the individual labor and equipment-use rates. Seed ranges from $1. 00 per pound in bumper years to $2. 00 in lean seed years. With seed at $1. 50 per pound, seeding on a light rough will cost about $6.00 per acre, including all inspections. Sowing 3 pounds of seed per acre on disked strips will cost about $8.50 per acre. These costs compare favorably with planting costs, which average between $12. 00 and $15. 00 per acre.

Loblolly Pine

On open areas, loblolly pine is probably more difficult to seed than either longleaf or slash pine. This statement may seem strange in view of the relative ease with which natural loblolly reproduction is obtained, but there are several reasons for it. First, because cotyledon-stage seedlings are easily frozen, germination must occur in the spring rather than in the fall. Consequently, the seed is exposed just when rodents are most numerous-and we have not yet found a practical method of controlling rodents. Second, mechanical seedbed preparation is needed on open cutover areas with a heavy grass sod. Loblolly seedlings normally grow only 3 or 4 inches in the first year, so they are quickly overtopped and eventually smothered by the rank growth of a well-established stand of grass. This loss is primarily due to competition for light, as loblolly seedlings have remarkable ability to withstand drouth. Finally, loblolly seed is slow to germinate and should be stratified for about 60 days. Even then it germinates much slower than longleaf seed.

At present, we believe that the best method is to sow one pound of 60-day stratified, Morkit -coated seed per gross acre on disked strips in late February. The disking should be done on a light rough in January or early February so the soil will be loose enough to wash and cover same of the seed.

We do not recommend large-scale seeding of loblolly pine at this time because the risk of failure due to rodents is too great. An effective rodent repellent must be found to assure consistent success. We are working on this problem in cooperation with the U. S. Fish and Wildlife Service, and have several excellent leads.

Seeding loblolly pine under a canopy of low-grade hardwoods seems much easier and cheaper than seeding it on open land. Hardwoods shade out the grass, making disking unnecessary. Furthermore, seeding on a fresh burn in November permits: the seed to reach mineral soil immediately. Later, much of the seed is covered and concealed by falling leaves. The new leafcast also helps to mask the burn from birds. Germination starts in February, when daytime temperatures reach 70 degrees F. Since overwinter exposure stratifies the seed thoroughly, no presowing treatment is required. A rodent repellent is needed for, seeding hardwood areas, too, because seed losses are heavy in January and February despite the covering of leaves.

Overtopping hardwoods should be deadened during the first summer, after a seedling survey indicates that there is enough pine reproduction to justify the work.

Slash Pine

Slash pine seeding research has been limited to open areas. Indications are that slash seedlings can withstand freezing temperatures, so fall sowing and fall germination are possible. This is highly desirable because bird and rodent depredations are less severe in the fall than in the spring. It also appears that disking is required to prevent excessive drouth losses in the first year. Slash seedlings can outgrow competing grass, attaining a height of 7 or 8 inches the first year, but they die quickly when soil moisture becomes critical. Stratification of the seed is needed to assure prompt germination. Morkit should be used for protection against birds. Because germination extends into January, even with stratification, a rodent repellent probably will be necessary before commercial seeding of slash pine can be undertaken.

Summary of Recommendations for Longleaf Pine

1. Prepare a seedbed by burning in late April or early May- -a light rough will develop by fall and will partially hide the seed from birds. In addition, on dry sandy sites, disk in late summer in- strips 6 or 8 feet apart. The object of disking is to remove competing grass and thus to reduce heavy first-year drouth losses.

2. Seed between late October and early December, as soon as soil moisture is adequate for prompt germination.

3. Treat seed with Morkit to repel birds.

4. Sow 10, 000 viable seed per acre. If stored seed is used, test it before sowing and make any necessary allowances.

5. Preliminary work should include control of town ants, the exclusion of hogs and cattle, and a careful inspection for heavy concentrations of seed-eating animals.

6. After seeding, examine the area carefully once each week until germination is complete.

7. Make a systematic seedling count after the seedlings are a year old.

A FOLDING SPUDDER FOR TREE PLANTING

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Although at the present time much tree planting in New York is dine by machines that do the complete job, a large amount is still done by hand. For a number of years now, "spudders" mounted onto the rear wheels of rubber-tired tractors have been employed in the western districts of New York as an aid to digging the holes for such hand planting. These devices mechanize the process of hole digging and result in a more uniform job, especially when inexperienced labor is employed. They reduce costs and speed the planting of the seedlings and therefore improve the quality of the job

One of the principal difficulties encountered in the use of spudders has been that of moving from one planting site to another. Ordinarily when crossing or travelling along a road or loading the tractor on a truck, it is necessary to remove the spudders from the wheels. A great deal of time is lost in this operation, especially in realignment of bolt holes at the new site. This problem can be solved by, making the spudder so that the digging points can be folded back out of the way. The following pictures show how we accomplish this.

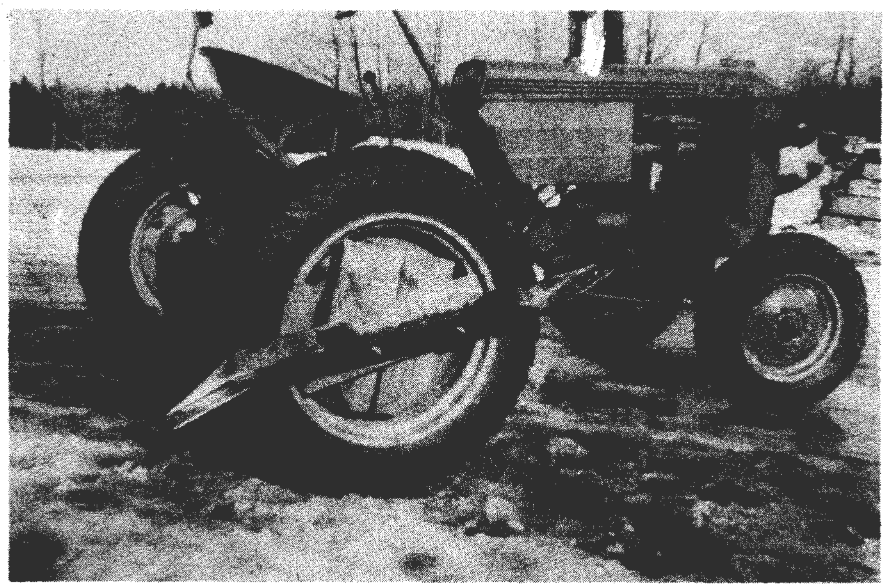

Figure 1. Spudder mounted on the wheel of a Case tractor. In planting, there is a spudder for the other wheel also. Spacing between rows is varied by changing distance between wheels (5 - 7 feet). Spacing in row is varied by planting every hole or every other hole (5- 10 feet)) Combinations of 5 x 5, 5 x 10, 7 x 5 and 7 x 10 are possible.

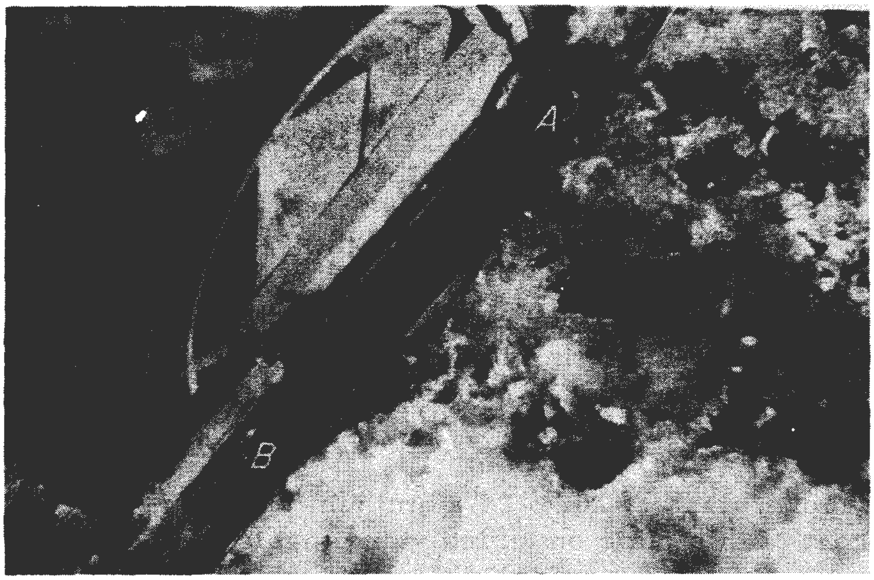

Figure 2. Close-up to show hinge and bolts that hold digger points in place. To fold, remove bolts A and B.

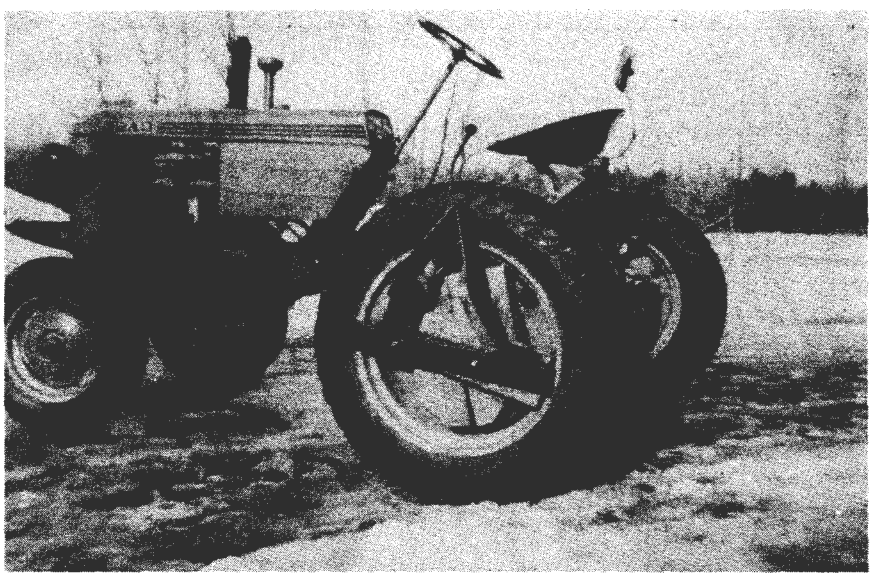

Figure 3. Folded spudder. Ends are held together by small bolt through the tips. Tractor can be easily moved over road or loaded on a truck without removing spudders from wheels.

A COLLECTING HOOK FOR YELLOW-POPLAR FRUIT

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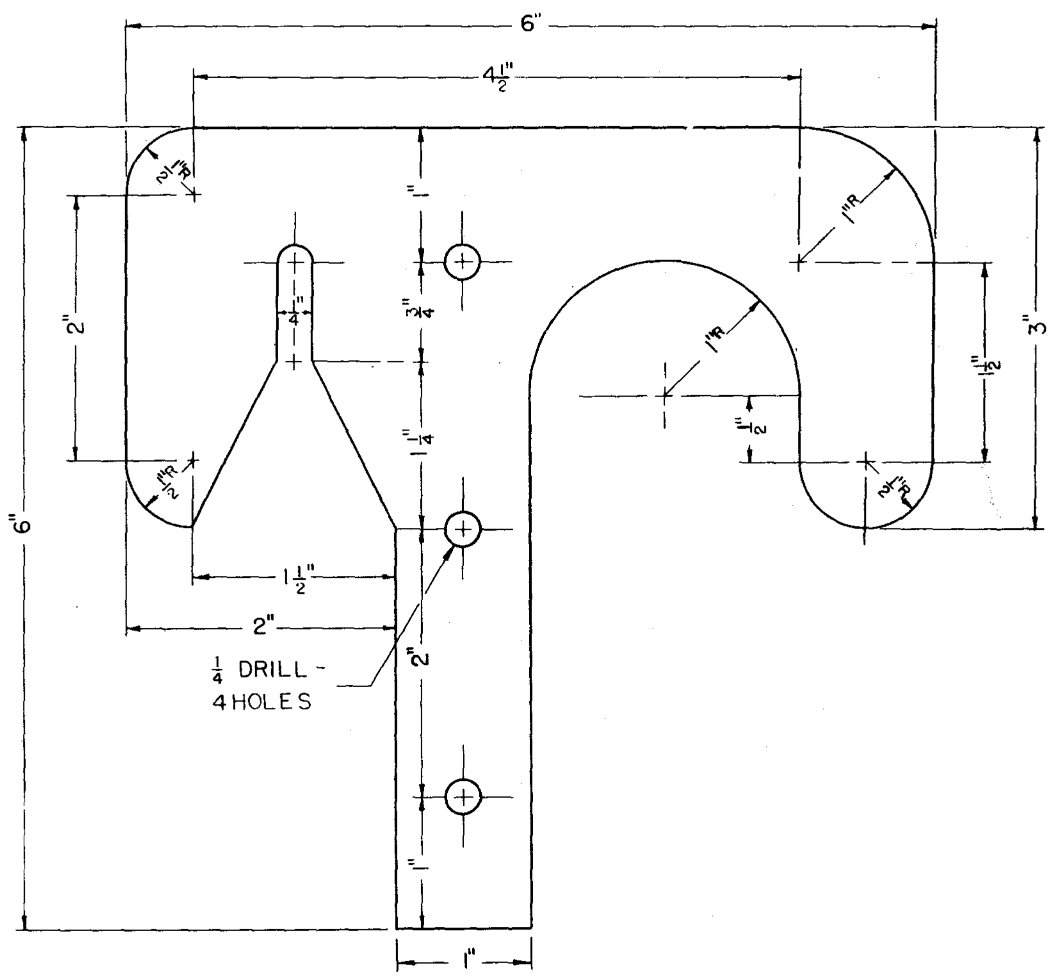
Prior to the development of the tool, pictured below, for collecting yellowpoplar (Liriodendron tulipifera L.) fruits, a variety of other hooks, saws, and loopers were used. However, our experience was that the fruit which projected at odd angles or was partially shielded by branches was uncollectible with such tools. This might amount to as much 10% of the crop. We therefore devised the hook described herein.

It is easily made from a blank of 2024-T4 aluminum plate, 1/4" by 6" by 6". The approximate cost of this plate on an individual basis is $2.00 but if a large number of hooks were to be made, a blank 6" wide by the desired length could be used. An economic method in which to utilize the stock would be to invert every other pattern and insert one branch hook under the other - thus three hooks can be made from a 6" x 13" blank.

A working drawing of the hook follows.



The manufacture of the tool is accomplished as follows:

1. the pattern can either be scribed on the stock with a scratch-awl or a paper pattern can be cut out and glued on the blank;

2. the three bolt holes and the rounded end of the 1/4" notch should be drilled (after center punching) using a 1/4" high speed drill with cutting oil;

3. the hooks and shaft shank are cutout using a jeweler's saw, a small band saw or a hack saw;

4. the outside edges of the branch hook and "funnel-notch" should be chamfered and rounded to prevent the otherwise sharp edges from bruising and cutting the branches;

5. for the sake of appearance, the entire tool might be burnished with fine emery cloth.

The pilot model required 3 hours to make, but this time can be halved with experience.

The funnel-shaped opening guides the fruit peduncle into the 1/4" notch which engages it and breaks off the fruit. The edges of this slot need not be sharpened because the fruit stalk need not be cut, it is very brittle where it joins the twig and breaks off easily.

This hook is easily bolted to the side or inserted into a slot cut in the center of any wooden or metal pole.

The hook may also be used in collecting other large headed, thin stalked fruit, such as sycamore, magnolia or sweetgum. An adaptation of the hook which might render it useful in the collection of pine cones would be to bevel and sharpen the "funnel" and slot edges to permit the cutting of the cone stalks.

The advantages of this yellow-poplar hook are: 1) it is inexpensively and easily made using common hand tools; 2) it is ideal for collecting yellow-poplar fruit because the "funnel-notch" assures the release of one or more fruit each time a peduncle is engaged; 3) it is light in weight and can be readily mounted on a variety of handles; and 4) it will not rust.

VAPAM SHOWS PROMISE AS A FOREST NURSERY HERBICIDE

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The use of chemicals to control weeds in forest tree nurseries has become standard practice. Mineral spirits (Varsol, Stanisol, Sohio Weed Killer, etc.) have performed satisfactorily as post-emergence sprays. Allyl alcohol has given some good results as a pre-emergence treatment, but it is dangerous to handle. During the winter of 1955-56 tests were run to evaluate Vapam? (sodium N-methyl dithiocarbamate dihydrate) as a pre-emergence drench.

The tests were performed in the LSU School of Forestry nursery. The soil is a silt loam. Vapam was applied by mixing the quantity required for treatment with 12 gallons of water and applying the appropriate amount of the mixture from a sprinkling can. Following application of the chemical the beds were watered with approximately 21 gallons of water per 100 square feet (0.33 inches).

The study was carried out in two parts. On November 5 Vapam was applied to one-half of sixteen 48 square foot nursery beds; the other half of each bed was left untreated as a control. Four intensities of application were used, each replicated four times. The final tally of weeds was made on December 8, just before the end of the growing season. The results are summarized in table 1.

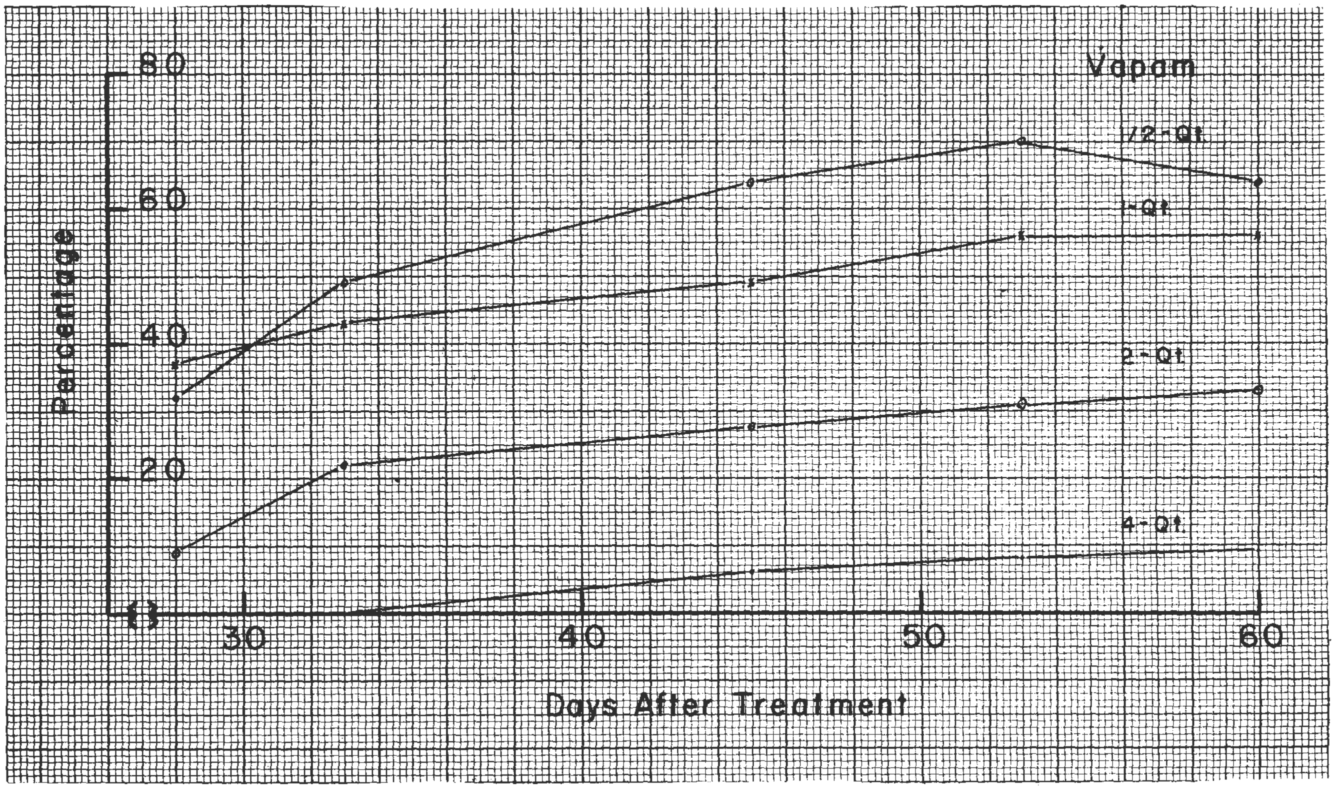
Vapam per 100 sq. ft.	Weeds per sq. ft. (av. of 8 sq. ft.)	
Quarts	Treated	Untreated
One-half	0.4	59.3
One	0.5	46.6
Two	0.0	88.7
Four	3.0	80.6

A second group of beds was treated in the same manner on February 25. The results shown in the following figure are expressed as the percentage of the

1/ Assistant Professor of Forestry and Student, respectively.

2/ Vapam used was supplied through the courtesy of the manufacturer, Stauffer Chemical Company, Box 7222, Houston 8, Texas.

cumulative number of weeds per square foot in the treated area compared to the cumulative number of weeds per square foot in the untreated area.



Cumulative number of weeds on the treated area expressed as a percentage of the cumulative number of weeds on the untreated area. Treatment is in quarts of Vapam per 100 square feet of bed area.

The heaviest treatment tested, four quarts of Vapam per 100 square feet of bed area, gave the best results: complete control for 35 days and 91 percent control for 60 days.

Germination, survival, and growth of spruce pine (Pinus glabra), loblolly pine (P. taeda), slash pine (P. elliottii elliottii), and longleaf pine (P. palustris) were apparently not affected when seed were sown twelve days after bed treatment. Of several hardwoods sown after the same lapse, only sweetgum (Liquidambar styraciflua) showed some chlorosis and reduction in height growth immediately following germination, but color was normal and cumulative height growth equaled that of the control seedlings by 90 days after sowing. There was no significant difference in germination or survival of longleaf pine sown three, six, and twelve days after treatment.

Although the details of optimum treatment remain to be worked out, Vapam shows definite promise as a forest nursery herbicide.

FORCE FEED SEED HOPPER

Charles C. Mony

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Vallonia, Indiana

The seed sowing machine used here at Vallonia Nursery is a Planet Junior 156 seeder with a homemade force feed hopper substituted for the original gravity feed hoppers. Before we made this modification we had to use absolutely clean seed; otherwise bits of gum, needles, wings, and other trash would often plug the cups and cause uneven sowings and skipped spots. The modified machine does our job very well indeed.

The force feed seed hopper is essentially a row of force feed cups mounted underneath a flat-bottomed U-shaped box 4' long, 10' high and 6-10" wide. It is mounted in front of the seeder frame in order to clear the lift arms and shoe hold-down bracket rods and springs; resting on 1/8" x 3" x 8" plates welded to the front seeder tongue braces. A double run feed cup for each drill row desired in the bed (in our case, 8) is fastened to the bottom of the hopper.

These cups are powered by a 5/8" square shaft connected by a chain to the original gravity feed shaft (from which the gravity feed hoppers and sprockets have been removed). The speed of this new shaft, and hence the rate of seed flow, is governed by placing the proper two of eighteen sizes of sprockets on the end of these shafts. The double run feed cups flow the seed via tubes to the seeder shoes in the conventional manner. The bill of material describes these various special parts.

Chain tension is maintained by 1 1/2 slotted (elongated) holes in base of seed hopper foot, below the single end bearing.

The gravity feed shaft behind the frame is kept to mount the seed flow shut-off clutch, and to receive the power train sprockets and #32 chain from the seeder drive wheel sprocket. The upper, 7-tooth, clutch mounted sprocket is usable, but in our case we had to discard the large bottom (wheel) sprocket and replace it with a 10-tooth, #32 sprocket (John Deere Y-1644 BG-$1.10).

In addition to the seed density adjustment provided by pair combinations of the 18 sprockets the general flow of seed is controlled by leaving all 8 pairs of holes in hopper floor open, or by plugging, either the right or left hand one of each pair. Normally only eight holes (those for the "narrow" side) are needed. However, white pine and larger seed require the eight "wide" side holes, and all sixteen may be needed when sowing such large seeds as soybeans, pin oak, or corn..

We have found that this machine is well adapted to large scale nursery work but when sowing loose or sandy soil particular attention must be given to its shoe adjustment for depth, otherwise it will sow too deeply. We feel that the importance of shallow sowing (1/4"-3/8") cannot be overstressed and when sowing a dry seedbed surface we set the opening plows very shallow. Also, we remove or discard the shoe tension springs and raise or remove entirely the covering devices since the packing wheels will cover small seeds sufficiently without them.

Fractional, or small amounts of seed may be sown by setting funnels in 8 holes in box. Divide seed into 8 parts and place equal parts in each of the 8 funnels.

Bill of Material

From: International Harvester Co. dealer, or from

International Harvester Company 180
N. Michigan Avenue Chicago 1, Illinois

"Standard McCormick-Deering Double-Run Feed, Grain Drill Parts"

Double-run feed cup and wheel, assembled - - 8 ea.

(Double-run feed cup and wheel, assembled complete, part numbers NA 610, NB 611 (or N-12444) plus feed wheels)

Seed tubes, spiral-steel ribbon, approx. 30 inches long, complete; with single delivery hole, tube top cups, to fit above; collars, pins, etc. included. - - 8 ea.

Feed shaft, square, 5/8" x 60" to fit above set of double-run feed cups - - 1 ea.

Estimated cost - $40

From: McMaster-Carr Supply Co. or Link-Belt Company
640 West Lake Street Chicago, Illinois
Chicago, Illinois

Sprocket wheels, cast or wrought-steel, center hole 3/4", round, no keyseat, with setscrew. Size #25 sprockets for implement chain #25, pitch diameter 1": - - 1 ea. of the following sizes

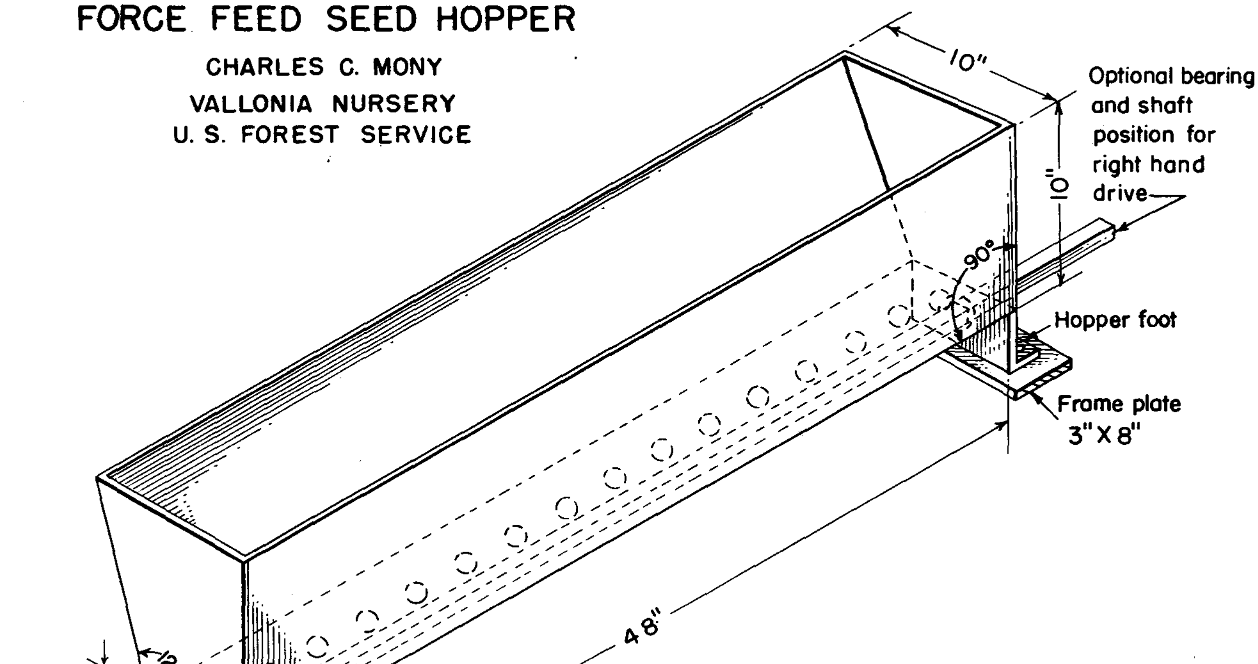
Teeth (number)	Approx. diam. (inches)	Teeth (number)	Approx. diam. (inches)
6	2	20	5 3/4
7	2 3/8	22	6 1/4
8	2 5/8	24	7
9	2 3/4	26	7 1/2
10	3 1/4	28	8
12	3 1/2	30	8 3/4
14	4 1/4	32	9
16	4 3/4	34	10
18	5 1/4	36	10 1/2

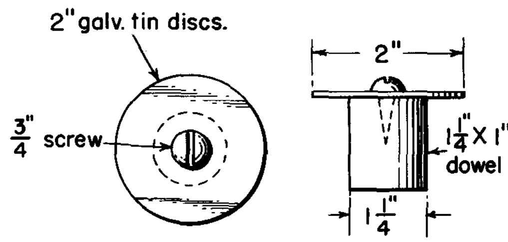
Note: Either 3/4" round hole or 5/8" square hole will work OK on 5/8" square shaft.

Estimated cost - $50

FORCE FEED SEED HOPPER

CHARLES C. MONY
VALLONIA NURSERY
U. S. FOREST SERVICE

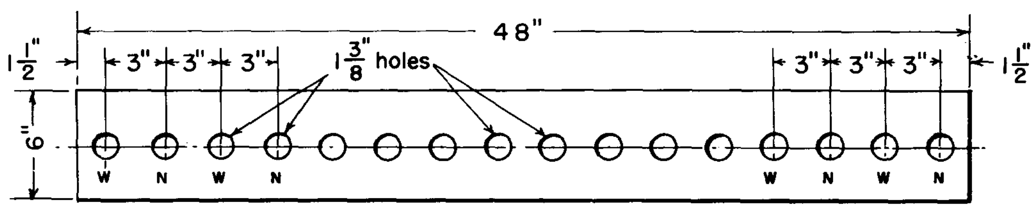




TOP SIDE

PLUGS

8-required. Plugs held in place by gravity.



W= wide side N= narrow side

DETAILS OF HOPPER FLOOR

Sixteen holes, $1\frac{3}{8}$" in diameter are drilled in the hopper floor, one directly above each side of the 8 double run feed cups. These are spaced about 3" apart, center to center.