AN INFECTIOUS DISEASE OF NURSERYMEN

Bureau of State Services, Public Health Service U.S. Department of Health, Education and Welfare Atlanta, Ga.

Introductory note:

During the past year, nine tree seedling nursery workers have become infected with a fungus identified as sporotrichum. This is the first time such injury has come to our attention. However, there is evidence that several people in years past may have been infected but the disease was not identified as sporotrichosis.

The Public Health Service has prepared the attached summary of the disease for distribution to all who handle forest tree seedlings. Note that the fungus is very widespread and is quite common among agricultural workers. Cure for the condition is not difficult after proper diagnosis.

As will be pointed out, infection takes place through an abrasion in the skin. After an incubation period of 1 to 4 weeks the infection becomes evident. All too frequently, the scratch heals and is forgotten, which makes it somewhat difficult to connect the cause and effect.

Preventive measures can be taken by treating all breaks in the skin, regardless of size. Washing the hands and arms with warm water and soap helps to keep them free of infection. Gloves and other protective clothing are not recommended; they may promote infection through minor abrasions unless the skin is kept dry. Lotions may help but have not been investigated thoroughly.

Forest workers developing a persistent infection should be taken to a doctor. It would be well to remind the physician of the unusual exposure to the fungus.

(U. S. Forest Service)

It has come to our attention that a fungus disease known as sporotrichosis has occurred with unusual frequency in nurserymen. In these cases the disease had not been properly diagnosed or treated, and ugly and deforming scars developed, usually on the forearms. We urge that you consult your doctor if you are a nurseryman and suffer from sores which will not heal. When you do this, remind him of your unusual exposure to this fungus. For your information the following summary of this disease has been prepared.

Sporotrichosis

Sporotrichosis is a disease of man, plants, and animals, caused by the fungus, *Sporotrichum schenckii.* In most cases of human infection, only the skin and lymph channels beneath the skin are infected. The fungus is widespread in nature, and has been found in the soil, as well as on flowers, vegetables, shrubbery, and bark. It survives extremes of temperature and altitude and, although it is found in all sections of the U. S., most infections are reported from the Midwest. Although anyone may be infected, the disease occurs most often in gardeners and farmers and it may be considered an occupational disease. It probably cannot be transmitted from person to person.

The typical infection follows an abrasion, scratch, prick, or bite, through which the spores of the fungus are introduced beneath the skin. In 1 to 4 weeks following exposure, a small, painless, pus-containing blister is formed, which may open, become raw, and slowly enlarge. Areas distant from the point of contact are infected as the fungus spreads through the lymph vessels, which may become visibly reddened and hard. Nodules may form along the infected lymph channels, which lead away from the point of initial infection.

Lymph glands in the armpit or elbow may become enlarged and sore. The disease is slowly progressive if untreated, and through the bloodstream fungi may be carried to the bones, abdominal organs, and the uninvolved skin. Since the disease may be simply and adequately treated, it is rarely fatal.

The diagnosis is made by growing and identifying the fungus in the laboratory. Material obtained from the initial ulcer or one of the small opened nodules is placed on a special growth medium (Sabouraud's agar) and the characteristic macroscopic and microscopic appearances of the fungus are noted. A special skin test may be used to confirm infection, or an animal may be injected with infected pus and the organism demonstrated microscopically after autopsy.

Iodides given by mouth specifically cure this infection. They are usually given in the form of potassium iodide solution, five drops three times daily, the dose being increased by one drop to a final dose of 35-50 drops three times daily. Penicillin and other antibiotics are not helpful or curative, but occasionally localized radiation to an ulcer may aid healing. Stilbamidine may be tried if the iodides cannot be prescribed.

Healing with only a scar remaining may be expected within 1-4 months after iodide therapy is started. Such scars may be large and disfiguring, however, if infected sores are allowed to progress and enlarge for a long period before being treated. To assure total healing, iodides should be continued for one month after healing is considered complete.

Theodore C. Doege, M. D.
Surveillance Section

AMMONIUM NITRATE FERTILIZER CAN EXPLODE

O.W. Moore, Road Construction Foreman,
Edward Blaser, Safety Officer[1]

Introductory note:

Until this year, we have not been too concerned with safety factors in the use of ammonium nitrate as a fertilizer. Then a devastating explosion involving the chemical occurred in Roseburg, Oregon.

The following discussion of the hazard attendant upon the storage of quantities of this commonly used fertilizer is based on information furnished by O.W. Moore of Region 2, Ed Blaser of Region 6, and the Manufacturing Chemists' Association, Inc.

Our recommendation is that if you make extensive use of this fertilizer, as in a tree nursery, then take every precaution in handling the material. You should check with the manufacturer for additional standards. If you make only a limited use of it, as for a few seedbeds or a lawn, you should buy only enough to use for the current need.

Jack Heintzelman
Safety and Employee Relations
Chief's Office, U.S. Forest Service

1. Handle ammonium nitrate much as you would handle material such as gasoline. Under all normal circumstances and with due care, the material is safe to handle.

2. Under conditions of extreme heat confinement (several hundred degrees F.) or open flame, ammonium nitrate can be dangerous.

   Prohibit smoking in storage areas.

3. Ammonium nitrate is not particularly flammable, but burns intensely when set on fire. Clean up dust from broken bags immediately; this dust is flammable.

   a. Bags of ammonium nitrate should be set on wooden pallets to insure cleanliness and protection from moisture.

   b. Do not store with explosives, organic chemicals, corrosive acids, or flam mable liquids. Keep storage areas clean of iron filings, sawdust, and rags.

   c. Do not store with work tools, equipment, or clothing, or in a shop area or repair area.

   d. Empty bags should be disposed of by burning- -a few at a time.

4. Ammonium nitrate should be stored in a building with good ventilation. Store not less than 3 feet from walls, eaves, or spreader beams overhead.

5. Ammonium nitrate should never be stored in a building capable of confining gases, such as a stone or concrete building with small windows. Aluminum roofing and siding on a wood stud framework are satisfactory. To facilitate cleaning, wood studs should be on the outside of the metal siding. A natural draft vent should be provided in the roof. Floors should be of a type that can be kept clean and dry, and reasonably fire resistant. A washdown drain should be provided. Heat should be externally furnished. Wiring should comply with Article 500 of the National Electrical Code.

1 Mr. Moore is a Road Construction Foreman on the Rio Grande National Forest, Monte Vista, Colo., and Mr. Blaser is in the regional office. Portland, Oreg. Both men are with the U. S. Forest Service.

6. Ammonium nitrate must never be contaminated with unknown materials or with materials not specifically recommended by the manufacturer of the nitrate. This is extremely important as a number of rather common substances may cause unpredictable reaction conditions if mixed with ammonium nitrate. Areas where ammonium nitrate has been spilled or otherwise contaminated should be sprinkled with lime and hosed down.

7. The dangerous mass limit of ammonium nitrate is 123 tons. At this level a fire can spontaneously change to a detonation. Every stock of 40 to 50 tons should be separated by at least 6 feet of space and a light metal partition, such as a corrugated iron sheet.

8. Ammonium nitrate can produce relatively toxic oxides of nitrogen and carbon monoxide while burning. An automatic sprinkling system with an overhead storage tank for water is advised, or at least some hose with pressure great enough to reach the fire without unduly exposing the firefighters to the fumes generated by the burning nitrate. Chemical extinguishers containing carbon tetrachloride, gas, or foam are useless for this type of fire and should not be used.

9. Flooding with water is the only effective way to fight a nitrate fire as the nitrate has its own oxygen supply built in.

10. Ammonium nitrate is not hazardous if three things are kept in mind: (1) No contamination unless specifically recommended, (2) no confinement or excessive heat (flame), and (3) no storage near the critical mass (123 tons).

Addendum

For those who make considerable use of ammonium nitrate, an excellent comprehensive booklet "Fertilizer Grade Ammonium Nitrate", Manual Sheet A-10, can be obtained from the Manufacturing Chemists' Association, Inc., 1825 Connecticut Avenue, N.W., Washington 9. D.C.

A TEST OF WOOD FIBER PADS AS A SEEDBED MULCH

Richard F. Watt, Research Forester
Lake States Forest Experiment Station, U. S. Forest Service
St. Paul, Minn.

Newly planted seedbeds, especially fall sown ones, are often covered with a mulch. These mulches serve a number of purposes--protection from wind and water erosion, retention of moisture, prevention of frost heaving, retardation of weed growth during the pregermination period, and reduction of premature germination in the spring. A variety of materials have been used, with burlap, straw, and pine needles probably the most common. None of these has all the properties that a nurseryman desires in a mulching material.

Recently a company in Cloquet, Minn., has been experimenting with loose pads of sulphite wood fiber as a mulch that might permit germinating tree seeds but not weed seeds to emerge through it. The low price of such material would allow the nurseryman to leave it on the seedbeds where it would eventually disintegrate after having served its purpose. Fungicides, insecticides, and fertilizers could be incorporated during the fabrication of the pad to increase its utility.

Tests of these pads in nurseries in a number of regions gave contradictory results. In some tests, the tree seedlings did successfully penetrate the mulch; in others they did not. Because of these conflicting results, the Lake States Forest Experiment Station was asked to set up a test in the greenhouse under controlled conditions to determine the effect of four densities of sheets upon germination and emergence of conifer seedlings.

Methods

Flats of silica sand, 10 inches square and 3 inches deep, were autoclaved and sown with 4 species; jack and red pines and white and black spruces, 1 species in each of the 4 drills. Each flat was then covered with one of the four densities of mat being tested, with the control left uncovered. This test, using 5 flats, was repeated 4 times to give a total of 20 flats. The seeds were sown to give a calculated density of 50 seedlings per row. Spruce seeds were cold soaked to overcome dormancy; no treatment was needed for the pine.

All flats were watered frequently to maintain god conditions for germination of the seed. Greenhouse temperatures fluctuated about 70 F., with somewhat higher temperatures on sunny days.

Germination and emergence were recorded at frequent intervals. In the control flats, counts were made of the seedlings as they emerged above the level of the sand. In the flats covered with mats, a seedling was counted as having emerged when it had penetrated the mat and was completely free from the main body of it. At the conclusion of the experiment, the mats were removed and those seeds that had germinated but whose seedlings were still under the mat were counted. A count of the seed that did not germinate was not needed because the seeds in each row had been counted carefully before planting.

The mats had the following characteristics:

Mat	Weight per cu. ft.	Thickness
	Pounds	*Inches*
A	3.16	0.162
B	1.86	.163
C	.96	.142
D	.75	.141

The lightest mat was extremely thin and appeared to be penetrable by *very* small seedlings. The heaviest one apparently was too strong to be broken even by vigorous seedlings.

The test began February 17 and ended 2 months later after it was evident that no additional changes in the results would occur.

Results

Surprisingly, the pads were not easily dampened by the water so that it was not until the sixth day of twice-daily watering that the heaviest pads were soaked through with water. The heavier pads actually supported the water on their surfaces without becoming wet. The manufacturer reported that this was due to the nature of the binder used. The thinnest pad, although the fibers were slow to wet, allowed the water to pass through to the sand beneath. As the flats had been well watered before mulching and the pads were effective in slowing evaporation, this difference in wetting did not affect the germination of the seed. Statistical analysis of results corroborated this conclusion.

Germination started March 1, 2 weeks after the start of the test, and judging by the ridges produced under the pads, germination in all flats occurred at about the same time. Germination in the control flats was completed by March 16, but the test was continued until April 21 to see if the pads would deteriorate and permit additional emergence of the seedlings imprisoned below the pads.

In all cases, the pads were strong enough to be self-supporting between the ridges raised by the rows of germinating seed, although some tearing of the lighter sheets occurred with watering. No such tears appeared in the heaviest sheet.

When emergence was poor, some mold appeared in the rows of jack pine, but not in the other species. However, germination tests run with the jack pine showed vigorous growth of molds, which probably started on the cracked and broken seeds that were present in the jack pine seed lot but not in the other species. These molds resulted in the destruction of some of the jack pine seedlings and probably introduced slight errors in the count of the seedlings at the end of the experiment.

Table 1 shows that the heaviest pad, A, did not permit a single seed to penetrate; no tears occurred in this pad even though it was raised well above the surface of the sand by the hypocotyls of the germinating seeds.

TABLE 1.--Total germination and emergence of conifer seeds

Pad	Red pine		Jack pine	
	Plants emerging	Total germination	Plants emerging	Total germination
A	0	208	0	230
B	4	215	3	226
C	47	202	90	261
D	141	214	214	270
Control	217	217	233	233
	White spruce		Black spruce	
A	0	381	0	182
B	2	394	0	195
C	56	379	42	233
D	138	369	93	207
Control	360	360	189	189

Pad B was also very resistant to penetration with only a very few seedlings, 1 percent of those germinating, coming through. Some tearing of the pad occurred where it was suspended between the rows of seedlings. However, the pad did not rupture along the rows, but between the rows when watered. Apparently, the weight of the water and its softening effect upon the pad combined to cause the rupture. This tearing, because it was between the drills, did not allow the seedlings to escape.

Slightly over 20 percent of the germinating seeds emerged above the second lightest pad, pad C. This weight material tended to rupture along the rows as the seedlings pushed upward against it, rather than to become suspended between the rows and then rupture. However, with many of the seeds, the pad conformed to the shape of the uplifted seed or hypocotyl and cupped the growing tip so that the pad could not slip free from the seedlings.

As expected, the lightest pad allowed the largest percentage of germinating seed to emerge. About 55 percent of the seedlings grew through pad D. Generally, this pad adhered to the wet sand with sufficient tenacity to break as the seedlings pushed against it. However, the thicker portions of the pad presented enough resistance to prevent emergence, giving patchy stocking of the drills.

The upper surface of the pads compacted and became horny with alternate wetting and drying, which added to the difficulty of penetration.

Conclusion

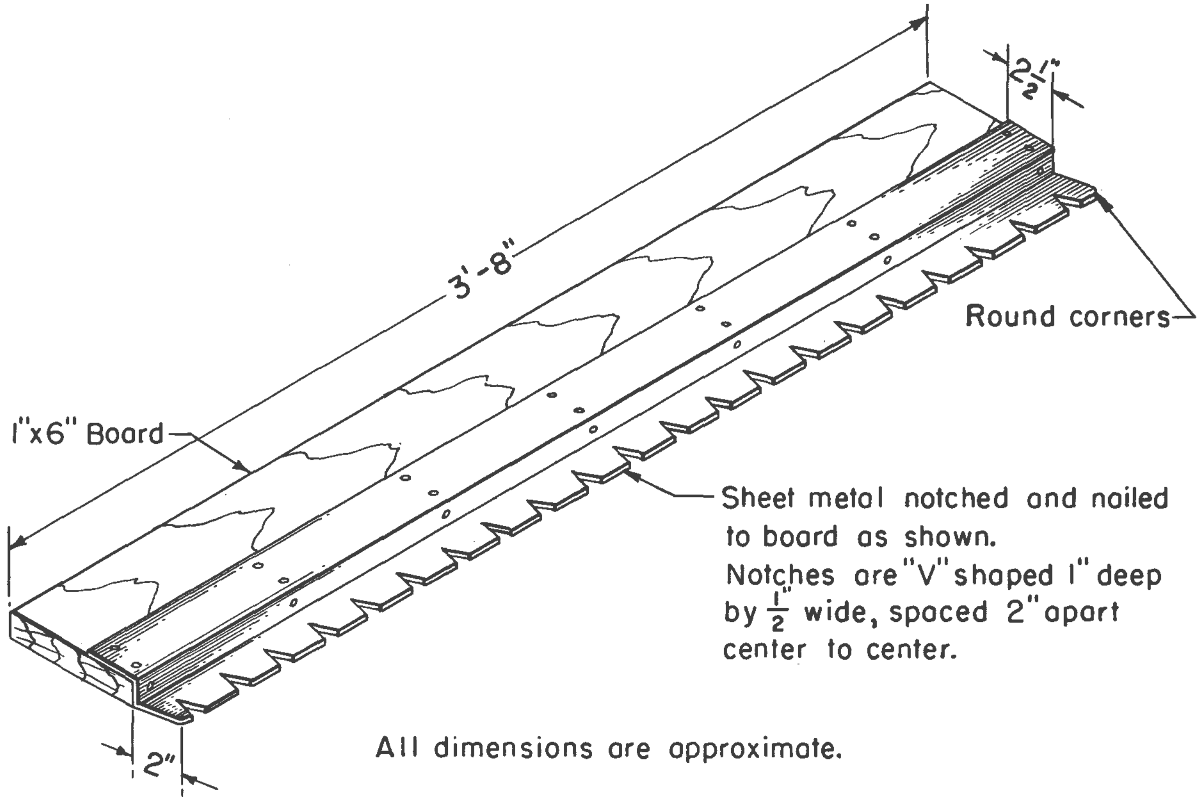
These tests indicated that the wood fiber pads supplied did not allow the germinating seeds to emerge in sufficient numbers to make the pads a desirable mulching material. Even the lightest pad, which would be difficult to place on a seedbed because of its low tensile strength, lowered the percentage of seeds which emerged. Germination was not influenced by the pads.

Further investigations, with modifications of this type of material, will be continued by the company in an effort to develop a mulch with the desired properties.

TRANSPLANTING AS DONE IN GERMANY

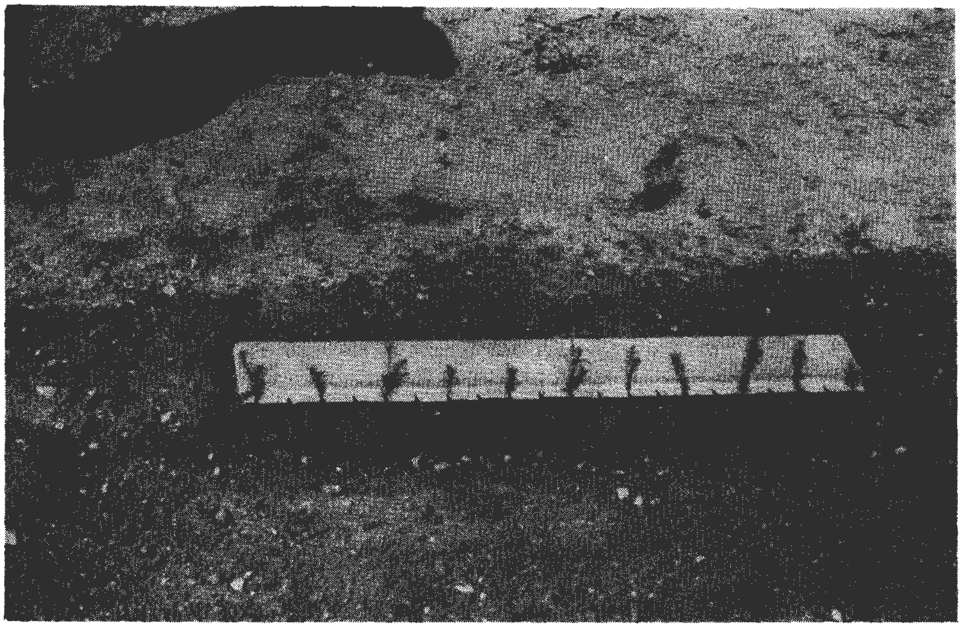
Roland Rotty, Assistant Director
Division of Cooperative Tree Planting, U. S. Forest Service
Washington 25, D. C.

Hundreds of millions of seedlings are transplanted annually in Germany with less and simpler equipment than I have ever seen in any forest nursery in America. There are no transplanting machines of the Holland or any other type, nor anything so complicated as a Yale transplant board. All that the Germans use is a notched piece of sheet metal fastened over a 1-inch board of convenient length and width. But the speeds at which they plant trees are amazing.



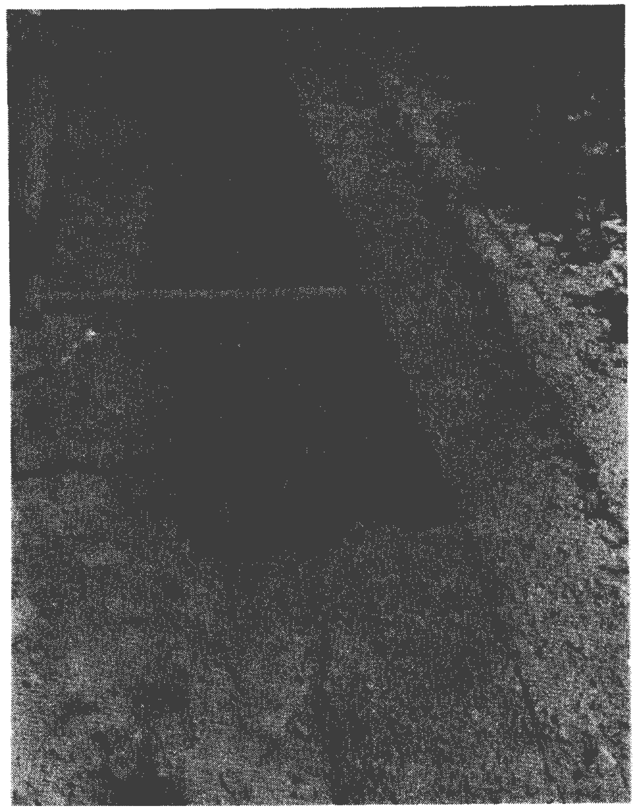
The technique is simplicity itself-the board is merely laid with its metal flange projecting out over the already opened trench (which has one side perpendicular, or nearly so) and the seedlings are then threaded into the notches by the worker who placed the board. A second worker then fills the trench and while he is firming the soil the first worker lifts the board and carries it to the end of the line to place and fill it again. Each worker carries his own supply of seedlings wrapped in a wet rag or some other convenient carrier. Under this system the roots are exposed to the air for only the few seconds required for threading the board and filling the trench. The system works well for a large, well-organized crew or for a person working alone.

Inspection to insure against unsatisfactory root placement is easy when such an open trench is used, for if the trench is so shallow that roots must be doubled back upon themselves the fault is readily observable.



The nursery pictured is operated by a forest district (Bad Grund) in the State of Lower Saxony to produce about 100M 2-2 spruce transplants annually. No power machinery is available and opening the trenches by hand is the most practical way.

The forstmeister insists upon wide spacing (about 4 x 8 inches) and the highest possible standard of performance in order to grow trees of maximum quality. This wide spacing requires that the workers fill and move many more boards per thousand plants than is the case at commercial nurseries where trees are grown at closer spacing. As a result these workers, including the trench digger who was also the foreman, were averaging only 3,000 trees per 9-hour working day.



At the very large commercial nurseries the trenches are opened by power machinery, the trees are spaced much-more closely together, and work standards, while satisfactory, are somewhat lower than at the forest districts' little local nurseries. At a commercial nursery in Lower Saxony, the work is paid for at piece-work rates and the best workers are said to achieve speeds of 18,000 trees per 9-hour day. The average worker plants 14,000 per day. A worker who cannot sustain a 12,000 speed is discharged because one cannot earn a living wage planting at a lesser speed. At a commercial nursery I visited in Holstein, the same average speeds were achieved, a crew of 35 workers planting half a million trees in 9 hours.

COTTONWOOD SEEDING AT THE MASON STATE TREE NURSERY

Hugh B. Wycoff, Nursery Superintendent
Mason State Nursery, Illinois Department of Conservation,
Topeka, Illinois

Our cottonwood beds are 42 inches wide inside, boxed in with 1 x 6 native lumber. Two rows of 1 x 6 bedboards are also used to divide the bed lengthwise into 14-inch strips. These interior boards serve as baffles to keep the cotton from drifting to the sides of the bed.

The 1 x 6 frame is covered with standard snow fence. The cottonwood catkins are hung from the snow fence wires. We hang a catkin in each space between laths in each of the three strips. This provides a row of catkins over each strip with the catkins about 3 inches apart in each row. Six-inch spacing would probably be sufficient with good catkins. The pods can also be stripped off the stems and scattered on the dry bed surface to open. When the humidity is low ripe pods open rapidly.

Burlap or Erosionet is placed over the snow fence to confine the cotton. The pods open under this covering. We do not start irrigation until sufficient seed has been dispersed on the surface of the bed. Once irrigation is started it is very important to keep the bed wet for several weeks. The covering is removed after the seedlings are established sufficiently to withstand heavy rain and other weather conditions.

Ripe cottonwood seed is creamy white; seed with a greenish cast is not ripe nor will it germinate well. With good seed we get too many seedlings. These can be thinned by removing the boards and placing the snow fence on the surface of the bed until the laths smother the seedlings under them. Additional thinning may be done with a cultivator or by hand.

Some wind action during seed dispersal is desirable, but too much will drift the cotton. We sometimes fan the cotton with apiece of cardboard to get better dispersal.

In a sheltered location where there is not much wind, and seeding of adjacent areas is not a problem, branches bearing catkins of seedpods may be scattered over the beds to be seeded. The pods will open and sow the seed. The paths and adjacent areas can be tilled to eliminate unwanted seedlings.

We find it necessary to use an insecticide, such as malathion, for beetles and a fungicide, such as captan, for leaf spot. Cottonwood seedbeds are fumigated prior to sowing to minimize the weed problem arising from the frequent irrigation and the slow initial growth of cottonwood seedlings.

NURSERY PRACTICE FOR GROWING SYCAMORE SEEDLINGS

Frank Vande Linde, Research Forester
Brunswick Pulp and Paper Company
Brunswick, Georgia

Our nursery is divided into two fields which are rotated each year- -each field growing a crop of pine seedlings every other year. The hardwood seedlings are grown in the field where the cover crop is sown. The reason for this is to eliminate damage from mineral spirits used to control weeds in the pine.

Site preparation for the hardwood nursery beds was the same as that for pine. One to 1 1/2 inches of sawdust was turned under to a depth of 8 to 10 inches. The area was then disked well to break up clods and smooth the soil for fertilizer application. A fertilizer mixture of 1,000 pounds of super phosphate, 100 pounds of lime, 400 pounds of potash, 200 pounds of ammonium nitrate, and 8 pounds of chlordane was added per acre. The area was completely disked again and followed by a rotivator which mixed thoroughly the fertilizer with the soil. The soil was dragged to level uneven areas and then a bed shaper prepared beds 4 feet wide and 3 to 5 inches high, similar to those prepared for pine seedlings.

Two methods are used to sow sycamore seed. In the first, seed are drilled in rows running perpendicular to the length of bed. These rows, 4 inches apart, are shallow with just enough soil added to cover seed. After sowing, the bed is mulched with pine straws to prevent erosion and desiccation.

In the second method, the sycamore seed are hand broadcasted and raked into the soil with a garden rake. The planted bed is mulched with pine straw.

Both methods have given favorable results, but a third method--broadcast the seed by hand and press into the soil with a roller--should be tried. Since germinating seed need a great deal of light, this would probably be the best method.

Sycamore seed should be sown at a high rate since they have a low germination percentage. My seed were estimated to be 30 to 40 percent viable. I was striving for 25 to 30 seedlings per square foot. Last season I ended up with approximately 26 seedlings per square foot. This season there are approximately 32 to 35 seedlings per square foot, but they are only 2 to 3 inches high. The count will probably be close to 30 per square foot at lifting time. Several seedlings will be lost through the weeding process. A count of 25 seedlings per square foot would be my recommendation for quality sycamore seedlings.

Shading is not required to grow sycamore seedlings. A total of 65 pounds per acre of ammonium nitrate was hand broadcasted in three light applications (June 26, July 25, August 29).

Weeds were pulled several times during the growing season. Neddless to say, this was a difficult and time-consuming job. Weed pulling could possibly be reduced by treating the soil with weed killer prior to planting.

The seedlings were watered twice weekly with 1 inch of water each time.

There was no noticeable damage to seedlings due to insects and disease.

The seedlings were lifted for planting in January. They had a vast, spreading root system and had to receive severe root pruning before planting.

The seedlings ranged up to 18 inches high, averaging 12 to 15 inches at time of lifting.

NURSERY GROWN SYCAMORE SEEDLINGS

MAKE EXCELLENT GROWTH IN PLANTATIONS

Some sycamore seedlings were grown in the Brunswick Pulp & Paper Company nursery and planted in an old field during the 1957-58 planting season. Results after the first growing season show considerable promise. Ninety-nine percent of the seedlings are surviving and putting on excellent height growth. Heights up to 6.7 feet were tallied with an average height of 3.2 feet for all seedlings.

Sycamore has the ability to adapt itself to a wide range of site conditions throughout the South. It reproduces naturally and makes excellent growth in even-aged stands.

Plantation management for this species looks very favorable.

SOIL FUMIGATION EVALUATIONS IN WHITE PINE SEEDBEDS AND OTHER NURSERY INVESTIGATIONS

C. L. Morris, Chief
Forest Insect and Disease Investigations, Virginia Division of Forestry
Charlottesville, Va.

General

In 1956 extensive evaluations of various fumigants and fungicides was completed at the east nursery at New Kent [1] and at the Charlottesville nursery. A complete report of the results of these trials is available in mimeographed form, entitled "Forest Tree Nursery Investigation--1956-57", March 26, 1958. These evaluations were part of an overall investigation into the causes of annual midsummer mortality of 1-year white pine seedlings at New Kent. A particularly favorable growing season in 1956 which resulted in only minor differences between treatments, and the failure of any of the materials tested to reduce midsummer mortality, resulted in a tentative conclusion that none of the fumigants or fungicidal drenches evaluated at New Kent was "financially" feasible. Nonetheless, all seedbeds planted to white pine in 1957 were drenched with Vapam (60 gal. per acre). Again we experienced the usual loss of from 20 to 30 percent of the germinated seedlings in late June and early July.

By this time it became increasingly apparent that either the fumigants used were ineffective or a physiological condition was responsible. Small scale shading plots and various mulching materials (including pine needles, chopped straw, and sawdust) were compared in 1958; there was no apparent reduction in the midsummer mortality by use of any of these cultural methods. Shading, unless it is extended over large areas, could well be ineffective in reducing heat damage because of free movement of hot air beneath the shades.

Fumigant Evaluations

In 1959, all nursery production was moved to a newly created "west" nursery at New Kent which had been carved out of a mixed pine-hardwood area in 1956. Limited planting of loblolly, shortleaf, Virginia, and white pine seed had been made in this new area in 1957 and all stock--white pine in particular--was stunted and generally inferior.

In order to investigate the desirability of fumigation of white pine seedbeds in this new nursery area, an evaluation of methyl bromide (as a gas) and Vapam (as a soildrench) was planned for spring 1959. Last minute arrangements with Bob Harrison and Dow Chemical's demonstration unit allowed us to include a series of test beds with three Dow products in several concentrations. A series of comparative evaluations of methyl bromide, formaldehyde, and Vapam were made concurrently at the Charlottesville Nursery.

Brozone (containing 68 percent liquid methyl bromide, 2 percent chloropicrin, 30 percent oil as a carrier), Dowfume MC-2 (as a gas through a tractor-mounted vaporizer) and Trizone (one of the newer Dow liquid fumigants) were all applied mechanically by the Dow crew on April 8 and the beds covered with polyethylene sheeting in one operation by an ingenuous tractor rig. The Vapam was applied April 17 at New Kent (along with two beds treated by hand with methyl bromide gas) as a drench in water; a total of 25 gallons of liquid was applied to 400 square feet of seedbed surface. The same drenching method and rate of application were followed at the Charlottesville nursery in the comparative series established on April 10.

Plastic covers (2 or 2.5 mil) were utilized with all fumigants except the Vapam and formaldehyde drenches. These covers remained on the seedbeds at New Kent for 48 hours;

[1] 20 miles southeast of Richmond. Va.

at Charlottesville--where the methyl bromide was vaporized--they remained on the beds only 12 hours. Seed stratified for 3 weeks was planted 10 days following all treatments at both nurseries.

Soil temperature at the time of machine application of the Dow products on April 8 at New Kent was approximately 65^0 F. Soil temperature at Charlottesville on April 10, when all fumigants were applied, was 63 F.

Soil moisture at New Kent was ideal; i.e., beds workable but still quite moist. At Charlottesville, the beds were somewhat drier in the surface two inches than was considered ideal for fumigation. The results indicate, however, this fact probably did not reduce effectiveness of the methyl bromide fumigation.

The strong differences in soil types involved in the fumigant trials are worth mentioning:

The west or Holly Landing section of the nursery where trials were carried out at New Kent is a very sandy soil. The older section, where fumigation was evaluated in 1956-57, is a "medium loam" (State Chemist's evaluation). The soil at the Charlottesville nursery is classified as a Cecil loam (VPI, 1953).

TABLE 1.--Surviving 1-year white pine seedlings in fumigated and unfumigated beds, west section, New Kent nursery, 1959

Treatment and rate of application	Location		Living seedlings per square foot[1]		
	Bed	Section	6/4/59	7/23/59	9/16/59
Dow Brozone (by injection):			*Number*	*Number*	*Number*
1/2 lb./100 sq. ft.	1	V	23.1	15.0	15.1
1 lb./100 sq. ft.	2	V	[2] 8.1	[2] 3.8	--
Dowfume (methyl bromide as gas by machine):					
1 lb./100 sq. ft.	3	V	14.5	13.1	10.4
1/2 lb./100 sq. ft.	4	V	30.8	16.4	16.0
Dow Trizone (liquid by injection):					
65 gal. active/acre.......................	5	V	35.6	22.6	21.3
50 gal. active/acre.......................	6	V	32.4	25.0	21.8
Dow Trizone (liquid by machine), 35 gal. active/acre.......................	7	V	40.0	30.0	22.1
Dowfume (methyl bromide as gas by hand vaporizor), 1/2 lb./100 sq. ft.	7	U	15.3	11.3	[3] 8.1
Vapam 4-S (as drench):					
60 gal. active/acre.......................	8	V	35.6	25.1	17.2
60 gal. active/acre.......................	5	U	27.6	13.8	12.4
Check (untreated).........................	9	V	12.9	6.2	--
Check (untreated).........................	9	U	--	7.8	6.7

[1] An average of (12) 4 ft.^{2} samples each treatment.

[2] The poor showing of Brozone in this treatment probably due to failure of material to dissipate completely prior to planting plus an unusually heavy mulch of sawdust following seeding.

[3] Replication of this treatment in Bed 8, Sec. U averaged 9.8 seedlings/sq. ft. this date.

The evaluation of the effectiveness of the various fumigants was made through periodic counts of surviving seedlings in treated and untreated beds throughout the summer of 1959. These counts for New Kent are shown in table 1. Similar counts in white pine seedbeds at the Charlottesville nursery are given in table 2.

One factor complicated the task of evaluation at Charlottesville. All pine seed was treated prior to planting with Dow Latex 512-R Sticker (1-9 diluation) and Arasan-75 for bird repellency. This treatment with a seed protectant strikingly reduced losses due to pre- and post-emergence damping-off fungi which had always been an annual problem with white pine at Charlottesville. Since all seed was treated, we can only assume that the unexpectedly good germination and survival of white pine in the "check" beds in table 2 were due to the seed treatment.

The white pine seedbeds involved in the evaluations at New Kent were confined to two "sections" (a section comprises nine 400 x 4 ft. beds) located on level land, while those at Charlottesville included four on comparatively level ground with the remainder running parallel to the contours on a 4-5 percent slope. Table 2 gives the average of all the sampling counts taken in four 100-ft. beds of each treatment on all positions of the slope. Differences between the fumigated and the check beds became more apparent on the lower slope beds where the soil is more eroded and compact.

The survival of white pine on the upper beds at Charlottesville is comparable regardless of treatment. As mentioned earlier, this fact is probably due to the preplanting treatment of seeds with thiram for bird repellency. The striking difference was apparent in the size and color of the seedlings in the treated beds. Seedlings in the Dowfume (methyl bromide as gas) and formaldehyde treated beds were comparable in appearance throughout the summer, were almost twice as tall as those from Vapam treated or check beds, were much more vigorous appearing, and maintained a dark green color. The differences in color were much less apparent by October of the first growing season. The size differential was still quite evident, however.

Differences in survival in treated and untreated beds at the New Kent nursery were much more striking. Here we lost 40-50 percent of the germinated seedlings regardless

TABLE 2.--Surviving 1-year white pine seedlings in fumigated and untreated beds, Charlottesville nursery, 1959

Treatment and rate of application	Location[1] (bed #)	Surviving seedlings per sq. ft.[2]	
		6/25/59	10/25/59
Methyl bromide[3], 3/4 lb./100 sq. ft.[2]	1, 5, 9, 13	33, 29, 28, 41 (33)	31, 21, 27, 44 (31)
Vapam 4-S, 60 gal./acre (in 25 gal. water per bed).....	2, 6, 10, 14	31, 28, 30, 38 (32)	25, 27, 25, 34 (28)
Formaldehyde, 37 percent, 340 gal./acre (in 25 gal. water per bed).............	3, 7, 11, 15	28, 24, 28, 36 (29)	23, 25, 29, 32 (27)
Check (untreated)...........	4, 8, 12, 16	30, 16, 30, 24 (25)	30, 15, 29, 22 (24)

[1] 100' long beds numbered consecutively from top of slope to bottom.
[2] Average of the (24) 4-ft.[2] samples in the 4 treated beds in parenthesis.
[3] Applied by hand and vaporized by dropping cans into hot water after puncturing.

of treatment. This same condition was experienced in the 1956 and 1957 trials. Dow Trizone, even at the lowest rate (35 gal. active/acre), was consistently superior to all other treatments. Vapam, as was the case at Charlottesville, produced a good starting crop but these seedlings were chlorotic and stunted in comparison with those in the Trizone treated beds.

Other Concurrent Investigations

High soil surface temperature was suspected since 1957 as being the major cause of 1-year white pine seedling mortality at New Kent. Tempril temperature pellets which melted at 125° F., 138°, and 150° were placed in the seedbeds on July 15, 1958. Periodic readings indicated that although 125° was probably reached in several cases during the summer, the pellets were placed too late in the season to catch the critical period in late June.

In 1959, pellets were placed in six areas under various mulching conditions on June 15. An examination on July 2 showed the above ground portion of 138° pellets had disintegrated in one area in the east nursery and one area in the west nursery. In both cases these pellets were in the sawdust mulch which covered portions of the beds. Surface temperatures of exposed soil in adjacent beds reached 1250 F. but did not get as high as 138°. A second series placed at New Kent on August 1, showed late season temperature failed to reach 1250.

Extensive heat damage to loblolly pine seedlings was experienced during 1959 in a number of the southern nurseries. Dr. Charles Hodges, of the Southeastern Forest Experiment Station, visited the New Kent nursery on September 4 and concurred that heat damage was probably the main cause of mortality. Such fungi as Sclerotium bataticola and Fusarium sp., which have been isolated several times from dying roots of 1-year white pine at New Kent in the past several years, no doubt contribute to the decline following weakening by heat.

Delayed Germination and Survival on Treated Beds

Because of the short period of stratification this year, seedlings continued to germinate throughout the summer season following periods of wet weather. On July 28, approximately 100 newly germinated white pine seedlings were staked in fumigated and unfumigated beds to check subsequent survival. It was interesting to note that only a very occasional seedling germinated in the Trizone treated beds, the material having apparently stimulated almost complete initial germination. The following counts were made on August 14. Percent of seedlings still living is also given.

Treatment	Location		Living		Dead
	Bed	Sec.	No.	Percent	No.
Check..........................	9	U	11	44	14
Check..........................	9	V	18	47	20
Dowfume (½ lb., by hand)	7	U	10	43	13
Vapam........................	8	U	3	13	19

There was little apparent difference between the survival of late -germinating seedlings in seedbeds treated with the several fumigants checked.

Relationship Between Soil Fungi and Vigor

In February 1959 a series of soil samples were taken at New Kent (east nursery) in an attempt to correlate soil fungi with seedling vigor. The only relationship apparent from soil dilution plates was the predominant population of Tricoderma spp. in soil supporting vigorous seedlings in beds drenched with allyl alcohol in spring 1958 and the great variety and large number of fungi isolated from untreated soil supporting seedlings of poor color and vigor. Conversely, other soil samples from spots in untreated beds supporting excellent seedlings yielded only a small number of fungus colonies.

Nematodes

A nematode survey in white pine seedbeds in the east nursery at New Kent was made in 1956. No parasitic nematodes were found at that time. Soil samples from two unfumigated areas in the west nursery were taken in August 1959 and analyzed by W. H. Matheny, Assistant State Entomologist, and he reports that from a 5-tablespoon soil sample from 1-year white pine beds (planted for first time this year) he found 50 saprophytes and one Aphelenchoides. "The latter is not considered of any consequence as far as tree seedlings are concerned." In a similar sample of soil from 1-year loblolly pine beds (planted for the first time this year) he found six saprophytic nematodes and two Neotylenchus. This latter nematode is suspected of feeding on fungi and algae in the soil. Matheny states further that: "The lack of saprophytic nematodes usually found in abundance as a natural part of the fauna indicates that some unhealthy condition must prevail."

Soil Analyses and pH

Annual soil tests are made at our nurseries by the State chemist. When a pH of 4.5 was noted in the west nursery in 1958, ground limestone was applied in spring of 1959 prior to planting. A series of twenty pH tests with a small colorometric kit on August 14, 1959, indicated the average pH at that time was 6.2. Additional potassium was also added in 1958 and 1959, when this element was found deficient.

Weed Control

Limited test with Neburon during the past several years has indicated its possible use in post-emergence weed control in the forest tree nursery. On July 2, a water suspension of Karmex-N (50 percent Neburon) was applied to two sections of 1-year loblolly pine at the rate of 4 pounds active per acre. A Hardie boom-type pressure sprayer was used to apply 100 gallons per acre at 80 p.s.i. Subsequent observations indicated this rate caused the death of only an occasional smaller-than-normal seedling in the treated beds. Since normal weed emergence suffered a sharp decline by July, no attempt to evaluate the degree of weed control was made.

Summary

Dow Trizone proved to be the outstanding soil fumigant evaluated at the west section of the New Kent nursery in 1959. The importance of fumigation in "new" soil was pointed up by the survival figures.

Heat injury is presumed to be the main cause of annual white pine seedling loss in late June-early July at the New Kent nursery. Soil surface temperatures were found to have reached 138^0 F. at least once between June 15 and July 2.

Methyl bromide released under plastic seedbed covers at the rate of 3/4 lb./ 100 sq. ft. by immersing the pressurized cans in a hot water bath produced excellent seedling stands of white pine at the Charlottesville nursery. Formaldehyde as a soil drench was about equally effective, but the high cost of this latter material must be taken into consideration. Vapam in the test this year at Charlottesville was relatively ineffective. These fumigant evaluations point out the Importance of finding the most suitable material for the particular soil in question.