EXPERIMENTAL FARM PLANTINGS OF ASIATIC CHESTNUTS

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Foresters and farmers often ask the following questions about Asiatic chestnuts: Can they produce nuts and timber? Are they resistant to the blight? Where and under what conditions do they thrive?

In the spring of 1939, the U.S. Department of Agriculture, through its Soil Conservation Service and Bureau of Plant Industry, Soils, and Agricultural Engineering, furnished 132 Pennsylvania and West Virginia farmers about 3,000 one- and two-year-old Asiatic chestnut trees of Chinese, Japanese, and mixed parentage.

Each farmer received from 10 to 25 trees, and was advised about their planting and care by a local S.C.S. farm forest technician. The important points stressed were: A, the selection of a suitable planting site--one that would be favorable to some of our better native hardwoods, if planted; and B, the vulnerability of chestnuts to severe damage by rabbits, deer, and livestock, necessitating screening or fencing until trees reached a height of 10 to 12 feet. Planting chestnuts, it was pointed out, required no special skill and was no more difficult than planting young fruit trees.

In June 1947, 8 years later, a survey was made of fifty of these plantings. The survey afforded an opportunity to observe the practices, errors, and hazards that made the establishment of chestnuts on individual farms a success or a failure.

Of the 50 farm plantings inspected, 25 showed satisfactory disease resistance and growth; the other 25 were complete failures. The ten best plantings occurred on deep, fertile soil with good moisture conditions. Aspect and slope were of little importance. A high survival percentage, rapid growth (about 11 feet average height), good form, and freedom from disease characterized these promising plantings. The survey also revealed the superiority of Chinese chestnuts to Japanese or mixed varieties.

Poor site selection was responsible for at least 25 percent of the mortality among the plantings that failed. The application of fertilizer could not offset the harmful effects of this error. Suppression by overstory hardwoods and competition from sprout hardwoods accounted for 14 percent of the failures. Damage caused by livestock, principally cattle, contributed to 6 percent of the failures. Some farmers allowed cattle to graze among successful chestnut plantings after the expiration of their 5-year SCS fencing contract. The current high market prices for cattle, they felt, did not justify withholding fine agricultural land for forestry purposes.

In June 1959, 20 years after the experiment had started, a visit was made to six of the plantings in West Virginia that looked promising in June 1947. At the first stop, the chestnuts had only recently been annihilated as a result of a local strip-mining operation. At the second stop, the chestnuts were completely suppressed by the older competing native hardwoods, among which they had been planted. No releasing had ever been done.

Inspection of the remaining four plantings, all in Marshall County, W. Va., was highly rewarding. Over 80 percent of the trees had survived. These averaged 8 inches in diameter and nearly 28 feet in height. Because the chestnuts had been planted in the open, the crowns assumed the shapes of orchard trees rather than forest trees (figs. 1 and 2).

The farmers were well pleased with their experimental Asiatic chestnuts. The trees are now bearing nut crops ranging from a peck to nearly a bushel, and are expected to progressively increase their yields from year to year. Some farmers have standing orders for nuts at 50 cents per quart in their local community. The four cooperators felt that the Department of Agriculture had done them a good deed in introducing the Asiatic chestnut, particularly the Chinese variety, to their lands.

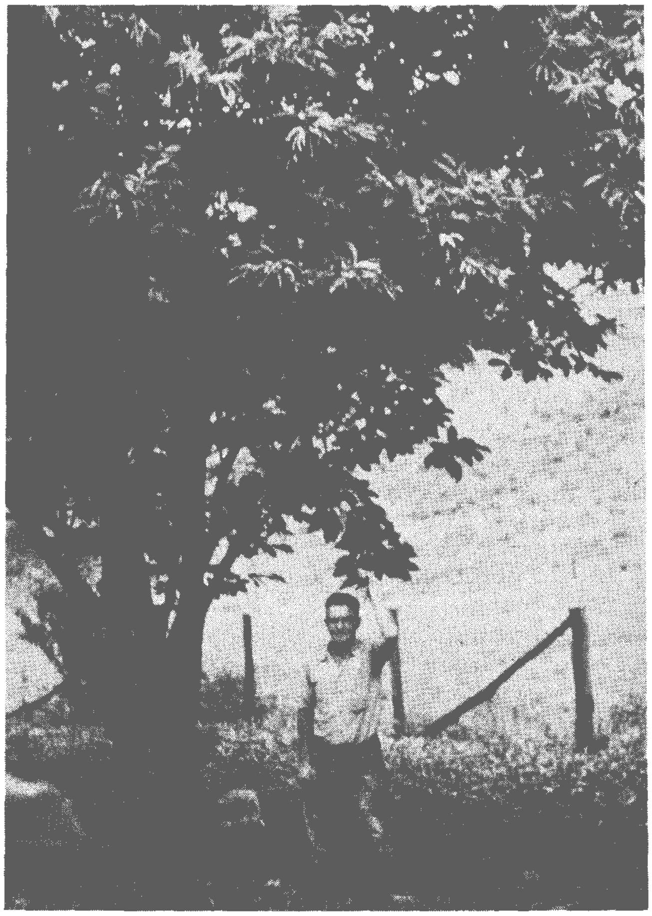

Figure 1.--A West Virginia farmer and two of his eight 20-year-old Asiatic Chestnut trees, which were furnished for an experimental planting by the U.S. Department of Agriculture in spring of 1939. The trees, planted in orchard formation are now bearing yearly crops of nuts.

Figure 2.--Another West Virginia farmer, with his grandson, and the row of Asiatic chestnuts which he planted 20 years ago. These trees are each year bearing increasingly heavier yields of nuts. His only regret, "I wish someone had told me to plant these trees farther apart".

WHAT'S YOUR SURVIVAL?

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What is the survival of last season's planting? This pertinent question is often foremost in the minds of foresters and others engaged in large-scale tree planting.

This paper describes sampling techniques that will provide reasonably satisfactory estimates of first-year pine survival at minimum cost and effort. It is based on 5 years experience in determining first-year survival of pine plantings within the Yazoo-Little Tallahatchie flood prevention project area. Fifty million loblolly seedlings are planted annually within the 19 north Mississippi counties in this flood prevention project.

The first step is to decide just what information is needed. In the following discussion it is assumed that a survival estimate of all planting is sufficient. It may be desirable to make comparisons between categories such as openland and conversion planting, or machine and hand planting. These breakdowns increase the sampling required, but the procedure for obtaining a valid estimate for each category is identical.

The second step is to compute the approximate number of plantations that will have to be sampled for an estimate likely to have the desired reliability. On the Yazoo-Little Tallahatchie project, 10 circular 1/100-acre plots are taken on each plantation sampled. It has been found over a period of years that the standard deviation (based on the total number of trees planted) for sets of 10 circular 1/100-acre plots rarely exceeds ± 20 percent regardless of survival. With this value and a tolerable error of ±10 percent of mean survival (meaning that unless a 1-in-3 chance has occurred the survival estimated will be ±10 percent of the true average), the minimum number of plantations that will need to be sampled depends directly upon the expected survival:

Expected survival	Minimum number of plantations required
(percent)	
30	45
50	16
70	8

The number of required plantations is estimated from the formula $n = (SD/TE)^2$, where SD is the standard deviation in percent (20 percent), and TE is the tolerable error--10 percent of the expected survival in this discussion.

An approximate survival percent is usually known to the practicing forester or can readily be determined by a cursory field check late in the summer.

The third and last step is to compile a list of all current plantations and to select those to be sampled. On the Yazoo-Little Tallahatchie project, currently planted acreage on each individual ownership is mapped and listed as a single plantation.

To eliminate the necessity of weighting plot data in the computations, plantations to be sampled should be randomly selected from the list, with probability of selection proportional to the area planted. One method is to accumulate the acreage in the list of plantations and compile an inclusive acreage column as in the example below. Numbers ranging from 0 to the total acres planted are then drawn at random. A plantation is sampled if the number drawn falls within its inclusive acreage. In the example, the number 047 tells us to sample the plantation whose inclusive acreage is 26-55.

Plantation size	Accumulative acreage	Inclusive acreage	Random numbers
(acres)			
20	20	0-20	018
5	25	21-25	
30	55	26-55	047
8	63	56-63	
116	179	64-179	087, 146
etc.	etc.	etc.	
	965 (total acreage planted)		

Sampling is with replacement; i.e., any plantation can appear more than once in the sample. In the example above, the fifth plantation was drawn twice; it would therefore be regarded as two samples in the computations, although in practice it would be sampled only once.

Field Procedure

The 10 plots to be sampled in each plantation may be located at random, but for convenience are often taken on a systematic grid. Aerial photographs are invaluable both to delineate the plantations and to decide on a grid spacing that will adequately cover them. Ideally, each 1/100-acre plot within the plantation should have an equal chance of being sampled.

Individual plots can be located by pacing with a hand compass. A staff is set at the plot center and a tape exactly 11.78 feet in length is used to measure the plot radius. A ring at the end of the tape permits it to turn freely on the staff and thus speeds the task of checking borderline seedlings.

The number of seedlings planted and the number of living seedlings are recorded for each plot. The survival on each plantation is computed as the ratio of the total number of living seedlings to the total number planted on the 10 plots. The survival for all plantings, or for any given cateogry of planting, is the average survival of the plantations sampled.

After each annual sampling it is advisable to calculate the relative standard error (in percent of mean survival) and the absolute standard deviation (in percent of total trees planted). The former will indicate if the results are within the desired ±10 percent limits of accuracy, the latter will show if the ±20 percent figure used as the standard deviation is adequate for future sample design. The standard deviation is computed as $\sqrt{\frac{\Sigma X^2 - (\Sigma X)^2/n}{n-1}}$, where the X's are the survival percents on the n plantations sampled. The standard deviation divided by square root of n estimates the standard error. Because sampling is with replacement, no correction for finite population is needed for computing the standard error. A more exact estimate of the standard error could be obtained by using a correction for within-sample variability, but such refinement is rarely worth the additional effort.

Plots may be permanently staked for future examination. Although seedling losses after the first year are usually negligible, the plots may also be a convenient means of collecting data on such topics as growth, tip-moth infestation, hardwood competition, or effect of time of planting. In north Mississippi, for example, there is evidence that survival of seedlings planted in February is higher than survival of seedlings planted **earlier** or later.

COPPER CARBONATE--BOON OR BANE?

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Copper carbonate, a chemical frequently used to repel rabbits from outplanted southern pine seedlings, appears to have caused high seedling mortality in north Mississippi. In a recent test of rodent repellents, loblolly seedlings treated at the nursery with copper carbonate and then baled and shipped to the planting site suffered considerably more first-year mortality than did untreated seedlings. Independent survival counts of copper-treated seedlings planted elsewhere in north Mississippi also showed above normal mortality.

In the test, five separate repellents containing copper carbonate, each mixed with a different emulsifiable sticker, were compared with untreated controls. The repellents were formulated with the recommended concentration of 80 pounds of copper carbonate (55 percent metallic copper) per 100 gallons of water-emulsion mixture, and were applied by high-pressure spray. The treated seedlings were lifted from the nursery beds, packed in Forest Service bales, and transported to the planting site, where they were planted within 48 hours of being baled.

Five hundred seedlings were planted early in December 1957 and an equal number early in January 1958. Individually numbered seedlings were examined at monthly intervals through April 1958 and again at the end of the growing season, in October. The results of these examinations are summarized in table 1.

TABLE 1.--Mortality of loblolly pine seedlings sprayed at the nursery with copper carbonate

Examination date	Copper carbonate in mixture with emulsions of:					Un-treated control
	Oil	Wax	Asphalt	Plastic	Latex	
April 1958	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
December planting.........	14	7	26	15	8	0
January planting..........	11	4	13	6	4	0
Total planting..........	13	6	19	10	6	0
October 1958						
December planting.........	19	27	53	40	31	8
January planting..........	58	50	48	35	28	10
Total planting..........	39	38	50	38	30	9

Seedlings treated with copper carbonate in asphalt emulsions, the most frequently recommended repellent, suffered the highest mortality, 50 percent. The copper-latex mixture seemed least harmful, mortality of seedlings treated with it being 30 percent. Although there appeared to be a considerable variation among the sticklers, the differences proved to be statistically nonsignificant. The overall year-end mortality of seedlings treated with copper carbonate averaged 39 percent, whereas that of the untreated seedlings averaged 9 percent.

In April 1958, an examination was made of some nonstudy seedlings (planted during December 1957 and January 1958) to determine the extent and severity of what at first appeared to be cold-weather damage. The seedlings had been treated with the copper-asphalt rabbit repellent. Of the more than 2,500 seedlings examined in April, 37 percent were green, 38 percent were brown but had green buds, and 25 percent were dead. By October, 57 percent of the brown seedlings and 26 percent of the green seedlings had died--a total year-end mortality of 58 percent.

Another independent measurement of mortality associated with the copper carbonate repellent was found in the survival figures of seedlings planted on the Yazoo-Little Tallahatchie flood prevention project during the 1957-58 planting season. Over 5,500 seedlings planted from December 1957 to March 1958 were examined in October 1958. The mortality averaged over 36 percent for the entire planting season. This figure and the "cold-weather" mortality of 58 percent substantiate the findings of the repellent test.

One unusual feature, apparent in April and associated with these high mortality rates, was browning. This is somewhat similar to winter kill.

Though copper carbonate is quite insoluble in water, it appears that toxic doses can be assimilated over a prolonged period in a saturated environment. Baling seedlings for storage or transport seems to provide such an environment. Duncan and Whitaker[1] reported virtually no injury to slash pine seedlings treated with the, copper-asphalt repellent shortly before planting but noted serious injury to those that had been treated and then baled for several days prior to planting.

It appears that copper carbonate should not be applied to seedlings in the nursery. Its use should be reserved for on-site applications by top-dipping or spraying. Where nursery application is the only measure deemed economically feasible, compounds other than copper carbonate should be used.

[1] Duncan. D.A.. and Whitaker, L.B. Repellents reduce cattle browsing on pines. U.S. Forest Serv. South. Forest Expt.. Sta. South. Forestry Notes 119. 1959.

DEEP PLANTING HAS LITTLE EFFECT IN A WET YEAR

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Deeper than normal planting has been advocated to enhance pine seedling survival in dry years, especially where small stock is used.

In February 1957, undersized slash and loblolly seedlings were planted to three depths--normal, half-stem, and deep--in a Texas field where Bermuda-grass and weeds competed heavily for moisture. Seedlings were set as they grew in the nursery for normal depth, with the base of the bud at ground level for deep, and halfway between these positions for half-stem depth. The soil was Cahaba fine sandy loam.

The seedlings represented standard grade 2 and three substandard grades: 3a (stems with slightly under 1/8-inch diameters, 5-inch tops and good roots); 3b (stems with about 3/32-inch diameters, 5-inch tops, moderate roots); and 3c (stems with 1/16-inch diameters, 4-inch tops, poorly developed roots). Planting was done by machine in furrows made by a 12-inch middle buster. Survival and tree growth were observed on three randomized blocks, each containing one 25-tree row of each of the 24 species-grade-depth combinations.

Rainfall of 63.7 inches was 16.7 inches above normal, but 26 rainless days caused a June-July drought, and 39 nearly rainless days in July and August subjected the seedlings to temporary moisture stresses.

Deep planting reduced survival for both species, though for slash the differences were not significant. Among loblolly seedlings, survival was 41 percent for those planted normally, 34 percent for those planted to half-stem, and 23 percent for those planted to the bud. During this season, neither of the deep plantings was beneficial to the smaller seedlings of either species.

When all planting depths were averaged, survivals of both species were significantly related to seedling grade. Among loblolly seedlings, survival of grade 3c--42 percent-was significantly inferior to that of all other grades; survival of grades 2 and 3a--63 and 64 percent, respectively--was significantly above that for grade 3c. Slash pine survival was more variable, but the 18 percent for grade 3c was significantly lower than the 46 percent average for grade 2. Average survival of grade 2 seedlings was 46 percent for slash and 63 percent for loblolly.

Height growth during 1957 averaged somewhat greater on deep-planted than on normally planted seedlings. Differences, however, were not significant for loblolly, and barely significant for slash. Despite their greater elongation, deep-planted seedlings still had less total height above ground at season's end than those planted to normal depth. Growth of both species was best on grade 2 seedlings and decreased with each poorer grade, but the differences were not statistically significant.

While the relatively moist season prevented a good test of the drought-hardiness of deep-planted seedlings, the results suggest that deep planting may have a slightly adverse effect in rainy years. Some of the deep-planted seedlings that died had been buried by silt from excessive rains. The slightly better growth of surviving deep-planted seedlings may be a favorable response to deeper root placement that, in a drier season, could have improved survival.

1 East Texas Research Center, maintained in cooperation with Stephen F. Austin State College, Nacogdoches, Tex.

REPLACEMENT POINTS FOR TREE PLANTING MACHINE

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The Virginia Division of Forestry was having difficulty extending the life of a vital part of their tree planters--the point. One solution was to treat the steel points with hard surfacing welding rod. This helped, but increased the cost. Then iron castings were tried and appear to be satisfactory (fig. 1). A check on use records for last winter indicates that the cast iron points were still usable after planting sixty to eighty thousand seedlings in typical Piedmont Virginia soils. The Division has been working with cast iron points of one type or another for over 5 years. The foundry handling the job for the Division is located at Waynesboro, Virginia. The approximate cost per point is $1. These are for Lowther type planters.

Figure 1.--Steel and cast iron points shown by Tom Turner, Nursery Superintendent.

CULTIVATION TOOLS FOR NEWLY ESTABLISHED WINDBARRIERS IN NORTH DAKOTA

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Clean cultivation of newly planted windbarriers is absolutely essential to the satisfactory survival and development of trees in North Dakota. We have found that over-the-row cultivation of these windbarriers during the first year or so is perfectly feasible with any of several common farm implements, such as a hay rake (fig. 1), Melroe-type harroweeder (fig. 2), finger weeder, or spring tooth harrow. Trees with an upright habit of growth, such as green ash, American elm, and caragana, can safely be cultivated in this manner for 3 or 4 years, depending upon the type implement used. Those with a spreading type growth, such as Siberian elm, Russian olive, or willow, can be cultivated in this manner for at least the first year.

Farmers and ranchers appreciate the over-the-row cultivation because it can be done from the tractor seat without additional manpower other than the tractor driver. The secret of the system is to cultivate when the weeds are one-half inch high or less.

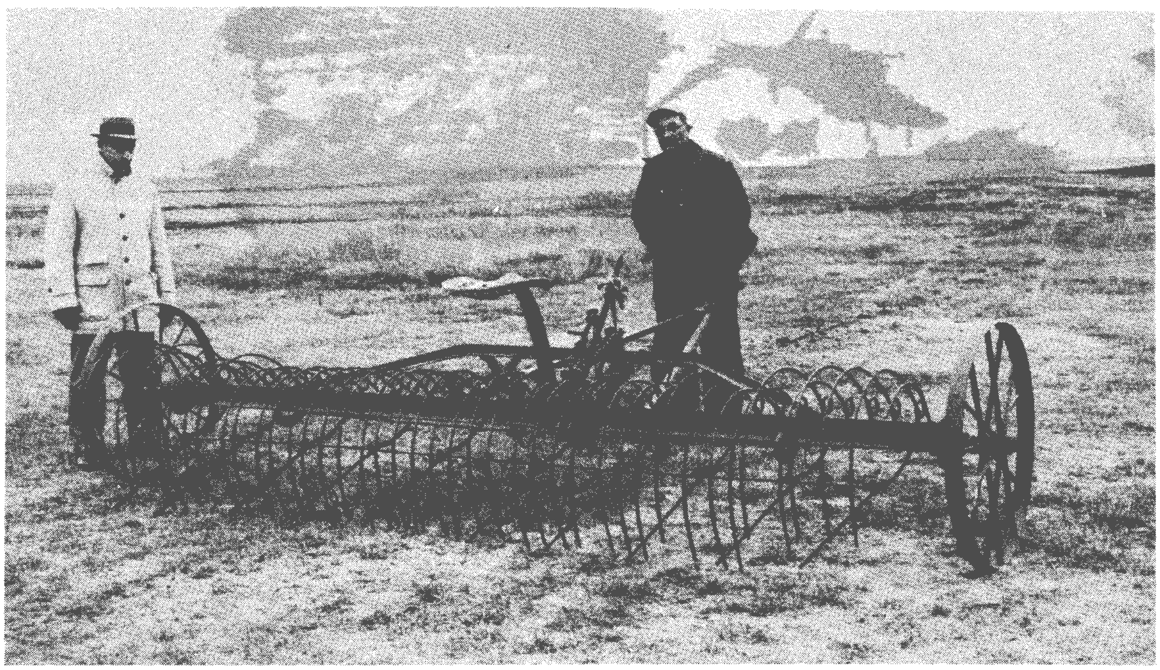

Figure 1.--Hay-rake tree cultivator.--This outfit is used to cultivate young trees by the over-the-row method. Note that sulky plow wheels have replaced the regular wheels. Oswald Pfeiffer (right), farmer at Fessenden, developed this outfit. Shown with him is Orville Overboe, SCS.

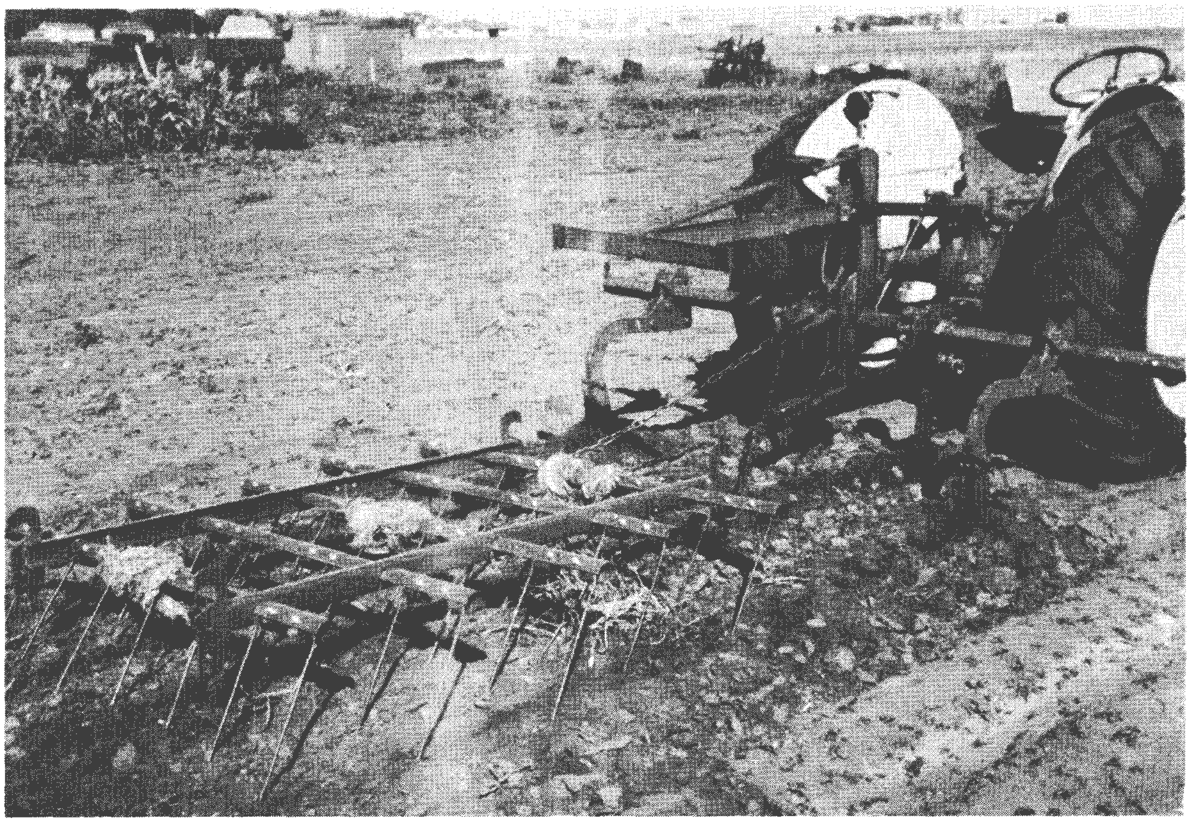

Figure 2.--Picture of Melroe-type harroweeder behind shovel cultivator. Note that the cross bars are wrapped with burlap to prevent abrading the trees. A speed of 4 to 6 miles an hour is recommended.

CHEMICAL WEED CONTROL IN WINDBARRIERS

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Adequate cultivation is necessary to obtain good tree survival and growth in the Great Plains. Weed control immediately adjacent to the trees requires special effort and special equipment. Survival and growth are better if the tree rows are free of weeds during most of the growing season. Soil sterilant herbicides may help solve this problem.

Farmer cooperation permitted herbicide trials on tree plantings to be extended beyond the experiment station in 1959. New plantings as well as one- and two-year-old plantings were selected. Soil textures ranged from silty clay loam to sandy loam. Rainfall varied generally from 9 inches in western Nebraska to 26 inches in the eastern part during the growing season.

Treatments consisted of diuron (4 lb/A), simazin (4 lb/A), and atrazine (2 lb/A). EPTC was tried, but it could not be worked into the soil in a satisfactory manner. This treatment was dropped. The controls in all but two plantings consisted of observations on plots which received no cultivation in the tree row. Many weed species had commenced growth when herbicides were applied during the third week in May 1959.

Results

Weed control with diuron, simazin, and atrazine was adequate at all locations for the entire growing season. Differences between the three herbicides were not significant except at Horning State Farm, Cass County, where volunteer grain sorghum was a weed. The sorghum thrived in the simazin (fig. 1) and atrazine plots which indicates that these

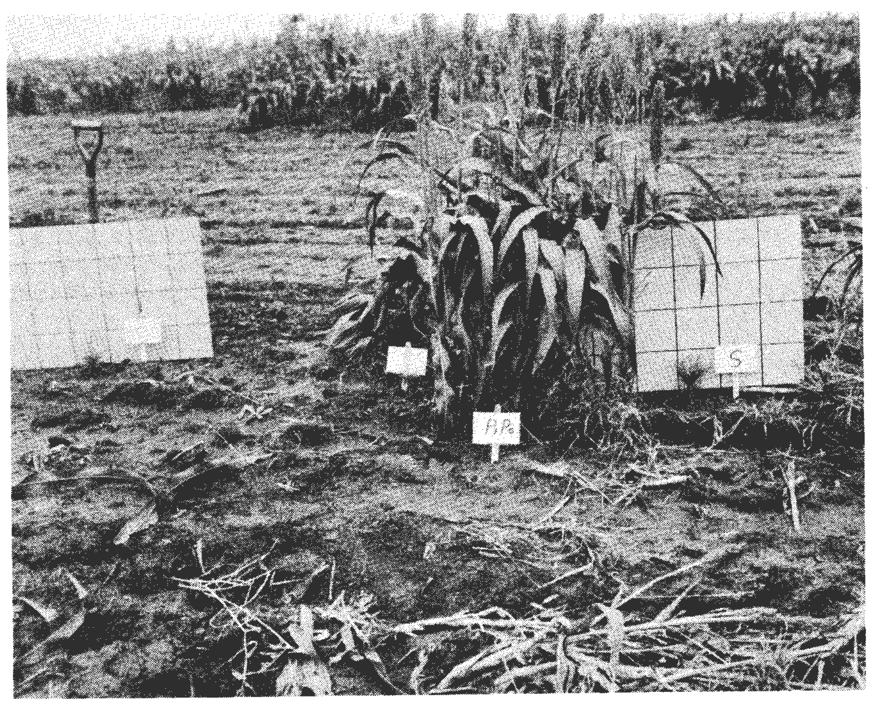

Figure 1.--A 1959 planting of ponderosa pine with control and simazin treated plots, Cass County. No injury to this species was observed during the first growing season.

chemicals acted as pre-emergence herbicides. Weedy grasses, barnyard grass (Echinochloa chloa crusgalli), bristlegrass (Setaria sp.), and crabgrass (Digitaria sanguinalis), encroached upon the treated areas in the simazinand atrazine plots in late July and early August. This was less noticeable in the diuron plots. Rainfall in Cass County approached 26 inches during the period May through August.

Chemical injury to trees was not apparent in 1 -year or older plantings, with the exception of the Alda (Hall County) plantation on a sandy loam soil. Survival of eastern redcedar (Juniperus virginiana) in this planting was lower than the controls in the diuron and simazin plots. Site-predisposed, chlorotic condition was intensified by diuron. Green ash (Fraxinus pennsylvanica), Siberian elm (Ulmus pumila), and Russian-olive (Eleagnus angustifolia) did not reveal herbicide injury and no mortality resulted. In comparison with others the latter two species were found to be quite susceptible to diuron in previous tests when it was applied immediately after planting.[1]

The 1959 tree plantings escaped serious chemical injury, with the exception of the Cass and Lancaster County plantings. High rainfall for the season, including 5 inches during June, caused deeper infiltration of the chemicals into the soil at these two locations in spite of a silty clay loam texture. As a result, considerably injury was noted in the diuron treatments of five species at Horning State Farm (table 1).

TABLE 1.--Effects of chemical weed control on the survival of new plantings at the Horning State Farm in 1959

Species	Cultivated	Diuron	Simizan	Atrazine
	Percent	*Percent*	*Percent*	*Percent*
Ponderosa pine (Pinus ponderosa)........	95	80	97	97
Austrian pine (Pinus nigra).............	95	60	83	93
Scotch pine (Pinus sylvestris)..........	90	[1] 60	83	83
White pine (Pinus strobus)..............	79	50	83	77
Red pine (Pinus resinosa)...............	73	[1] 20	50	60
Blue spruce (Picea pungens).............	62	57	57	83
White fir (Abies concolor)..............	50	67	57	73
Balsam fir (Abies balsamea).............	62	30	83	63
Douglas-fir (Pseudotsuga menziesii).....	87	77	70	87
Eastern redcedar (Juniperus virginiana).	84	70	73	77

[1] Significant at 5 percent level.

The most serious chemical injury appeared on Pinus resinosa in diuron-treated plots. The reason may have been the small, shallow-rooted planting stock rather than differences in tolerance between species. Simazin and atrazine caused less injury.

In the Lancaster County planting, diuron, simazin, and atrazine caused early chlorosis on Rosa sp., Manchu (Nanking) cherry (Prunus tomentosa) and Tatarian honeysuckle (Lonicera Tatarica). With one exception all these treatments recovered and made excellent growth (figure 2). The injury to Lonicera by atrazine resulted in heavy mortality. This substantiates other evidence[2] that some plants either tolerate more or absorb less of a herbicide than others.

1 Bagley, W. T. and Loerch, Karl A. Diuron for weed control in new windbreak plantings. NCWCC. 13th ann. meeting. Proc. 13: 66-67. 1956. (Also in Tree Planters' Notes 33. June 1958.)

2 Ries, S. K., Grigsby. B. H., and Davidson, H. Evaluation of herbicides for several species of ornamentals. Weeds, 7: 409-417. 1959.

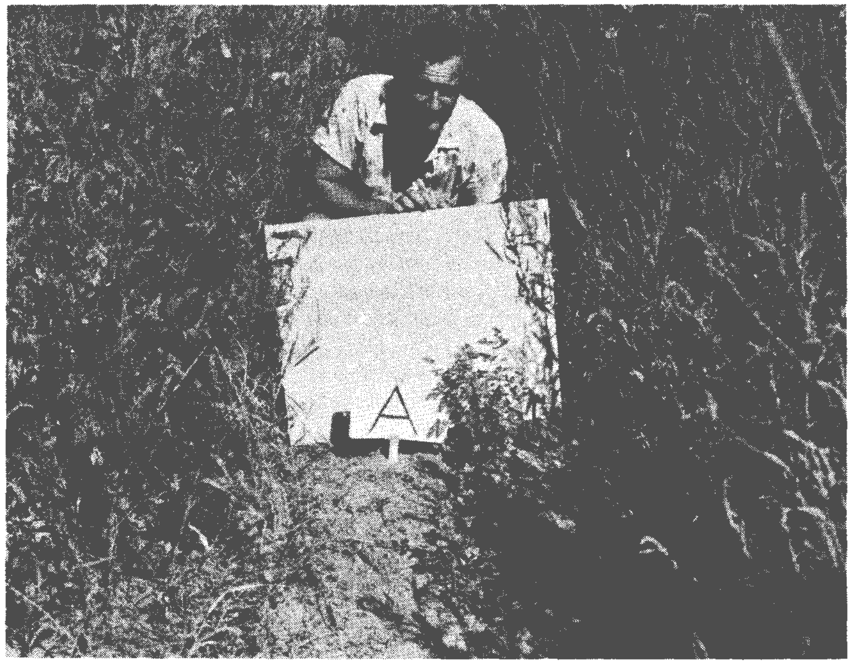

Figure 2.--Atrazine provided excellent weed control with a little early chlorosis on a shrub species in a 1959 wildlife planting, Lancaster County.

A comparison of the control plots and chemical treatments of three 1959 plantings in central Nebraska illustrates the value of weed control. Although the plantings received some machine cultivation, no attempt was made to hoe the tree row. Trees in control plots were soon overtopped by weeds. Vigor and growth were impaired. Survival was generally lower in the control plots than in herbicide treatments. It can be assumed from this that weed competition was more serious in most instances than injury by herbicides.

In many cases, any loss of trees due to herbicides will be offset by a reduction in mechanical injury and death caused by cultivation equipment. This type of injury is very difficult to avoid when trees become obscured by weeds before cultivation is attempted. Soil moisture, often a limiting factor in the growth in the Great Plains, can be conserved by controlling weeds. This is probably the greatest single reason why interest will continue in the use of herbicides in tree plantings.

ROTARY CUTTER PREPARES PINE SEEDBED FOR NATURAL REGENERATION WHILE CLEARING BRUSH

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Tests in north Arkansas show that tractor-powered rotary brush cutters are effective for preparing shortleaf pine seedbeds where natural regeneration is difficult to attain. Treatment with the brush cutters resulted in a more satisfactory seedling catch, following the bumper 1957 seed crop, than was obtained by prescribed burning or chemical control of hardwoods. After 2 years, sprouting from stems severed by the cutters is not yet a problem, and it is likely that the pine will come through without early need for chemical eradication of competing hardwoods, though vines such as greenbrier and poison-ivy may be troublesome.

Use of rotary brush cutters is, of course, restricted to rock-free sites of moderate slope. The test area--on the Henry R. Koen Experimental Forest near Jasper, Arkansas-had sandy soil supporting a poorly stocked stand of shortleaf pine in mixture with a heavy growth of undesirable hardwoods. Vegetation to 3 inches in diameter was readily mowed by the swiftly rotating blades, and the soil surface was scarified without loss of litter and humus. The litter and smaller stems were mulched thoroughly, so that the forest floor had a park-like appearance.

In October 1957, just before seedfall, plots were prepared by brush cutting, prescribed burning, and chemical eradication of undesirable hardwoods with no seedbed disturbance. Some plots were also left untreated. The plots were in four contiguous blocks, with each treatment randomly replicated in each block on 0.5-acre plots. The chemical was the propylene glycol butyl ether ester of 2, 4, 5-T (4 pounds acid equivalent per gallon) used in a 16 pounds ahg concentration in diesel oil. It was sprayed onto the basal portions of all stems less than 4 inches d.b.h. and into frill girdles on larger stems.

In March 1959, one growing season after treatment, the sites prepared by brush cutting had 7,088 seedlings per acre, as compared with 1,362 for the burned plots, 1,012 for those chemically treated, and 1,200 on the check plots. Differences between brush cutting and the other treatments were significant at the 1 percent level. No measure of stocking distribution was obtained.

The machine used in the test (fig. 1) was one of several makes that are now on the market. This model has a tempered steel rotor that is driven at about 750 r.p.m. from the power takeoff of the tractor. Reversible, flat blades are jointed to the ends of the rotor by a single bolt, lockwasher, and nut (figs. 2 and 3). The blades are held in cutting position by centrifugal force as the rotor turns. The machine can mow swaths as much as 7 feet wide. The jointing protects the blades by reducing the shock when obstacles are struck. Heavy shielding around a strong frame contains the cut material until it is discharged out the rear.

Two types of hitches are available. The "integral" type can be used on any tractor having a standard three-point hitch and power takeoff. In effect, the cutter becomes part of the tractor when it is attached, being supported only by a wheel or a pair of steel skid shoes which takes the strain off the lift and gives a floating action over rough ground.

Another hitch is of the "pull" type, with a rigid A-frame and a handwheel for leveling. It can be fitted with either a remote hydraulic cylinder or a manual screw jack to position the cutter for operation. Two caster wheels ease the lift strain and assure accurate tracking over uneven ground. This kind of machine can be used with any tractor having standard drawbar and power takeoff dimensions.

Cutting height can be adjusted from ground level to 14 inches above the ground. Setting the cutting height at ground level on the integral type increased the scarification action by causing the implement to drag on the straightaway and slide and scrape on the turns.

Initial costs vary from $400 for a model cutting a 5-foot swath to $750 for a 7-foot model. Shields to protect the operator and the cutter wheels from flying debris can be purchased. Operating costs are approximately $3 an hour.

Observations indicated that crawler tractors might be more practicable than wheel tractors in dense stands of small saplings and entangled vines.

The tractor should have sufficient weight and power so that the operator can maintain control at all times. Operators should take precautions to guard against injury that could result from material thrown free by the mower. Steep slopes cannot be mowed with safety no matter what type of motive power is used. Costly repairs can be prevented by making a preliminary survey of the treatment area and marking boulders, stumps, and other major obstructions so that the operator can avoid them.

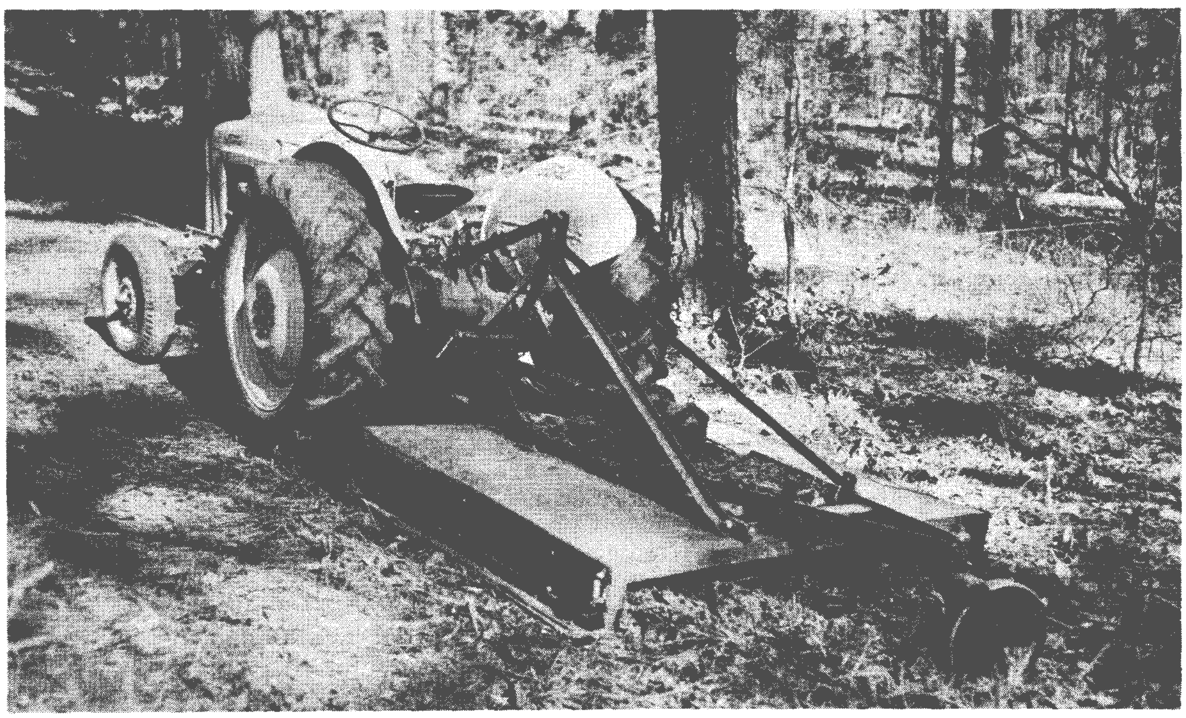

Figure 1.--Rotary brushcutter in operating position.

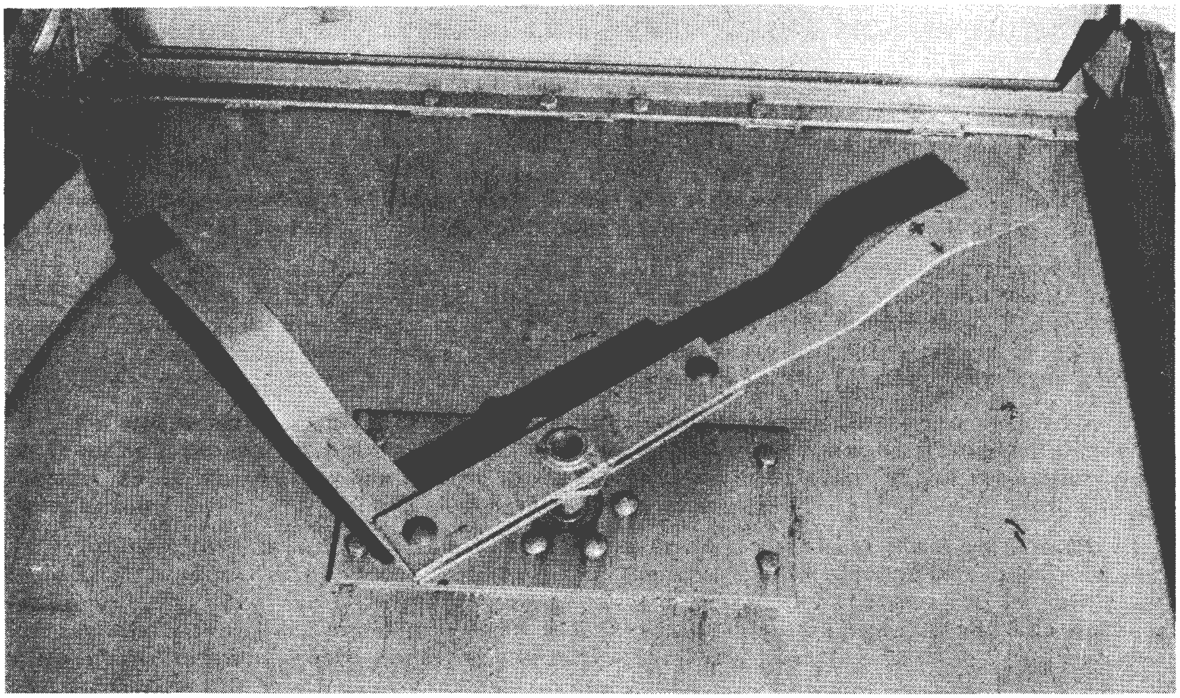

Figure 2.--View of jointed cutting bar from below. A single bolt attaches the cutter to the carrier or rotor. One blade has been swung back to show position after striking an obstacle.

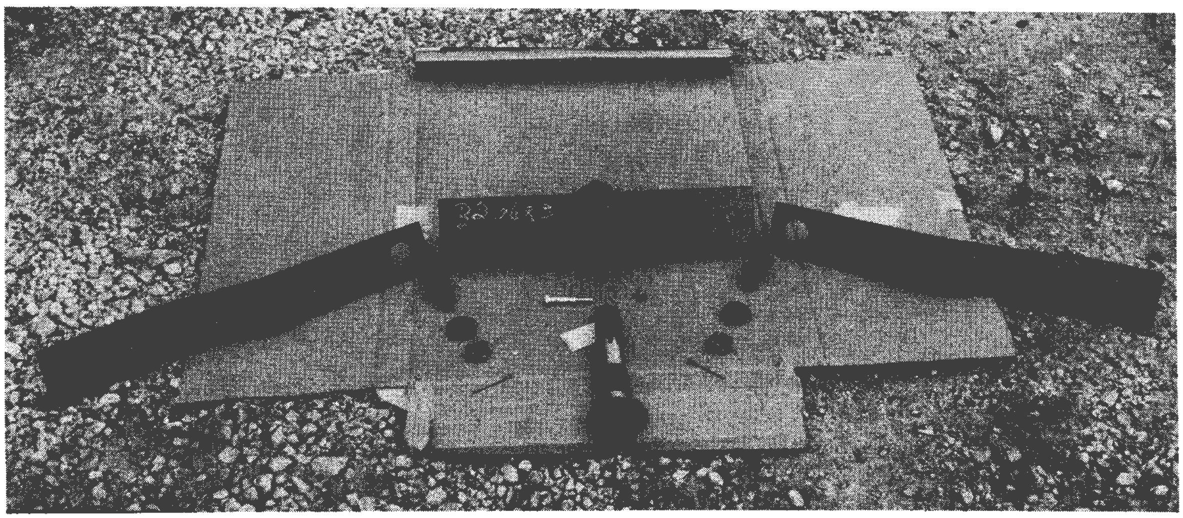

Figure 3.--Exploded view of the parts that made up the brush-cutting mechanism of the rotary brushcutter used in this study. The blades are 22 inches long and 3 inches wide. The carrier, which measures 20 by 3½ inches, is made up of two such lengths between which fit the ends of the two cutting blades. The drive shaft fits into the splined hole in the carrier and extends above the heavy steel enclosure, where the bevel gear is connected with the power take-off of the tractor.

SUBSOILER FOR IMPROVING SURVIVAL IN HARDPAN AREAS

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During the spring of 1959, while tree-planting equipment was being field tested on the Dixie National Forest, a problem cropped up which may be troublesome elsewhere.

Although the Holt Plow was quite successful in digging contour trenches for erosion control and competition removal, the colter on the planting machine would not dig into the *clay* hardpan in the bottom of the trenches for more than 4 inches. This was not deep enough to plant the trees. At the suggestion of the tractor company, we tried a subsoiler or panbreaker in an effort to break the hardpan sufficiently to allow machine planting.

The subsoiler completely shattered the hardpan down 18 inches below the bottom of the trench. The water-holding capacity was greatly increased. The planter was able to function as it should. At the end of the first season, mortality of the transplants is about 1 percent.

Pan breaking is an additional step to the normal machine planting operation. Where needed, it is done after trenching to make the soil in the bottom of the trench receptive to the colter, shoe, and tamping wheels on the planter. First season tests on the Dixie indicate that the pan breaking cost will average about $ 5 per acre. The extra cost is cheap when compared with regional averages for hand planting.

The model pictured is manufactured by the John Deere-Killefer Company, Los Angeles, California, and is listed as The Ripper Model #22A-0C. It attaches directly to the 3-point lift on John Deere tractors. It costs less than $100 and has the following dimensions

1. Length from tip to crossbar--33"
2. Width of point--2-1/2"
3. Distance from crossbar to top of linkage--18"
4. Crossbar length--33"
5. The blade can be shortened from tip to crossbar if full depth is not desired.