A LOOK BACK AT MECHANICAL WEED CONTROL

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Abstract.-- Mechanical weed control was often employed in forest nurseries daring the first half of this century. Tools developed for weed control ranged from simple hand implements such as the "puddy" knife and hoe to tractor powered within-drill cultivators. Mechanical cultivation reduced hand-weeding requirements at some nurseries by 40%. This paper gives a cites a number of examples from the literature to provide a better understanding of what weed control was like before effective herbicides were available.

Additional keywords: Forest nursery, cultivation, handweeding, seedbed.

INTRODUCTION

Prior to 1950, nursery managers had to employ various methods of weed control in order to keep ahead of the weeds. Such methods included sanitation, crop competition, crop rotation, biological control, use of fire, handweeding and mechanical cultivation. Even so, weed populations were often high. For example, more than 3,500 person-hours were required in 1930 to handweed an acre of slash pine seedbeds at a nursery in DeRidder, Louisiana (From A.D. Read's manuscript "Southern Reforestation"). This equals to about 2.4 hours for a person to handweed a thousand seedlings. In 1934, 848 person-days were needed to handweed an acre of pines at the Stuart Nursery (McKellar 1936). A C.C.C. enrollee at this nursery took about 1.4 days to handweed a thousand seedlings. Even with mechanical cultivation more than 280 person-days were needed to handweed an acre of pines at the Muscle Shoals Nursery in 1945 (Umland 1946). A thousand mechanically cultivated seedlings at this nursery required 0.3 day to handweed. In contrast, many nurseries today require less than 100 person-hours per acre (less than 8 minutes per thousand) to handweed (South 1986).

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There are five areas where mechanical weed control can be used in southern forest nurseries: non-crop areas, cover-crop areas, pathways, pine seedbeds, and hardwood seedbeds. Although mechanical weed control is also used in transplant-beds, southern forest nurseries currently do not produce transplants.

Weeds in roads can be controlled during grading or by 'rowing. Mowing can be used on grassed areas. Weed cutters (using a rotating nylon cord) can be used to control weeds next to buildings or fence posts. Weeds in fallow areas can be controlled with plows, discs or harrows. Peanut diggers have been used in forest nurseries to control nutsedge (Cossitt 1957). The machine picked up tubers and deposited them on the soil surface. The operation was conducted in hot dry weather and after 4 days of drying, the nuts were killed.

Another method which can help in controlling nutsedge and bermudagrass on fallow ground involves working the soil up for winter. After the summer cover crop is turned under, a disk harrow is used to level the soil surface. The area is then plowed on the contour with a middle buster plow which throws up a high ridge called a "listed bed". In severe winter, soil infested with tubers or rhizomes will freeze in at least the upper third of the listed bed, thus killing the weeds. Over the winter, the beds will weather down and expose more tubers and rhizomes to the freezing weather. This method was used by Carl Muller to prevent soil erosion and help reduce nutsedge at the Hauss Nursery in Alabama.

COVER-CROPAREAS

Most nurseries in the South grow sorghum, sorhgum-sudan hybrids, or millet as a summer cover crop (Bayer and South 1984). These crops are usually broadcast or sown in narrow drills which preclude mechanical weed control. However, corn is grown as a cover crop in some southern nurseries and can be mechanically cultivated when sown in wide rows.

PATHWAYS

The "alleyways" or "pathways" between seedbeds can be cultivated for weed control. Approximately half the large nurseries in the Northwest cultivate for weed control in pathways (Owston and Abrahamson 1984). Rolling cultivators or rototiller cultivators have been used to cultivate the paths (Lawman and McLaren 1976, Raymond 1973). Few nurseries in the South cultivate paths for weed control but several do plow the paths to improve surface drainage and retard bed erosion.

PINE SEEDBEDS

The use of mechanical weed control rapidly declined with the increase in use of mineral spirits daring the late 1940's and early 1950's. Presently, no nursery in the South operationally uses mechanical weed control in pine seedbeds. However, mechanical weed control in conifer seedbeds is used to a limited basis in about one-fourth of the

nurseries in the Northwest (Owston and Abrahamson 1984). Currently federal nurseries in the Northwest are not allowed to use herbicides and therefore must rely on methyl bromide fumigation, mechanical cultivation, handweeding, and sanitation for weed control.

The following are some statements from the past which deal with weeds and mechanical weed control in pine seedbeds.

Toumey and Korstian (1931)

"Hand cultivators of the type of the Planet Jr., which can be adjusted for deep or shallow cultivation, are useful in cultivating narrow rows running lengthwise of beds. When the drills run crosswise of narrow beds the ordinary garden hoes or special nursery hoes are used in the cultivation. The Spitzenberg wheel hoe has been found rapid and effective in working the soil between the rows and keeping it free from weeds. It is made in varying widths to conform with the spacing of the drills."

Jack May (1935) - Stuart Nursery

"The nursery being newly developed on an open field which was idle for several years made many grass and weed seeds germinate with pine seed. Weeding began on April 23 and was discontinued October 31. The beds were weeded by boys frcm the C.C.C. Camp. During the initial weeding, the boys sat in the paths and pulled weeds with their fingers. After several days, it was found necessary to furnish benches, weeding spuds and knives. The benches were made of light 1 inch pine material 4 1/2 feet long and 8 inches high. By putting the benches crosswise of the bed, grass could be picked from the center of each bed without damaging the seedlings. The weeding spuds were made from 1/8 inch wrought iron, resembling a flat spoon sharpened on one edge, and were used in digging out roots of plants which clung too close to the ground for finger picking. Large roots such as craw's foot grass, had to be cut just below the root collar with a sharp knife. The paths were hoed preceding weeding and raked afterward."

Jack May (1938) - Ashe Nursery

"Each compartment was cultivated and hand weeding from thirty to fourty-five days after the burlap was removed. Cultivation between the drills exterminated all small weeds and grass. Weeds growing in the tree drills were removed by hand. All species were cultivated three times and hand weeded five times. The Ashe cultivator and hand spuds were the only implements used."

The following table indicates the relative time spent on mechanical cultivation and hand weeding at the Ashe Nursery in 1937. Seeds were sown in March. Total production was 22,574,000.

Table 1. Labor required for weed control at the Ashe Nursery in 1937.

Method of weed control	Person-days					
	May	June	July	August	September	Total
Ashe cultivator	22	15	4	0	0	45
Handweeding	129	189	49	51	49	467

Wakeley (1954)

"Depending on seedling age and row spacing, 30 to 50 percent of the surface of drill-sown beds can be freed from weeds, at the time weeding is most needed, by means of narrow-bladed hoes or mechanical cultivators. Many millions of southern pine seedlings have been weeded mechanically with more or less satisfactory results (Cossitt 1938; McComb and Steavenson 1936; Tourney and Korstian 1942; Umland 1946). Mechanical cultivators have reduced total weeding costs by as much as 40 percent (Umland 1946), even though they have had to be supplemented by hand weeding close to and within the *rows.* Cultivation must be very shallow to avoid injuring seedling roots. The chief drawbacks of mechanical cultivation have been destruction of seedlings at or outside the margins of the rows, mechanical injury to and possible Sclerotium infection of surviving seedlings, and lodging of soil against or on seedlings, especially longleaf, with attendant damping-off. These difficulties have been reduced greatly by using improved cultivator shoes that slice just under the soil surface instead of raking it, and that have sideguards to keep loose dirt away from the seedlings."

"Cultivation has several disadvantages. It requires drill-sowing; for application beyond the early months of the growing season it requires fewer than 8 drills to the 4-foot bed. Hand and especially machine cultivation increases sand splash of longleaf pine (Davis 1941), and can cause mechanical injury to all species. In one study, machine cultivation, in addition to increasing the cost per bed, reduced the number of plantable seedlings by 16 percent."

HARDWOOD SEEDBEDS

Mechanical weed control has been used in hardwood seedbeds for many years. However, only the Morgan Nursery in Georgia and the Natchez Nursery in Mississippi currently use mechanical weed control in hardwood seedbeds. The Morgan Nursery sows hardwoods three drills to a 4-foot bed and uses the Fobro-Brush-Hoe. The Natchez Nursery sows four drills to a 4-foot bed and uses Lilliston rolling cultivators.

Sudworth (1900)

"It is recommended that all seedbeds be sown in rows, both to facilitate weeding and also to give an opportunity easily to cultivate the soil about the plants." "...the seed is sown in rows 3 to 3.5 feet apart, so as to allow the easy passage of a small horse cultivator, or 2 feet apart if cultivated by hand."

Tourney (1916)

"Seedbeds should be kept free from weeds. This necessitates from 3 to 6 weedings or cultivations the first season. The frequency depends upon the condition of the soil, particularly its freedom from weed seed. It is also influenced by the season. Horses may be, and usually are, used in cultivation broadleaved species sown in wide-spaced *rows.*"

Anonymous (1954)

"Control of weeds in hardwoods planted in rows is by mechanical cultivation and hand-weeding. The cultivator is equipped with duck-foot *plows* which sever small weeds; metal shields protect the seedlings. 'No men, one on the tractor and one on the cultivator, can easily weed five acres of hardwood seedlings in a half-day. The cultivator eliminates weeds between the rows of seedlings. Weeds in the rows are removed by hand."

Stanley (1970)

"We have, for the past 4 years, grown certain hardwoods in 36-inch rows so they can be cultivated by the *row* crop method. These species consist of dogwood, redbud, white oak, chestnut oak, swamp chestnut, black walnut, sweetgum, baldcypress, and catalpa."

"After the seed germinate and the small seedlings appear, any three point hitch cultivator with sufficient feet and plow sweeps can be used to cultivate the seedlings and eliminate almost all weed and grass problems. Approximately three or four hand-weedings are required in one graving season. In comparison, yellow poplar and sycamore are still being groan in 4-foot beds and requires one hand-weeding every 2 to 3 weeks, or approximately 10 to 12 during one growing season."

South (1975)

Sycamore and sweetgum seeds were sown in 14-inch drills on a 4-foot-wide seedbed. It was hoped that by sowing in drills, mechanical cultivation equipment could be used for weeding. When the seedlings were a month old, an attempt at cultivation was made using 4-inch sweeps. "However, the seedlings were so small that they were damaged by soil thrown by the sweeps. To avoid this damage, the cultivation was done slowly, allowing the lifted weeds to drop back into place with little control being realized. Hand weeding was later required."

Barham (1980)

Rick Barham delayed cultivation of 1-0 hardwoods until mid-June when the seedlings were at least 3 inches tall. "A tractor-mounted, 3-point hitch Lilliston rolling cultivator was modified to cultivate 4-foot-wide seedbeds with hardwood seedlings planted in four drills, 12 inches apart." "Handweeding times were reduced by cultivation in both sweetgum and sycamore seedbeds. Six weekly cultivations reduced handweeding times (after mid-June) by 56 and 57 percent in sweetgum and sycamore, respectively."

CULTIVATION FOR REASONS OTHER THAN WEED CONTROL

There are nurseries, with less than desirable soil textures, which have problems with the soil surface crusting. Individuals managing nurseries on fine-textured soils sometimes claim that cultivation can increase the absorption of water (May 1938; Umland 1946; Bunting 1964). This has been shown to be true for the Benalla Nursery in Australia which was located on a soil containing less than 20 percent sand (Bren and Farrell 1982). However, the benefit is short lived and therefore frequent cultivations are required to maintain the higher levels of infiltration. This is because a crust will form again after the next irrigation or rainfall (Warketin 1984).

The chance of crusting is usually less at nurseries with greater than 75 percent sand (most nursery authorities recommend locating a nursery on soils with greater than 75 percent sand). Even when dry, most sandy soils usually remain loose and friable. A survey of 53 nurseries conducted in 1982 by the Auburn Universisity Southern Forest Nursery Cooperative indicate nurseries with sandy topsoils have greater initial infiltration rates than nurseries with fine textured topsoils. It is doubtful that the rate of initial infiltration on sandy topsoils will be improved substantially from cultivation. No benefit from soil tillage beyond weed control have been observed in porous, well-aerated sandy loam soils (Klingman and Ashton 1975). Claims of better soil aeration, increased water absorption, and increased seedling growth from cultivation of sandy forest nurseries soils have not been documented.

Fran Wakeley (1954)

"Except for weed control, surface cultivation of southern pine seedbed is used only on a few peculiar nursery soils and cannot be generally recommended. The alleged benefits of such cultivation - breaking up surface crust, reducing damping-off, increasing water absorption, reducing water loss, and stimulating seedling growth - have not been generally or strikingly demonstrated in southern pine nurseries."

From Klingman and Ashton (1975)

"One of the most important reasons for growing crops in rows, instead of broadcast, is to permit tillage or cultivation. Only one

benefit from cultivation stands out as distinct and clear. This is the benefit of weed control.

Other benefits for cultivation are occasionally claimed, such as increased soil aeration, the breaking of surface crusts, and increased rainfall penetration. In some cases these may be enhanced, in other cases hindered.

Cultivation, especially late deep cultivation, may injure crop roots. It may also cause rapid moisture loss and rapid drying of the soil. Cultivation is nearly always associated with a decreasing organic-matter content in the soil."

EQUIPMENT FOR WITHIN DRILL CULTIVATION

Equipment to cultivate between drills can either be fabricated or purchased. Plans for one type of cultivator (Lott and Stoleson 1969) can be obtained by writing the USDA Forest Service, Equipment Development Center, Bldg. 1, Fort Missoula, Missoula, MT., 59801. Other plans for older cultivators can be found in Tree Planters' Notes (Mony 1954; McDaniel 1954). There are several venders of cultivation equipment (Lowman and McLaren 1976). The following lists some cultivators which have been used in forest nurseries.

BUDDING - Wheel Hoe

The Budding Wheel Hoe has been used by some western nurseries. This cultivator has wire wheels that rotate to disturb the soil surface. This cultivator can be modified for different wheel sizes and drill spacings. The cultivator is mounted to a 3-point hitch and is usually guided by the tractor driver.

EGEDAL - Bed Cleanser

The Egedal Bed Cleanser is available in 4-, 5-, or 6-row models and can be used either with goose-foot shares or spring-tooth cultivators. The cultivator is mounted to a 3-point hitch and is manually guided by a person standing on a small platform on the rear.

MEDAL - Rotating Bed-Cultivator

The Egedal Rotating Bed-Cultivator is available in a 4-raw model which consists of five shielded rotary cultivators. The cultivator is mounted with a 3-point hitch and is manually guided by a person sitting over the cultivators.

EGELAL - Blower Machine

The Egedal Blower Machine has been tested in transplant beds at a nursery in Canada (Bunting 1964). This machine using a combination of duck-foot type cultivators and a blower unit. The cultivators are used first to throw soil around the seedlings. Then after the weeds begin to germinate and are less than 3/4 inch tall, the blower unit is used to blow the soil and weeds away from the transplants. To be effective, it appears the operation must be carried out every ten to fourteen days.

The cultivator is mounted with a 3-point hitch and is manually guided by a person standing on a small platform on the rear.

FOBRO - Multiple Row Brush Hoe

The Fobro Multiple Raw Brush Hoe is currently used in hardwood seedbeds at the Morgan Nursery in Georgia. In addition, these machines are currently in use in nurseries in Oregon, Michigan, New York and New Jersey. This machine can be ordered with various raw spacings. The rotary cultivators are composed of stiff plastic brushs which can be adjusted for various cultivation depths. The seedlings are shielded during cultivation. The cultivator is mounted with a 3-point hitch and is manually guided by a person sitting over the cultivators.

SUMMARY

Prior to 1950, several nursery managers in the South employed mechanical cultivation to control weeds in both seedbed and non-crop areas. However, with the increased use of selective herbicides, the need to employ cultivation in pine and hardwood seedbeds dramatically decreased. If judges, legislatures, or regulatory agencies do not prohibit the use of effective herbicides in southern forest nurseries, the use of mechanical weed control will be limited to mainly non-seedbed areas.

LITERATURE CITED

Anonymous. 1954. Operations manual for TVA forest nurseries. Tennessee Valley Authority, Division of Forestry Relations. 57 pp.

Baker, Lyle *A.* 1962. Seedbed and path cultivator for forest tree nurseries. Tree Planters' Notes 52:19-20.

Barham, Richard 0. 1980. Handweeding times reduced in hardwood seedbeds by a modified rolling cultivator. Tree Planters' Notes 31(4):30-32.

Bren, L. J. and P. W. Farrell. 1982. Irrigation efficiency in a Radiata pine nursery. Victoria Forestry Commission, Australia. Forestry Technical Paper 29:25-32.

Boyer, James N. and David B. South. 1984. Forest nursery practices in the South. South. J. Appl. For. 8(2):67-75.

Bunting, W. R. 1964. Transplant weeder. Ontario Dept. of Lands and Forests. Nursery Notes No. 7. 4 pp.

Cossitt, F. M. 1938. Cultural practices in southern forest nurseries. U.S.D.A. Forest Service Region 8, 21 pp.

Cossitt, F. M. 1947. Mineral spirits as a selective herbicide in southern pine seed-bed. South. Lumberman 175(2201):203-204.

31:1011-1016.

Klingman, Glenn C. and Floyd M. Ashton. 1975. Weed Science: principles and practices. John Wiley & Sons, Inc., New York. 431 pp.

Lowman, Ben J. and Jan McLaren. 1976. Nursery equipment catalog. U.S.D.A. Forest Service Equipment Development Center, Missoula, Mont. 111 pp.

Lott, James and Roland Stoleson. 1969. A cultivator for forest tree nurseries. Tree Planters' Notes 20(1):1-3.

May, Jack. 1935. Stuart Nursery Annual Report - 1934. U.S.D.A. Forest Service, Region 8. 24 pp.

May, Jack. 1938. W.W. Ashe Nursery Annual Report - 1937. U.S.D.A. Forest Service, Region 8. 39 pp.

May, Jack. 1939. W.W. Ashe Nursery Annual Report - 1938. U.S.D.A. Forest Service, Region 8. 44 pp.

McComb, *A.* L. and H. A. Steavenson. 1936. Some new nursery equipment. J. of Forestry. 34:698-701.

McDaniel, Vern E. 1954. Roto-tiller cultivator. Tree Planters' Notes 18:13-15.

Minko, G. 1969. Effects of early soil lifting, and repeated application of simazine, on the yield and growth of Pinus radiata D. Don, seedlings in heavy soils. Victoria Forestry Commission, Australia. Forestry Technical Paper 20:32-35.

Mony, Charles C. 1954. Vallonia rotary tooth cultivator. Tree Planters' Notes 16:17-20.

Owston, P. W. and L. P. Abrahamson. 1984. Weed management in forest nurseries. In: Forest nursery manual: Production of bareroot seedlings (M. L. Duryea and T. D. Landis, eds), p.193-202. Martinus Nijhoff/Dr. W. Junk Publishers, The Hague/Boston/Lancaster. 386 pp.

Raymond, Dick. 1973. "Path cultivator" controls weeds in nursery seedbeds. Tree Planters' Notes 24(3):9.

South, David B. 1975. The determination of nursery practices for the production of quality sweetgum (Liquidambar styracifllua L.) and sycamore (Platanus occidentalis L.) planting stock. Unpublished M.S. thesis, School of Forest Resources, North Carolina State University at Raleigh, N.C. 91 pp.

South, David B. 1986. Herbicides for southern pine seedbeds. South J. Appl. For. (IN PRESS).

Stanley, Howard. 1970. Hardwood weed control. In: Proceedings, Southeastern Area Nurserymen's Conferences (LeRoy Jones, ed.), p.60-61. U.S.D.A., Forest Service. Atlanta, GA. 110 pp.

Sudworth, G. B. 1900. The forest nursery: Collection of tree seeds and propagation of seedlings. U.S.D.A. Division of Forestry. Bull. 29. 63 pp.

Tourney, James W. 1916. Seeding and Planting. John Wiley & Sons, Inc., New York. 455 pp.

Tourney, James W. and Clarence F. Korstian. 1931. Seeding and planting in the practice of forestry. Ed. 2; Wiley, New York. 507 pp.

Umland, Charles B. 1946. Nursery weeding costs reduced by mechanical cultivation. J. of Forestry. 44:379-380.
y, AL. 104 pp.

Warkentin, B. P. 1984. Physical properties of forest-nursery soils: Relation to seedling growth. In: Forest nursery manual: Production of bareroot seedlings (M. L. Duryea and T. D. Landis, eds), p.53-61. Martinus Nijhoff/Dr. W. Junk Publishers, The Hague/Boston/Lancaster. 386 pp.

Wakeley, Philip C. 1954. Planting the Southern Pines. U.S.D.A. Monog. 18, 233 pp.