INTEGRATED WEED MANAGEMENT IN SOUTHERN FOREST NURSERIES

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Integrated weed management provides an optimum level of weed control by utilizing many types of control tactics and results in economic or optimal production with minimum deleterious effects on the environment. However, many nurserymen rely on only a few weed control tactics. Some nurserymen rely heavily on one herbicide and might apply it twice a week throughout the growing season. This practice can lead to a buildup of resistant weeds. Some nurserymen fumigate yearly for weed control with methyl bromide which is not only expensive but also can be dangerous to humans and can have detrimental effects on beneficial soil organisms. A few nurserymen have eliminated their need of fumigation for weed control, reduced their herbicide usage, and reduced their weed population by integrating several types of weed control practices.

PAST PRACTICES OF INTEGRATED WEED CONTROL

Prior to 1947, southern pine nurseries were weeded almost entirely by hand or in combination with mechanical cultivation (Wakeley 1954). Weed populations were high and an acre of seedlings often required from 200 to 800 man-hours to handweed (McKellar 1936). Wakeley (1935) reported that several methods including sanitation practices, cultivation, cultural practices and biological control measures could be used by the nurserymen to reduce weed populations. To avoid spreading nutsedge (Cyperus rotundus L. and C. esculentus L.), use of spiked-toothed or spring toothed harrows was not recommended since the tubers tended to cling to the tines. Toothed harrows were recommended for controlling bermudagrass (Cynodon dactylon (L.) Pers.) since the rhizomes would be brought to the surface and exposed to freezing temperatures over the winter which resulted in reduced survival. By sowing late, germinating weeds could be controlled by working the soil before sowing. Weed seed population for the following season could be reduced by preventing the weeds on areas adjacent to the nursery from going to seed. Introduction of weeds from outside the nursery was prevented by not using soil admendments contaminated with weed seed. The use of heavy cover crops was recommended to shade out the weeds and reduce their population. Even biological control of nutsedge was recommended. Geese were used to eat the leaves of nutsedge and hogs would eat the tubers. McKellar (1936) reported that serious perennial weeds were controlled by digging up the soil, and sifting it to remove the vegetative parts.

Millions of southern pine seedlings were mechanically cultivated in the nursery with more or less satisfactory results (Wakeley 1954). Because of narrow row spacing, seedlings were often destroyed by cultivation and incidence of injury and disease was increased. For this reason, mechanical cultivation of southern pine seedbeds is no longer practiced. Mechanical cultivation becomes more feasible when row spacing is wider, such as with hardwoods. For the past twenty years, Howard Stanley (1970) has mechanically cultivated hardwoods grown in 36-inch rows. Several types of seedbed and alleyway cultivators are available (Lowman and McLaren 1976).

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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 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 to prevent soil erosion and help reduce nutsedge at the Hauss Nursery in Alabama.[2/]

INCREASING THE POPULATION OF HERBICIDE RESISTANT WEEDS

Today, however, many nurserymen tend to rely heavily on the use of chemicals and less on sanitation and cultural practices. By using the same chemicals year after year in the seedbeds these nurserymen discover that the population of hard-to-kill weeds increases each year. The reason for this is a simple matter of genetics. The nurserymen are selecting the resistant weeds by allowing them to go to seed. In addition, by not using a herbicide for the cover crop to which these weeds are susceptible, the population is allowed to increase each year.

In 1947, Floyd Cossitt (1947) stated that, "...the population (of weeds resistant to mineral spirits) can be reduced greatly by persistent removal before seed is formed." Many nurserymen paid little attention to this advice and 21 years later Mason Carter (1968) was saying, "In many cases, the use of mineral spirits over many years has led to an increase in weeds which are resistent to it." At one nursery, a weed resistant to mineral spirits, buttonsnakeroot (*Eryngium protratum* Nutt.), had increased to such a population that an acre of seedlings required 600 to 900 man-hours of handweeding annually (Shoulders *et al.* 1965). Other instances of weeds acquiring resistance have been reported. At the Mt. Sopris Tree Nursery in Colorado, common purslane (*Portulaca oleracea* L.) has apparently developed resistance to herbicides (Landis 1976). At one nursery in Washington where simazine or atrazine had been used once or twice annually for ten years, common groundsel (*Senecio vulgaris* L.) built up resistance (Ryan 1970). Even when simazine was applied at 16 lb ai/A, the resistant groundsel was unaffected. Normally, common groundsel is susceptible and 1 lb ai/A of simazine can provide effective control.

The buildup of resistant weeds could have been prevented by integrating two practices into the nurseries' weed control program. First, by persistent removal of resistant weeds before seed production, their population would decrease. And second, by rotating to a different herbicide (one from a different herbicide family) when growing cover crops, resistant weed populations would be further suppressed. Examples of herbicides which can be utilized in cover crops are presented in Tables 1 and 2.

[2/] Personal communication, Carl A. Muller, Hammermill Paper Company, Selma, Alabama.

Table 1

EXAMPLE OF A WEED CONTROL PROGRAM FOR GRASSES AND BROADLEAVES IN PINE NURSERIES[a/]

Time of Application	Herbicide Trade Name[b/]	Comments
April	Modown + Devrinol[c/]	Apply to seeded beds before or after mulching. If mulch is likely to be washed off bed, application should be made before mulching. Apply herbicides before weed seed germination (within 48 hours after seeding is possible). Make sure herbicides are applied to riserlines before weeds germinate.
	Velpar	Apply to fencerows and other non-crop areas where weeds may grow to produce seed. Since this product is persistant in the soil, do not use on areas to be planted to crops.
May	Modown	Apply 4-6 weeks after seeding. Best results are obtained when applied before weeds appear. If weeds are not present, irrigate after application. If small weeds are present, the EC formulation will provide more contact activity than the WP formulation. Contact activity will be enhanced if irrigation is not applied until 48 hours after treatment. The use of a surfactant may slightly improve contact activity. Weed control will be decreased if weeds are past the 1-2 leaf stage. Handweed to prevent resistant weeds from going to seed.
June	Modown	Apply 8-12 weeks after seeding in same manner as above if needed. Handweed resistant weed species.
July-November		Keep all weeds around nursery from going to seed.
December-March		Lift pine seedlings.
May		For soybean cover crop
	Basalin or Prowl or Tolban or Treflan + Vernam tank mix	Apply preplant incorporated.
		OR
	Lasso + Sencor	Apply a preemergence herbicide after planting soybeans.
	Basagran or Tenoran + surfactant	Apply postemergence to small weeds if needed.
		For corn cover crop
	Sutan+ or Eradicane	Apply preplant incorporated.
		OR
	AAtrex or Atrazine or Princep or Lasso	Apply a preemergence herbicide after planting corn.
	AAtrex or Atrazine	Apply postemergence if needed.
		For grain sorghum cover crop
	Milogard	Apply preemergence.
		OR
	AAtrex or Atrazine	Apply postemergence.

[a/] This does not constitute recommendations by Auburn University. This is only an example of a theoretical weed control program. Since soil conditions and weed populations vary from nursery to nursery, specific recommendations should be made only to fit each nursery's situation.

[b/] Read the label and use recommended rates.

[c/] We do not recommend the use of Devrinol on soils containing less than 1% organic matter. On soils less than 1% organic matter or in states where Devrinol is not registered, Enide sometimes may be helpful in controlling some grasses.

Table 2

EXAMPLE OF A WEED CONTROL PROGRAM FOR A LARGE INFESTATION OF NUTSEDGE IN PINE NURSERIES[a/]

Time of Application	Chemical Trade Name[b/]	Comments
Fall	methyl bromide	Best results are obtained when soil temperature is above 60°F, at the 4-inch level and soil is moist, fine and loose. Moisture content of the tubers must be high for good control. Continuous tarping reduces the possibility of leaving some soil untreated.
March	EPTAM 7E	Apply and incorporate at least 14 days prior to seeding.
April		Plant pine seed and apply appropriate preemergence herbicides to control grasses and broadleaves.
May-September	Roundup	Apply as a spot spray to nutsedge on riserlines, in allyways and in fallow fields. Nutsedge should be sprayed when it's large, healthy, rapidly growing, and just before it goes to seed. Care should be used when treating nutsedge plants among the pines since seedlings will die if the spray contacts their foliage. The use of shields can help reduce seedling injury. Also, well placed dribble applications may be less harmful to the pines than spray applications.
December-March		Lift seedlings.
April-May	Roundup	After lifting seedlings, leave the area undisturbed and let the nutsedge tubers germinate. Encourage nutsedge growth by irrigation if necessary. When the nutsedge is large, rapidly growing, and just prior to putting on seed, spray with Roundup. Do not cultivate the area until 14 days after treatment.
May		For soybean cover crop
	Vernam	Incorporate thoroughly into the soil.
	Basagran	Apply as a postemergence treatment when yellow nutsedge is young and rapidly growing. (Will not control purple nutsedge.)
		For corn cover crop
	Eradicane or Dual	Incorporated thoroughly into the soil. Preemergence.
	AAtrex or Atrazine + emulsifiable oil	Apply after the crop and yellow nutsedge have emerged, but before the nutsedge plants reach a height of 3 inches.
		For sorghum or sorghum-sudan cover crop
	AAtrex or Atrazine + emulsifiable oil	Apply after the crop and weeds have emerged, but before the weeds reach aheight of 3 inches.

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[b/] Read the label and use recommended rates.

USING LESS FUMIGATION

At many nurseries, herbicides can provide weed control equal to or better than that obtained with methyl bromide fumigation. If control of annual grasses and broadleaves is the major objective, herbicides are often a better choice than methyl bromide fumigation because herbicide applications cost about one-tenth as much, are easier and safer to apply, and provide at least as effective weed control.

For methyl bromide to provide effective weed control, exacting soil conditions must be met. The soil should be fine and loose with no lumps or clods. Soil temperature at the 4 inch depth should be above 60°F. Soil moisture should be moderate (but not too wet), since moisture content of weed seeds must be high for good control.

When fumigation of the nursery is done by a contractor, special problems may arise. Often a contractor is available at the nursery for only a few days and has to fumigate the nursery under less than ideal conditions. We know of one case where the contractor arrived at the nursery and began fumigating, but had to stop because of a snow storm. If fumigation is done in the spring, any delay by the contractor can delay planting.

It should be remembered that methyl bromide has no residual activity. Weeds will grow vigorously on fumigated soil if the area is contaminated by weed seed in straw mulches, nonfumigated soil, or by wind-carried seed.

From 1972 to 1977, ten studies at seven nurseries were conducted to compare weed control obtained from methyl bromide fumigation with that obtained from herbicides. All but two of the tests indicated that herbicides alone provided better weed control than fumigation (Figure 1).

At most nurseries, the cost of fumigation is unjustified for controlling annual grasses and broadleaves. However, methyl bromide can be justified when controlling high populations of nutsedge or when pathogens are a problem.

USING LESS HERBICIDE

There are several applicators available which allow the nurserymen to make more efficient use of herbicides. One such device is known as a rope-wick applicator which is primarily used for the application of glyphosate (Roundup) (Dale 1978). Since glyphosate is expensive but effective against perennial weeds, use of this applicator might be most appropriate at nurseries with a nutsedge problem. The principle of the applicator involves a loose woven nylon wick which conveys the concentrated herbicide to weeds that physically contact the wick as the tractor moves through the field (Figure 2). A conventional broadcast application of glyphosate would waste herbicide that was sprayed on bare ground. Although a higher concentration of herbicide is used with the rope-wick applicator (approximately 50% Roundup with 50% water), the only herbicide used is that which is directly rubbed off onto the plant. This applicator not only can be used in non-cropland situations, but also can be used early in the growing season when the nutsedge plants are much taller than the pine seedlings. However, if the rope comes in contact with the seedlings or drops of herbicide fall unto seedlings, death of seedlings will result.

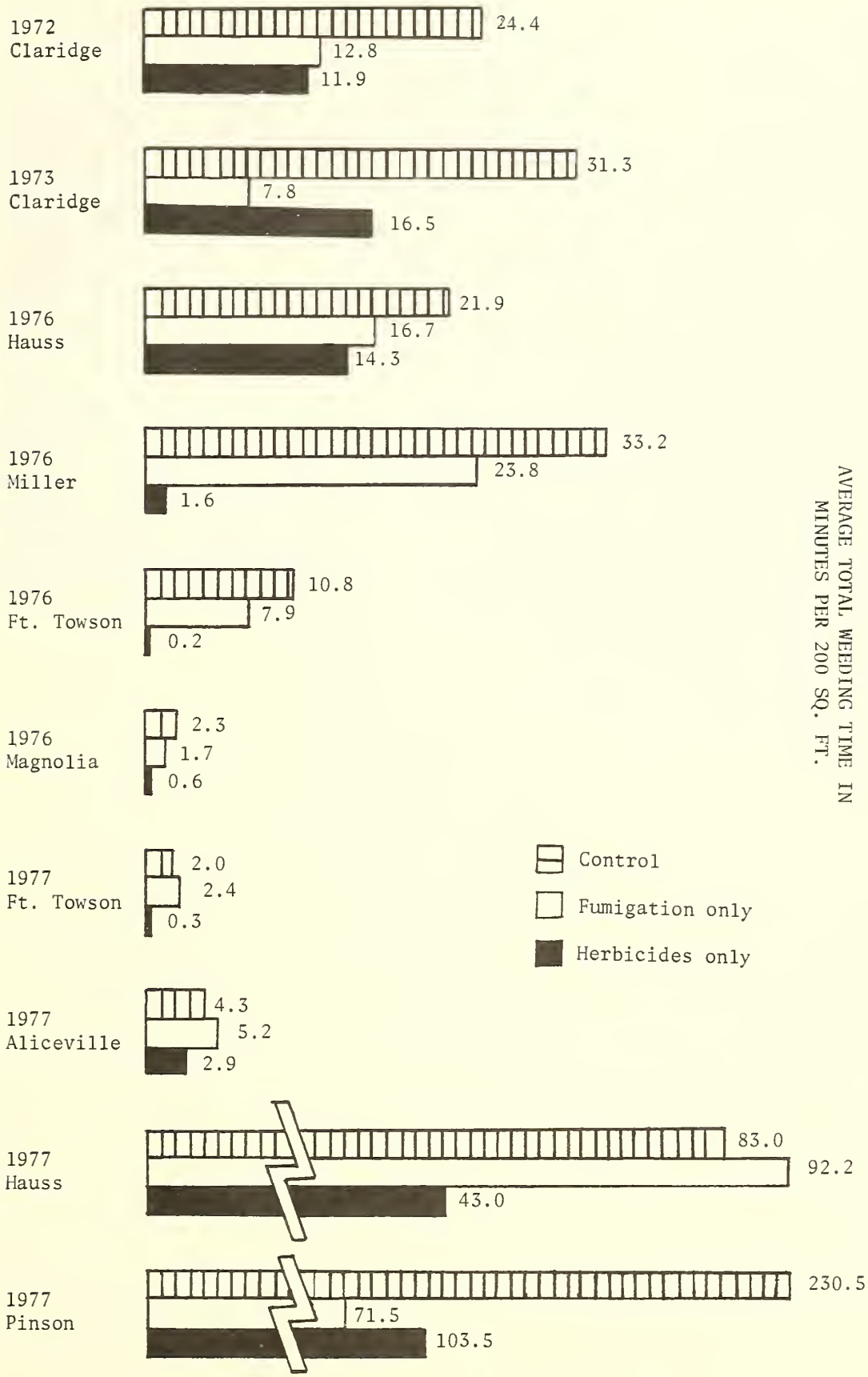

FIGURE 1. WEED CONTROL FROM FUMIGATION AND HERBICIDES AT SEVERAL SOUTHERN FOREST NURSERIES

Figure 2.-- Rope-wick applicator

Another applicator which might reduce herbicide usage is one which involves Ultra Low Volume Application (ULVA). The ULVA device runs off of batteries which spin a disc that produces uniform herbicide droplets in the range of 250 microns in diameter (McGarvey 1978). By producing a uniform droplet size, the company claims better plant coverage is obtained and lower herbicide dosages are required to obtain adequate weed control. This applicator might be most appropriate for use around seed orchard trees and for use along fencerows, etc.

One applicator which should replace the putty knife for nutsedge control is the pump spray bottle (Figure 3). The putty knife only removes the top of the nutsedge plant and doesn't get to the "root" of the problem. A pump spray bottle (such as that used for window cleaners or household cleaners) can be used to directly apply a glyphosate solution (approximately 1 part Roundup to 10 parts water) to nutsedge plants. The herbicide will translocate down and kill the tubers and is much more efficient in controlling nutsedge than just removing the tops.

Figure 3.--A spot application of glyphosphate on nutsedge using a "pump spray bottle"

INTEGRATED WEED MANAGEMENT PROGRAM

An integrated weed management program must be adapted to each nursery's particular situation. Weed species dictate which practices should be emphasized and the practicality of the practice will determine to what extent it is utilized. When designing a weed control program, the following practices should be considered.

I. Sanitation

A. Prevent the introduction of weeds and weed seed into the nursery
   1. Use weed-free mulches
   2. Use cover crop seed which are free of weed seed (use certified seed)
   3. When irrigation source is a lake, pond, or river, use screens to filter out weed seed
   4. Do not bring in combines or other machinery which are contaminated with weed seed
   5. Do not use soil amendments which are contaminated with weed seed (such as leaves from lawns which contain weed seed (i.e., bermudagrass)
   6. Use windbreaks to reduce the introduction of wind borne seed

B. Prevent weeds from going to seed
   1. in seedbeds
   2. on riserlines
   3. on fencerows
   4. in cover crops
   5. in drainage ways and culverts
   6. in all areas adjacent to the nursery

C. Limit the spread of weeds which reproduce vegetatively
   1. Keep all machinery clean of vegetative parts
   2. Cultivate weed-free areas before entering infected areas

C. Cover crops
   1. Annual grasses
      a. butylate (Sutan+) - also controls bermudagrass from seed
      b. EPTC (Eradicane) - also suppresses rhizome bermudagrass
      c. cyanazine (Bladex)
      d. alachlor (Lasso)
      e. metolachlor (Dual)
      f. fluchloralin (Basalin)
      g. trifluralin (Treflan)
      h. profluralin (Tolban)
      i. vernolate (Vernam)
      j. propazine (Milogard)
   2. Broadleaves
      a. atrazine (AAtrex)

II. Mechanical Weed Control

A. Cultivation
   1. of cover crops
   2. of hardwoods grown in wide rows
   3. on noncrop areas
   4. of alleyway

B. Separation of nutsedge tubers from the soil
   1. Peanut diggers
   2. Modified rock picker
   3. Soil screens

III. Chemical Weed Control

A. Pines
   1. Annual grasses
      a. diclofop (Hoelon)*
      b. napropamide (Devrinol)
      c. diphenamid (Enide)
      d. oxyfluorfen (Goal)*
      e. mineral spirits (Amoco Weed Killer)
   2. Broadleaves
      a. bifenox (Modown)
      b. oxyfluorfen (Goal)*
      c. mineral spirits (Amoco Weed Killer)
   3. Nutsedge
      a. methyl bromide
      b. EPTC (Eptam)

B. Hardwoods
   1. Grasses
      a. trifluralin (Treflan)
      b. napropamide (Devrinol)*
   2. Broadleaves
      a. oxadiazon (Chipco Ronstar)
   3. Nutsedge
      a. methyl bromide

b. propazine (Milogard)
c. simazine (Princep)
d. cyanazine (Bladex)

3. Nutsedge
a. butylate (Sutan+)
b. EPTC (Eradicane)
c. vernolate (Vernam)
d. alachlor (Lasso) - erratic control of yellow nutsedge only
e. metolachlor (Dual) - yellow nutsedge only

D. Noncropland
1. All weeds
a. glyphosate (Roundup)
b. hexazinone (Velpar)
c. diuron (Karmex)
d. simazine (Princep)

IV. Biological Weed Control

A. Handweeding
B. Geese
C. Hogs
D. Competition from cover crops

* Not registered at time of printing

SUMMARY

Handweeding constitutes at least 10 percent of the total cost of seedling production at approximately half of the forest nurseries in the United States (Abbott and Fitch 1977). Costs for fumigation and herbicides would run the total cost of weed control even higher at these nurseries. By utilizing an integrated weed control program, need for fumigation for weed control can be eliminated and the total cost for weed control can be reduced to only 22¢ per thousand seedlings ($.00 per M for fumigation, $.08 per M for handweeding, $.08 per M for herbicides and $.06 per M for labor associated with herbicide application).3/

PESTICIDE PRECAUTIONARY STATEMENT

All uses of pesticides must be registered by appropriate State and Federal agencies before they can be recommended. Since Federal registrations are constantly changing and some states also have pesticide restrictions, check with the Forest Nursery Weed Control Cooperative at Auburn University or with the Pesticide Specialist for U.S.F.S. State and Private Forestry at Atlanta, Georgia for up-to-date information. Caution: Pesticides can be injurious to human, domestic animals, desirable plants, and fish or other wildlife - if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

3/ Personal communication, Carl A Muller, Hammermill Paper Company, Selma, Alabama.

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