

# WOODY COMPETITION CONTROL

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## ABSTRACT

Control of woody competition is necessary to maintain shortleaf pine (*Pinus echinata* Mill.) as an important component of natural stands and to maximize shortleaf pine plantation productivity in the Southeast. Competition control is key to maximizing timber production since growth is moisture-limited over much of its range. Volume growth gains of 40% have been reported following woody competition control in mature stands. Larger stem size gains can be expected from earlier treatment provided the released stand is thinned appropriately through time. Forage production also is stimulated by woody competition control; however early herbaceous competition control will further increase pine growth gains.

Mechanical control methods offer high individual stem selectivity but have the disadvantages of relatively high cost, high probability of human injury and rapid regrowth of most hardwoods. Fire is a relatively inexpensive, widely used woody competition control tool. Fire also offers only temporary control of small stems, reduces growth of pine residuals if crowns are scorched and requires careful smoke management. Herbicides offer positive control of susceptible species and may be used at any stand age. However herbicides are less selective than mechanical means, can be costly; and like fire, require specialized knowledge for effective use. Six herbicides are registered for shortleaf pine release in the Southeast.

## INTRODUCTION

Hardwoods are the climax vegetation type on virtually all sites where shortleaf pine occurs naturally, therefore hardwood species must be controlled in some manner if shortleaf pine is to be maintained as a major component of southern forest types. A variety of methods are available for use in controlling encroaching hardwoods. The effort and cost expended in woody competition control, the tool or treatment used, application timing and frequency can vary widely among public, industrial and non-industrial private lands due to differing management objectives and philosophies.

A key consideration in selecting a given method is its selectivity in precisely controlling the targeted stand component(s) with minimal direct effect on the residual vegetation. Cost, treatment efficacy and environmental considerations also will constrain tool selection and use. Competition control is an active area of research with new or improved procedures reported frequently in technical papers and proceedings. Everyone involved in competition control activities can benefit greatly by staying abreast of changes in this technology and becoming more proficient in its use.

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The objectives of this paper are to examine (1) the reasons for woody competition control, (2) its timing relative to stand development and (3) the tools available for woody competition control in shortleaf pine management. Biologically, pine thinning is woody competition control but the topic will not be covered in this paper.

#### WOODY COMPETITION CONTROL RATIONALE

Shortleaf and the other southern pines are relatively shade-intolerant and hardwoods are the climax vegetation in most areas of the southeastern United States. Therefore woody competition control is necessary to maintain shortleaf pine as a major component of managed forests, be they naturally regenerated or planted forests. If the stands are being used for timber production, control is necessary to maintain good tree vigor for enhanced pine growth and resistance to insect attack.

All higher plants draw upon soil moisture reserves in approximate proportion to their contribution to total leaf area on the site. Growing season soil water availability is a major growth-limiting factor on many sites supporting shortleaf pine. In addition to floristic changes, competition control usually increases the vigor and growth of the remaining stand since additional moisture and other potentially limiting factors, e.g., light and nutrients are made available to the remaining stand. Ting and Chang (1985) reported less soil moisture depletion by 21-year-old shortleaf than by longleaf (*Pinus palustris* Mill) or loblolly (*Pinus taeda* L.) pine stands of the same age and density.

Bower (1968) found that equal increments of understory hardwood removal resulted in approximately equal increments of growth on the remaining 50- to 65-year-old shortleaf pine overstory. Complete removal of 33 square feet of hardwood understory increased residual stand basal area growth by 31% (.3 sq ft) over the five years following removal (Fig. 1). Rogers and Brinkman (1965) found a 40% increase in 30-year-old shortleaf pine volume growth 10 years following complete control of the hardwood understory which was composed of 900 stems/ac with 14 square feet of basal area and 3500 stems/ac less than 0.6 inches in diameter.

Removal of the hardwood understory from 53- and 47-year-old loblolly/shortleaf pine stands in southeast Arkansas resulted in a 14 year response of 359 cubic feet of volume and 9.9 square feet of basal area compared to untreated stands (Grano 1970). Shortleaf however does not respond as dramatically to release as does loblolly in mixed stands (Guldin 1985a). Smalley (1974) also clearly demonstrated the value of intensive stand improvement, primarily hardwood competition removal, on subsequent development of mixed shortleaf-loblolly pine stands over a 19-year period. Volume growth was 427 cubic feet on the check area versus 1498 cubic feet of growth on the intensively treated area.

Mature pines do not always exhibit increased growth following removal of a hardwood understory (McClay 1955, Russell 1961). In the case of the former investigator, the loblolly pines were 40 to 50-years-old when treated; in the latter, response was slight but non-significant. Such an outcome could be expected on site where soil water availability is not a growth-limiting factor.

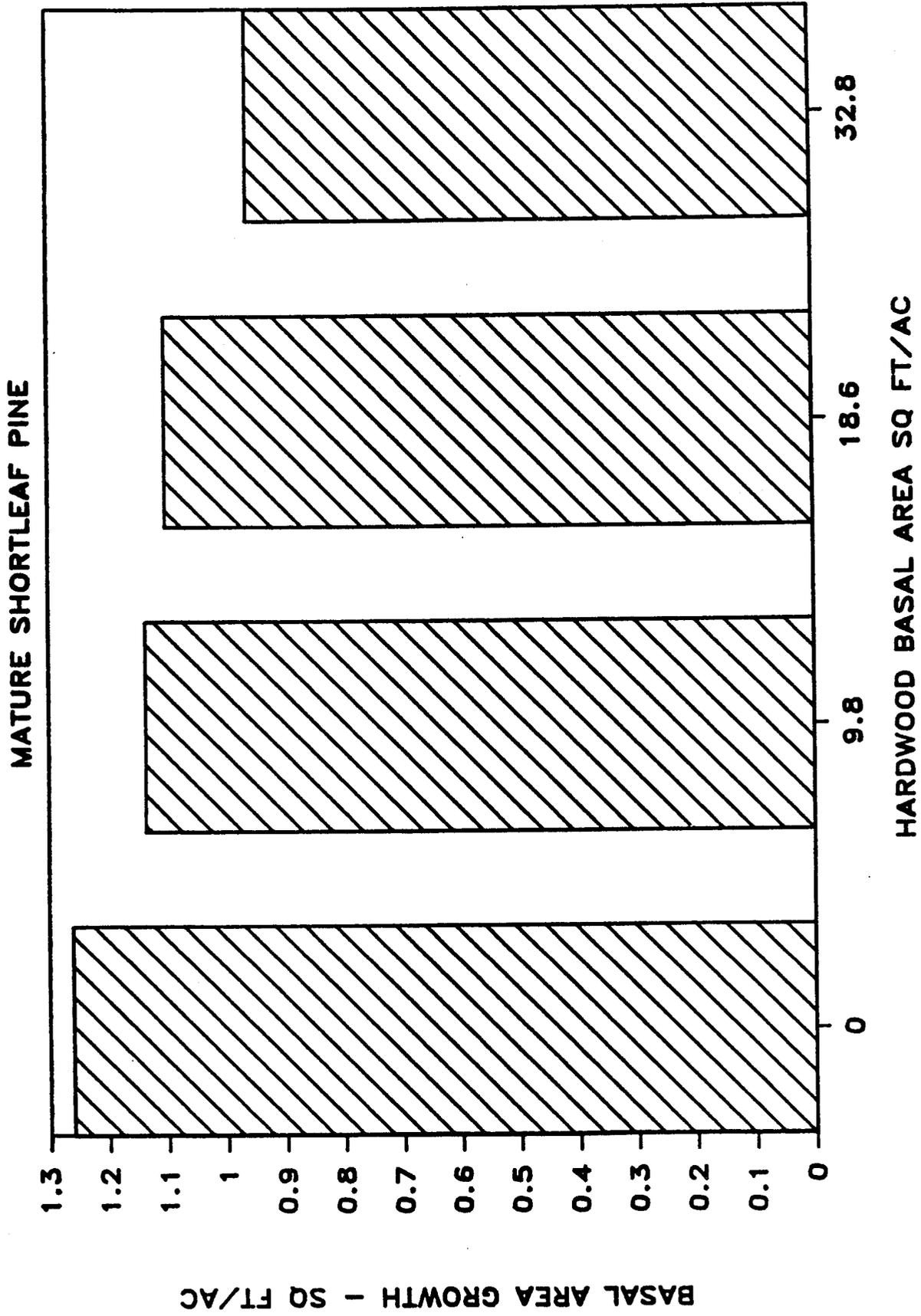


Figure 1. Five-year growth response of 50 to 65-year-old shortleaf pine to removal of varying levels of understory hardwood competition. From Bower (1968).

Control of woody competition from the time of stand establishment results in even more dramatic growth response than seen in the above examples. A replicated loblolly pine site preparation study in Fayette County, Alabama resulted in hardwood basal areas ranging from 0 to 100% of total stand basal area at age 24. Pine yields declined dramatically as the proportion of hardwood in the stand increased (Glover and Dickens 1985) (Fig. 2). These data indicate that pine yield in stands with 30% hardwood basal area was only 50% of that in stands with 4% hardwood basal area (Fig. 2). The percent hardwood basal area at age 24 was essentially the same as at age 11. Hardwood ingrowth and pine mortality combined to maintain this constant proportion in the face of more rapid growth of individual pines. Control of both the herbaceous and woody competition early in stand life will produce even larger growth gains (Glover and Dickens 1985).

Woody competition control benefits go beyond residual tree growth. Native grass growth was doubled following control of heavy hardwood brush in a natural shortleaf stand in southeast Oklahoma. However, the grasses were quickly suppressed where dense pine regeneration developed following the brush control (Elwell 1967).

Stand access and visibility for future silvicultural operations and cruising are additional major reasons for controlling woody competition in commercial forests. Thinning and final harvest costs or stumpage values are negatively impacted by the presence of non-commercial woody competition in the stand. Pine stands in South Carolina without dense hardwood understories tend to bring bids \$5 to \$10 higher per thousand board feet than brushy stands because of improved visibility and safer logging conditions (Guldin 1985b).

#### WOODY COMPETITION CONTROL TIMING

Woody competition control can be done at any time given the variety of tools available today; these will be covered later. Control should be done when: (1) woody competition is recognized as a problem in the context of management objectives, (2) a suitable control tool is available, (3) the benefit/cost ratio weighs clearly in favor of control, (4) resources are available to carry out the control, and (5) control is the highest alternative use of available resources.

In plantations targeted for wood production, woody competition control should be done when pine and hardwood crowns begin to form a continuous canopy. Earlier removal may be called for if the economics and biology of the intended procedure are favorable. But, a dramatic increase in the herbaceous component will likely result since herbaceous species are capable of faster response to release from hardwoods than the pines. In most cases the herbaceous competition is more detrimental to early pine survival and growth than the woody component. Bacon and Zedaker (1986) found maximum early pine growth response when hardwoods were reduced to a low level and herbaceous competition was controlled completely.

Elimination of woody competition for any length of time is virtually impossible with any single treatment application (Cain and Yaussy 1984). Control of all woody competitors at the time of pine establishment also may not be desirable biologically because of their ability to suppress herbaceous competition development. Some species are particularly effective

LOBLOLLY PINE, AGE 24

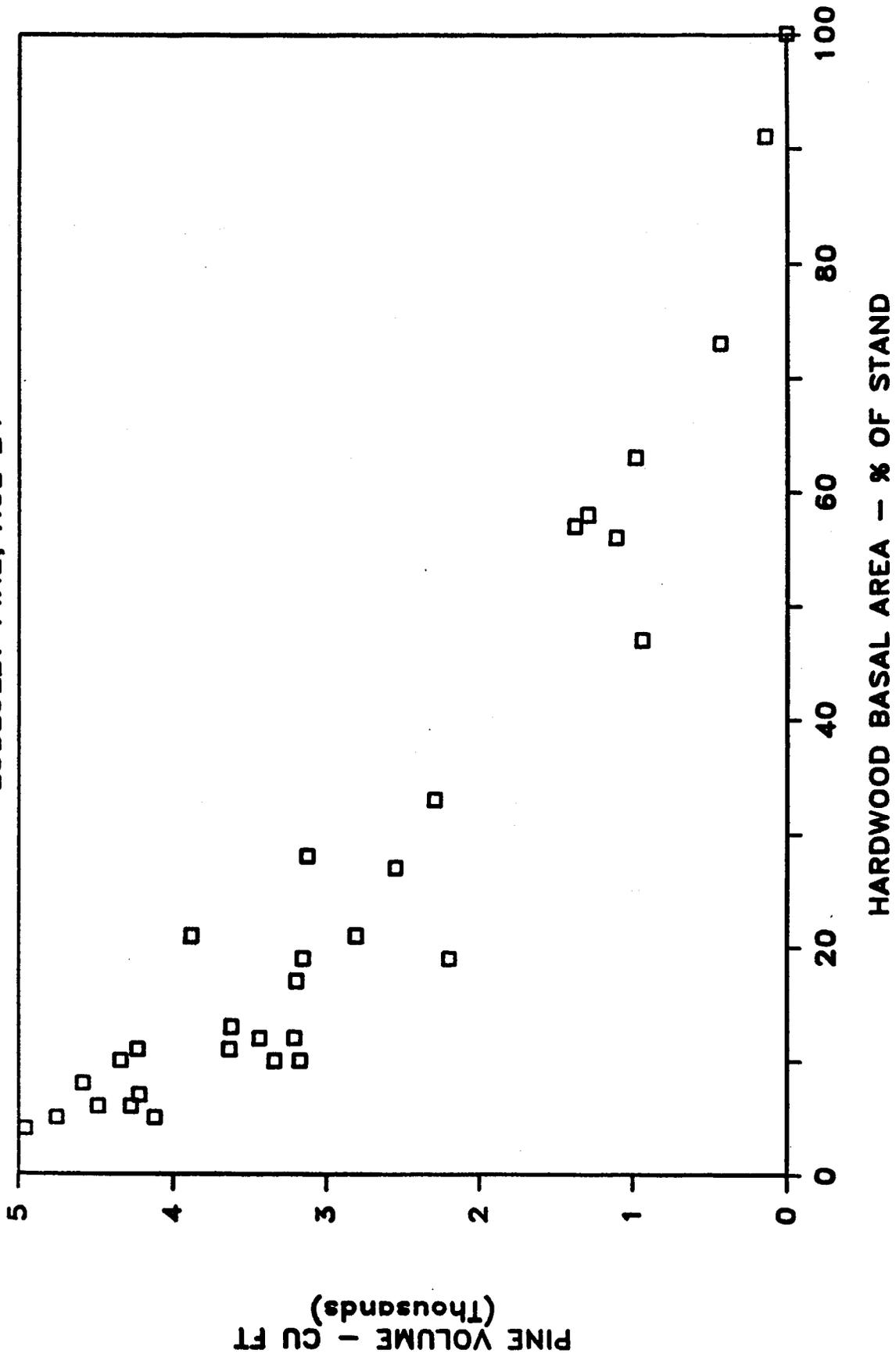


Figure 2. Impact of hardwood competition on loblolly pine yield 24 years after planting. From Glover and Dickens 1985.

against certain problem weeds, e.g., many prairie grasses will not grow under the relatively open canopy of winged sumac (Rhus copallina L.) (Petranka and McPherson 1979). Allelopathic effects of the sumac appeared to be the most important factor reducing density of the grasses. Grasses are major competitors and a fire hazard in many young pine plantations across the southeast; their control is often not attempted for lack of a cost effective treatment.

Woody competition control is best done prior to the culmination of mean annual height increment if the objective is to maximize timber production. This occurs relatively early in stand life, i.e., age 5 - 10 years. After this time the tree responds more slowly to release than if released prior to or during this period. Older shortleaf however are capable of responding to release (Guldin 1985b); also recall the data of Bower (1968) and Grano (1970) presented above. Control of a significant woody competition component in a pine stand will produce growth response at older ages but it will not be as large as if it had been done earlier and the stand maintained in a vigorous condition thereafter. However if the management objective is high quality saw timber and the stand is older and in need of release, woody competition control may still be an attractive investment since the incremental response will be in the form of high value wood and the investment can be recovered relatively soon. Elimination of woody competition control late in the rotation also has the potential of reducing or eliminating the need for control in the stand that follows.

Woody competition control for stand access reasons should be done the season prior to its need so regrowth will be minimal. However if safety hazards will be posed by large decaying stems, the control should be done three to five years prior to need. Natural regeneration needs can best be met by control the season prior to an expected good seed crop.

## WOODY COMPETITION CONTROL METHODS

### MECHANICAL

Woody competition can be controlled in existing stands by several means: mechanical, e.g., cutting; by use of prescribed fire; or through the use of herbicides. Mechanical control is perhaps the most positive in terms of immediate effect and can be highly selective. However if not used in combination with one of the other means it is least likely to provide more than temporary top-control. Most woody plant species in the southeast, including shortleaf pine, sprout profusely and can again become serious competitors shortly after cutting (Troth et al. 1986). Repeated annual or more frequent cutting will eventually kill the plant through depletion of root system reserves. However this is not practical in most forest land situations.

Mechanical control is effective and necessary for some purposes, e.g., improving access for harvesting, reducing stem sizes so that fire can be used for subsequent control or lowering browse levels and improving low-level game cover. This method is most likely to be used during thinning operations, especially in pre-commercial thinning where excess planted or naturally regenerated stems of the crop species are removed along with other unwanted woody competition.

The axe or saw is a highly selective tool, removing only the unwanted stems. The size and shape of the area impacted also is easily controlled. This infinitely variable effect on the timber stand in terms of the numbers and species removed, is limited only by the mental processes of its wielder. Its other strong advantages are that it can be used at almost any time of the year and in any terrain. Its chief disadvantages are high cost in some situations, the fact that top control is often all that is accomplished and the high probability of human injury associated with its use. Accidents in labor intensive forest work such as pre-commercial thinning and woody competition control with chain-saws are more frequent and severe than with most any other silvicultural operation. Newton and Dost (1984) report that the cost of accidents are approximately 10,000 times greater per unit area with such labor intensive vegetation management treatments than with aerial herbicide treatments.

## FIRE

Fire is perhaps the most widely used silvicultural tool in the southeastern U.S.; some 6.5 million acres are burned annually. The primary reasons for such wide-spread use are low cost, its ability to "clear out" the understory, ecosystem resiliency to its use and human fascination with fire. However burning is not without some major disadvantages: (1) a limited number of days in the year when fire can be used successfully and legally, (2) difficulty in predicting fire behavior and thereby effects on target as well as residual plants (3) limited effectiveness on large stems in selective control applications, (4) need for trained, experienced personnel to conduct burns, and (5) potential liability for smoke impacts away from burn area.

None the less, prescribed fire is widely used in an attempt to selectively control woody competition in shortleaf and other southern pine stands. This selectivity of control derives from the differential morphological capacity of various species and size classes to insulate meristematic tissues from high temperatures produced by the passing fire, e. g., thicker bark provides better insulation. Like mechanical methods, fire usually only top-kills woody competitors by killing the cambium near the ground, thereby girdling the stem. However, unlike mechanical methods, fire is normally effective only against small diameter stems when safely used in established stands. It follows that small pine stems also will be top-killed in such fires though relatively thick bark offers a degree of protection. Small stem control can dramatically improve visibility within a stand though and greatly facilitate certain activities, e.g., cruising, marking and thinning.

Hardwoods with groundline diameters greater than 2 inches are rarely top-killed by winter fires (Lotti 1960) considered safe in stands less than 30 feet tall. However, a series of annual summer burns in taller pine stands can be very effective in eliminating small sprouting competitors (Lotti et al. 1960), particularly if the burns are conducted early in the growing season when root carbohydrate reserves are low (Hodgkins 1958). Summer burns are difficult to execute though when hardwood basal area exceeds 40% of total stand basal area; the same is true for repeat annual winter burns in stands containing many hardwoods (Brender and Cooper 1968).

Care must be exercised in prescribed burning not to excessively scorch crop tree crowns. Crown scorch at any age has a major negative impact on

shortleaf and loblolly growth (Cain 1985), as well as the other southern pines (Bruce 1947, 1952; Johansen 1975; Muntz 1948), in proportion to the degree of live crown scorch. These effects may last several years as the crown is rebuilt and cambial damage repaired. If the scorch is severe, growth losses will more than offset the gains from competition control and stand access.

Smoke is becoming a troublesome by-product of fire which can create serious problems when it drifts into rural home sites, urban areas or onto public roads. The latter has contributed to serious vehicle accidents exposing the smoke generator to major liability claims. Prescribed fire use may decrease with time if regulations pertaining to emissions from silvicultural burning are tightened further. All who use fire in the forest have an obligation to improve smoke management practices, become more sensitive to public smoke management concerns and respond to them in a pro-active manner. Otherwise use of prescribed burning may be severely restricted.

## HERBICIDES

Herbicides, like mechanical competition control, can be used at any stand age. But unlike control with fire or mechanical means, herbicides can provide complete kill of stems and root stocks from a single application. Herbicide use is far more closely regulated than is prescribed burning and, like burning, herbicides must be used carefully, i.e., careful planning, handling, application and attention to environmental considerations. However, because of the vast amount of information required to obtain use registration, herbicides applied in accordance with label recommendation are probably safer to use and give more predictable results than fire.

As a group, broadcast-applied herbicides are less selective in control than mechanical methods but, depending on the situation, more selective than fire. Selectivity tends to be expressed at the level of genera. Individual stem injection allows one to be very selective within all except the smallest diameter classes. Selectivity can be altered further by: (1) using directed instead of broadcast application to avoid application to susceptible crop species, (2) varying season of application to capitalize on target species susceptibility or minimize crop species susceptibility to damage, (3) use of adjuvants to increase target species susceptibility.

Herbicides can be applied in conjunction with mechanical operations to prevent sprouting of the cut trees. Troth et al. (1986) however found herbicide "flash-back" into residual shortleaf and loblolly pine following treatment of shortleaf stumps. Residual pines also suffered soil-active herbicide injury from hardwood stump treatments. These findings point out the importance of thoroughly understanding herbicide performance and behavior before making large-scale applications.

Some 20 herbicides are registered for woody competition control in southern pine stands. The seven formulations that can be used for pine release contain one of four active ingredients (Table 1). An additional promising pine release herbicide, Arsenal(tm) is available for use in 1986 only under an experimental use permit. Hexazinone formulations have the potential for producing the greatest growth response due to their activity against many herbaceous as well as hardwood competitors. Arsenal also controls many herbaceous plants.

**TABLE 1. Herbicides currently registered for pine release in the southern United States and application methods.**

<b>Common Name</b>	<b>Trade Name</b>	<b>Application Method</b>
<b>Dichlorprop</b>	<b>Weedone(tm) 2,4-DP</b>	<b>Broadcast * Directed Spray</b>
<b>Glyphosate</b>	<b>Roundup(tm)</b>	<b>Broadcast Directed Spray</b>
<b>Hexazinone</b>	<b>Buckshot(tm) 10-PH</b>	<b>Broadcast</b>
	<b>Pronone(tm) 5G</b>	<b>Broadcast</b>
	<b>Pronone(tm) 10G</b>	<b>Broadcast</b>
	<b>Velpar(tm) L</b>	<b>Broadcast Grid Spot</b>
<b>Triclopyr</b>	<b>Garlon(tm) 3A</b>	<b>Directed Spray</b>

**\* FIFRA Section 24-C labeling only for loblolly pine in AR, LA, MS, NC, OK and TN**

None of these herbicides are a panacea for woody competition problems. But excellent results can be obtained in most situations if the prescription is developed with a thorough understanding of the limitations and behavior of the herbicide, if the herbicide is matched to stand and site characteristics, and if it is properly applied. A recently published silvicultural herbicide use guide (Cantrell 1985) should be of considerable value to those using herbicides in forestry.

#### SUMMARY

Woody competition control is necessary for the long-term maintenance of shortleaf and other pines in the natural forests of the Southeast. Control also is necessary to maximize timber production in both natural stands and plantations since growth is limited by soil moisture availability over much of its range.

Substantial growth gains have been reported following woody competition control in mature stands. Larger gains can be expected from earlier treatment provided the stand is appropriately thinned at later ages. Growth gains are inversely related to the proportion of total stand basal area that is woody competition. Forage production also is stimulated by woody competition control; however, herbaceous control early in stand life will produce substantial additional pine growth gains.

Mechanical control methods offer the most individual stem selectivity but have the disadvantages of relatively high cost, high probability of human injury and only temporary control of most sprouting woody plants.

Fire is a relatively inexpensive, widely used woody competition control tool. However fire provides only temporary control of small stems and reduces growth of residuals if crowns are scorched. Fire use also requires careful smoke management in many areas.

Herbicides offer positive control of susceptible species and may be used at any stand age, but are less selective than mechanical means and can be costly. Herbicides, like fire, require specialized knowledge for effective use. Six herbicides are registered for shortleaf pine release in the Southeast.

Forest competition control technology is a rapidly evolving field in the South. All using these practices should develop a good understanding of the basic principles involved, stay abreast of developments and use the technology in a responsible manner.

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