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CHEMICAL CONTROL OF WOODY SPROUTS FOLLOWING MECHANICAL REMOVAL OF LARGE HARDWOODS WITHIN A LONGLEAF PINE MATRIX

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Abstract: Historically, frequent low-intensity wildfires prevented hardwood encroachment in mature longleaf pine (*Pinus palustris* Mill.) forests. When overstory pine stocking is reduced, however, especially when in conjunction with reduced fire frequency, hardwood encroachment can lead to a mixed pine-hardwood overstory and a change in the groundcover. To restore one such area on Ichauway, a 29,000 acre reserve in southwest Georgia, large hardwood stems were harvested and prescribed fire utilized to control hardwood brush. Because fuel loads were low due to low pine basal area, however, the sites did not burn effectively and small hardwood sprouts dominated the understory. Based on results from a pilot study, we implemented an operational project to compare effectiveness of three herbicides in rapidly restoring fuels while protecting longleaf pine regeneration, wiregrass (*Aristida beyrichiana* Trin. & Rupr.) and legumes (specifically goat's rue - *Tephrosia virginiana* (L.)). We applied the herbicide treatments on the 33 acre tract using 3 replications. Garlon 4F (4 qt acre^{-1}) and Arsenal (16 oz acre^{-1}) treatments were broadcast applied in the fall of 2002, while Velpar L (3 qt acre^{-1}) was band applied in spring 2003. Vegetation composition was monitored using a 1.6 ft^2 quadrat at points along a 1.5 x 1.5 chain grid. All treatments protected the species of concern. The Arsenal treatment was extremely effective in controlling oaks and woody shrubs and had a significantly higher percentage of goat's rue by May 2004. Garlon 4 initially killed hardwood sprouts; however, the response did not persist and sprouts were significantly higher in this treatment by fall 2003, likely due to application outside optimum conditions. Hardwood control on Velpar plots was intermediate to the other two treatments.

INTRODUCTION

Historically, frequent, low-intensity fires in the southeastern United States prevented large accumulations of fuel (Heyward 1939; Brockway and Lewis 1997), created a bare mineral soil seedbed for longleaf pine regeneration (Hodgkins 1958; Rebertus et al. 1989; Brockway and Lewis 1997; Brockway and Outcalt 2000; Provencher et al. 2001), impeded hardwood encroachment (Heyward 1939; Rebertus et al. 1989; Brockway and Lewis 1997), promoted flowering of certain species (such as wiregrass (*Aristida beyrichiana* Trin. & Rupr.); Mulligan et al. 2002), provided habitat for wildlife (Brockway and Lewis 1997; Brockway and Outcalt 2000) and controlled brown spot needle blight infection (Rebertus et al. 1989; Brockway and Lewis 1997; Brockway and Outcalt 2000).

When overstory pine stocking is reduced, however, especially when in conjunction with reduced fire frequency, hardwood encroachment can lead to a mixed pine-hardwood overstory and a change in the groundcover. Specifically, herbs, grasses and overall diversity are reduced while hardwood sprouts are increased. Over time, the hardwoods grow into the mid- and overstories, further degrading the sites (Heyward 1939; Rebertus et al. 1989) by reducing the amount of flammable litter. In addition, large diameter hardwoods are generally difficult to top-kill using prescribed fire (Heyward 1939; Rebertus et al. 1989; Provencher et al. 2001), therefore, alternative methods may be required for restoration in these degraded areas (Heyward 1939; Brockway and Outcalt 2000; Provencher et al. 2001).

Mechanical means can be used to remove large stems from the overstory; however, mechanical treatments alone can result in excessive hardwood sprouting (Provencher et al. 2001). The use of herbicides has been suggested as a means of effectively removing hardwoods, reducing competition and increasing light availability at the forest floor, thereby promoting the growth of grasses and herbaceous vegetation (Brockway and Outcalt 2000). Herbicides have been successfully used to restore degraded sandhill sites (Harrington and Edwards 1999; Brockway and Outcalt 2000; Provencher et al. 2001). And, in a pilot study (Gagnon et al. 2003), the efficacy of a Garlon 4/Tordon/Escort mixture in restoring fuels to field edges and hedgerows in a degraded condition was demonstrated.

The difficulty in prescribing herbicide treatments is chemicals which control hardwoods generally also affect either the grasses or herbaceous plants in the groundcover; i.e., we can control the brush but we will potentially also kill either the grasses or forbs, both of which we desire to maintain in the groundcover for fuels, nutrient cycling, wildlife and aesthetics. To determine which chemical formula is most effective in killing the hardwood sprouts while protecting the desirable vegetation, we examined the effects of three different chemical treatments, Garlon 4, Arsenal, and Velpar L. These herbicides were chosen for their different effects on groundcover plants.

METHODS

Study site

This adaptive management study was conducted at the Joseph W. Jones Ecological Research Center, at Ichauway, located in southwestern Georgia, USA, in the lower Gulf Coastal Plain. The 29,000 ha property contains approximately 18,000 acres of mature (70+ years) fire-maintained second-growth longleaf pine. The climate for this area is classified as humid subtropical with an average annual precipitation of 52 inches, distributed evenly throughout the year. Mean daily temperatures range from 69 to 93°F in summer and 41 to 63°F in the winter.

The soils in the 33 acre study area consisted of somewhat excessively drained or well-drained Kandiudults. Overstory vegetation, prior to hardwood removal, consisted of mixed longleaf pine hardwoods, and the dominant hardwood species were southern red oak (*Quercus falcata* Michx.) and live oak (*Q. virginiana* Mill.). The majority of large hardwood stems were mechanically removed during 2001. The density of the remaining overstory longleaf pine was sparse and the canopy was essentially open. Two-thirds of the area was burned in 2001, the remainder in 2002. Because fuel loads were low due to low pine basal area, however, the sites did not burn effectively and small hardwood sprouts dominated the understory. There was, however, a significant population of both wiregrass and goat's rue (*Tephrosia virginiana* (L.)).

Field Work

Building on the results of a pilot study (see Gagnon et al. 2003), we applied 3 different herbicide mixtures on the 33 acre tract using 3 replications (approximately 11 acres total per mixture). The herbicides included: Arsenal (active ingredient Imazapry), a post emergent spray for control of most annual and perennial grasses, broadleaf weeds, vines, briars and hardwood sprouts; Velpar L (active ingredient hexazinone), which provides both contact and residual control of annual, biennial and perennial weeds and hardwood sprouts; and Garlon 4 (active ingredient triclopyr), which controls annual and perennial broadleaf weeds and hardwood sprouts, but not annual grasses.

Garlon 4F (4 qt $acre^{-1}$) and Arsenal (16 oz $acre^{-1}$) were broadcast applied in the fall of 2002, while Velpar L (3 qt $acre^{-1}$) was band applied in spring 2003. By spring 2004, hardwood sprouts were abundant in the Garlon 4 treatment areas and the herbicide was re-applied to approximately 6 of the original 11 acres in July, 2004.

Changes in vegetation composition were monitored by placing a 2.7 ft^2 quadrat at temporary points along a 1.5 x 1.5 chain grid. Relative cover (of 100%) of vegetation in each of the following categories was recorded: wiregrass, other grass, forb (including legumes), vine, live oak, other oak, woody, debris, bare ground, shrub, fern, and goat's rue. General observations of the remaining overstory hardwoods and pines, as well as advanced longleaf pine regeneration, were also noted. Monitoring occurred in fall 2003 and 2004 and in the spring of 2004. All data were analyzed using ANOVA procedures and Duncan's Multiple Range Test in SAS. Significance was determined at $\alpha = 0.05$.

RESULTS

Arsenal

Arsenal was effective in top-killing hardwood sprouts (Figure 1). As a result, the amount of bareground present in the spring of 2004 was highest for this treatment (7% vs. 1 and 2 % for the Garlon and Velpar treatments, respectively), creating space for legume and forb growth. By fall 2004, coverage of wiregrass (11%) and herbaceous plants (13%) was high, providing fuels for future prescribed fires. Two years after herbicide application, oak sprouts remained sparse (3%), however, other woody vegetation was highest among the treatments (11%) due to a proliferation of *Rubus* spp. in the openings created by hardwood dieback.

Velpar

Velpar initially top-killed all woody sprouts except for Sassafras (*Sassafras albidium* (Nutt.) Nees), which is tolerant of hexazinone. There was also mortality of the remaining large overstory hardwoods on the site. And, while wiregrass and forb coverage were lower than in the Arsenal treatment, they were not significantly lower by fall 2004 (11 and 9%, respectively). Although not indicated by the data, personal observation indicated that there was an increase in oak sprouts by the fall, indicating a need for either prescribed fire or re-application of the herbicide.

Garlon

Initially, the Garlon treatment was also effective in top-killing hardwood sprouts. However, by the spring of 2004, live hardwood sprouts were once again abundant (47% of groundcover vs. 10% and 14% for the Arsenal and Velpar treatments). The Garlon was applied late in the growing season, past the optimum date. We re-applied the treatment to half of the originally treated area in July 2004. By September, live hardwood sprouts were reduced to 3% of the groundcover in these re-treated areas (data not shown). However, there was also a corresponding decrease in forb coverage immediately following application (1% cover vs. 13, 11 and 9% for Arsenal, Garlon and Velpar, respectively).

CONCLUSIONS

All three chemicals in this study protected wiregrass, goat's rue and longleaf pine regeneration and promoted the development of fine fuels, but it is apparent that timing of application is quite important. That is, if applied at the appropriate time, Garlon can control woody vegetation and it is quite likely that Arsenal, applied during the growing season, would be detrimental to wiregrass. Most importantly, the chemical applications will not control hardwood stems indefinitely in these open canopy forests, and aggressive prescribed fire is required for continues control. Each of the chemicals are useful tools when thoughtfully matched with stated management objectives.

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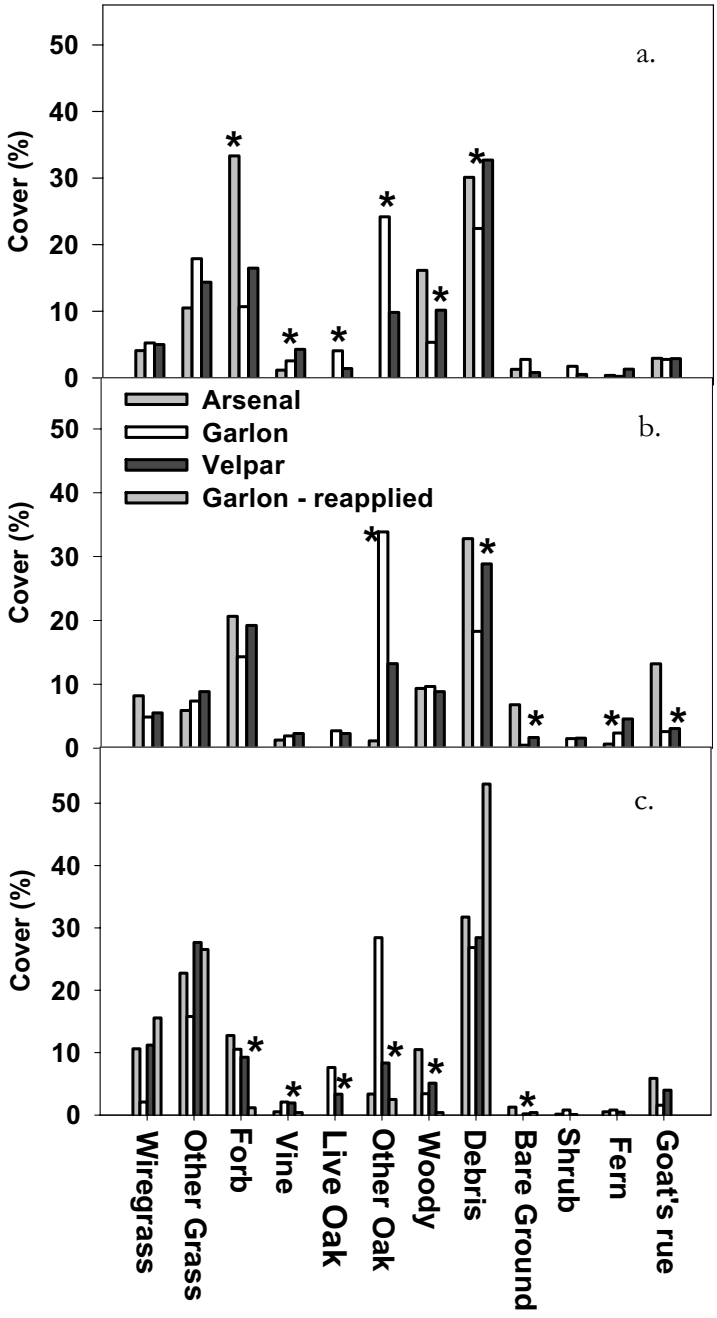

Figure 1. Percent cover by species group in (a) fall 2003 (b) spring 2004, and (c) fall 2004.