

LOBLOLLY PINE GROWTH FOLLOWING OPERATIONAL VEGETATION MANAGEMENT TREATMENTS COMPARES FAVORABLY TO THAT ACHIEVED IN COMPLETE VEGETATION CONTROL RESEARCH TRIALS

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Abstract—Different combinations of chemical site prep and post-plant herbaceous weed control installed at three Upper Coastal Plain locations were compared in terms of year 3 loblolly (*Pinus taeda* L.) pine response to determine the better vegetation management regimes. Site prep treatments were different herbicide rates applied in either July or October. Site prep treatments were followed by different herbaceous weed control application timings. July site prep applications performed better than October applications and the higher site prep herbicide rates performed better than the lowest rate. First year herbaceous weed control was more important than second year but first plus second year had the greatest response. Year 3 pine response to the operational vegetation management regime of July chemical site prep with first year herbaceous weed control was comparable to or exceeded year 3 pine response to complete weed control reported in a previous research experiment conducted on similar sites.

INTRODUCTION

Selection of an optimal vegetation control regime to provide the best pine response is complicated because pine response depends on amount and composition of competing vegetation, the degree and duration of vegetation control achieved, and pine tolerance to the herbicides used. It is necessary to examine treatment combinations on many sites and to evaluate pine response, not just weed control. Long-term studies are cost prohibitive because of the large number of potential treatments and because operational treatments change relatively quickly due to new technology and changing treatment costs. However, comparing short-term response to responses observed in older, long-term research trials provides a useful comparison of early stand development and longer-term growth and yield expectations. This paper compares different combinations of chemical site prep and post-plant herbaceous weed control (HWC) to determine the most effective operational vegetation management regimes for establishing Upper Coastal Plain loblolly pine plantations. These operational treatments are compared to more intensive control treatments in a long-term research trial reported by Miller and others (2003).

Miller and others (2003) summarized pine response in a multiple location study designed to determine maximum potential growth of loblolly pine following complete early control of woody, herbaceous, and woody plus herbaceous plants. They found that for high hardwood (> 10 percent stand basal area in hardwood at age 15) or high shrub sites it was more important to control woody competition than herbaceous competition and that the greatest response was achieved by controlling both. Further, that early response to herbaceous weed control was sustained only in the absence of woody competitors. Controlling both woody and herbaceous vegetation increased year 15 merchantable volume 66 percent on average with gains ranging from 23 to 121 percent depending on location.

By comparison, the operational vegetation management strategy examined in this multiple location study used

Chopper® (BASF Corporation, Research Triangle Park, NC) herbicide site preparation to control woody vegetation. Different timings of Arsenal® (BASF) Applicators Concentrate plus Oust® (E.I. DuPont de Nemours and Company, Wilmington, DE) herbaceous weed control were applied following Chopper® herbicide site prep to determine the most effective operational treatment regime for both woody and herbaceous control in Upper Coastal Plain loblolly pine plantations.

METHODS

An operational vegetation control study was installed in 2002 to examine timing and rate of Chopper® herbicide site prep followed by post-plant HWC on Upper (Middle and Hilly) Coastal Plain sites. There were six Chopper® herbicide site prep treatments applied as main plot treatments and replicated three times at each of three locations. The six chemical site prep treatments were 32, 48, or 64 ounces per acre Chopper® herbicide applied either in July or October. A tank mix herbicide was included at a constant rate at each location to control blackberry (*Rubus* spp.). Treatments were broadcast using a CO₂ powered backpack research sprayer with a 3 nozzle boom using Turbo Flood® (Spraying Systems, Co., Wheaton, IL) 2.0 nozzles at 10 gallons per acre with the swath centered on tree rows. This technique provided very uniform rates for each subplot row that received subsequent HWC treatments. Six different herbaceous weed control treatment regimes were applied as subplot treatments to tree rows 120 feet (70 feet at the Zwolle location) in length within each chemical site prep treatment plot. Therefore, each herbaceous weed control treatment described in table 1 was applied to 18 subplots at each location. The exception to this was at Barnett Crossroads where an additional main plot treatment without Chopper® herbicide site prep was included. The HWC treatment for all application dates was 4 fluid ounces per acre Arsenal® Applicators Concentrate (AC) plus 2 ounces per acre Oust®. HWC treatments were applied as 6-foot bands using a 2 nozzle (Turbo Flood® 2.0) boom at 15 gallons per acre. Table 2 lists mechanical site preparation, fertilization, Chopper® herbicide application dates and tank mix herbicide for the three study locations.

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Table 1—Description of post-plant herbaceous weed control treatment regimes

Herbaceous weed control timings	Descriptor used in tables and figures
None	No HWC
March 2003	Yr 1 March
March 2003 combined with March 2004	Yr 1 March + Yr 2 March
June 2003	Yr 1 June
June 2003 combined with March 2004	Yr 1 June + Yr 2 March
March 2004	Yr 2 March

Pine groundline diameter (g.l.d.) and total height was measured in December 2005 at the end of the third pine growing season. Year three stem volume index was computed as a volume of a cone using g.l.d. and total height. Vegetation development was measured using ocular estimation of cover through the first two growing seasons.

RESULTS AND DISCUSSION

This experiment used currently available products at operational rates to develop treatment regimes that optimize pine response. There were a total of 36 different Chopper® site prep and herbaceous weed control combinations. There was no interaction between site prep treatment and HWC treatment and results for main effects are provided.

Herbaceous Weed Control Timing

Single applications—Year 3 gains in volume index from the best first year herbaceous weed control treatment were 92, 77, and 159 percent at Barnett Crossroads, Crossett, and Zwolle, respectively (fig. 1). First year HWC was more important than second year HWC at all locations. First year March HWC performed better than first year June at Barnett Crossroads and Zwolle, but not at Crossett where the June application was best. Examination of weed control efficacy and pine response indicated that uncontrolled herbaceous development between March and June at Barnett Crossroads restricted pine growth, that March applications at Zwolle

provided better herbaceous control than June applications, and that later season weed control was more important at Crossett due to slow early season development of both pines and herbaceous cover on this soil type.

Double applications—Pines responded positively to an additional year of HWC (fig. 2). Second year March HWC following first year March HWC increased stem volume by 5, 23, and 21 percent at Barnett Crossroads, Crossett, and Zwolle, respectively. At Barnett Crossroads the dominant herbaceous competitor was broomsedge (*Andropogon* spp.). The second year March HWC treatments did not control this dominant competitor resulting in the small response at this location.

The positive pine response to an additional year of weed control is an important finding for landowners. It is reasonable to expect a 20 to 25 percent increase from the additional year of weed control when the treatment is effective. Previous work by Lauer and others (1993) investigated the benefit of a second year of herbaceous weed control on eight sites. Pines on only three of eight sites had a significant diameter response to a second year of weed control. However, Lauer's studies used multiple applications to achieve near complete control of weeds during the first and second years and do not address the question of response from single HWC treatments with modern herbicides in consecutive years.

Table 2—Description of site preparation and fertilization for Chopper herbicide site prep study locations

	Barnett Crossroads, AL	Zwolle, LA	Crossett, AR
Mechanical site prep	April burn and early June single pass rip and bed	June pile and burn with little soil disturbance	Early June bed
Fertilization	None	91 pounds per acre DAP applied in 4 foot band	None
Chopper® herbicide application dates	7/26/2002, 10/11/2002	7/20/2002, 10/14/2002	7/19/2002, 10/15/2002
Chopper® tank mix herbicide	32 ounces per acre Garlon® (Dow Agrosciences, Indianapolis, IN) 4	64 ounces per acre glyphosate (41% formulation)	64 ounces per acre glyphosate (41% formulation)

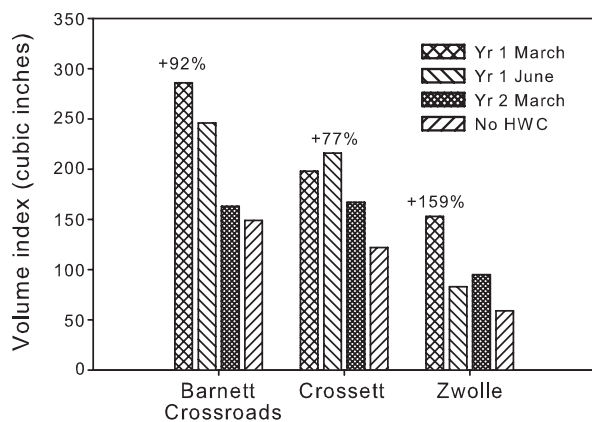


Figure 1—Third year loblolly pine stem volume index for no herbaceous weed control (No HWC) and different timings of a single Arsenal® AC plus Oust® herbaceous weed control treatment. Application timings were first year March (Yr 1 March), first year June (Yr 1 June), and second year March (Yr 2 March). Percentages show the percent gain over No HWC from the best timing at each location.

Chemical Site Prep

Chopper® herbicide timing—July applications yielded greater pine growth than October applications. These differences were most important for the best growing treatments that combined July application with first year HWC. Under these circumstances, the July timing increased growth over October by 12 to 26 percent (fig. 3). These results are consistent with Lower Coastal Plain studies in which Chopper® herbicide site prep earlier in the year resulted in better pine growth (Lauer and Quicke 2006).

Chopper® herbicide rate—Rates of 48 or 64 fluid ounces per acre resulted in better growth than 32 ounces per acre on all three sites. Growth increases from the higher rates ranged from 5 to 20 percent (fig. 4).

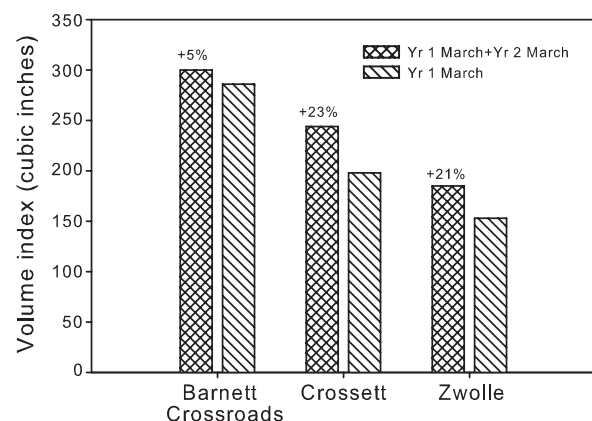


Figure 2—Third year loblolly pine stem volume index for the single first year March (Yr 1 March) and first year March plus second year March (Yr 1 March + Yr 2 March) application of Arsenal® AC plus Oust® herbaceous weed control treatment. Percentages are the gain from the second year application.

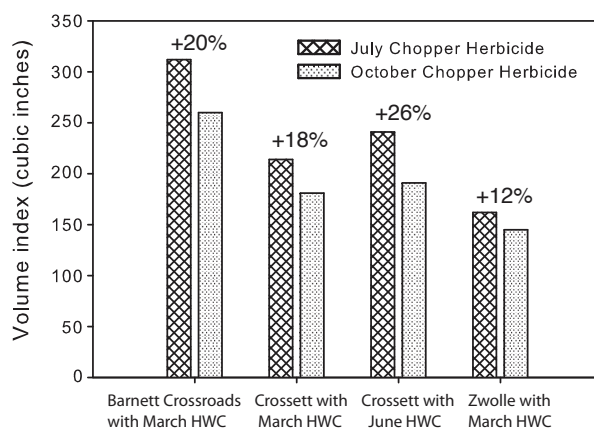


Figure 3—Third year comparison of July and October Chopper® herbicide site prep when used with year 1 herbaceous weed control. Percentages show the gain in loblolly pine stem volume index for the July over the October application timing.

Operational Conclusions

These results indicate that first-year HWC is important on Upper Coastal Plain sites, that earlier season Chopper® herbicide applications should be preferred but is not essential if operational constraints prevent them, and that Chopper® herbicide rates of 48 or 64 ounces per acre provided better pine response than 32 ounces per acre.

COMPARISONS

Herbaceous Control without Herbicide Site Prep

The Barnett Crossroads location included an additional main treatment plot with no Chopper herbicide site prep. The pattern of response to different herbaceous weed control regimes was similar with or without herbicide site prep. However, all herbaceous weed control treatments combined with Chopper® herbicide performed considerably better than those without (fig.

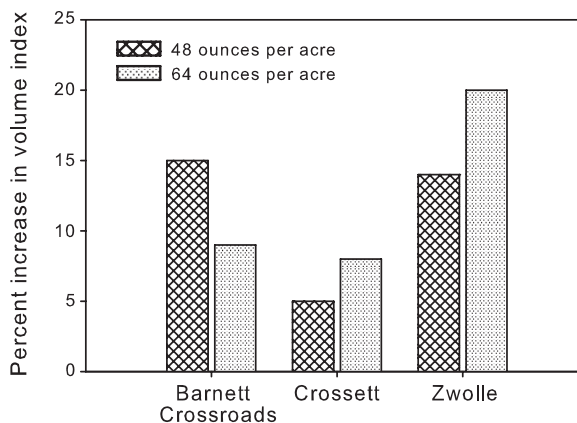


Figure 4—Third year percent increase in stem volume index for the 48 or 64 fluid ounce per acre rate over the 32 fluid ounce per acre rate of Chopper® herbicide.

5). Combining Chopper herbicide site prep with HWC resulted in a synergistic (more than additive) response (fig. 6).

Long-term gains from first year herbaceous weed control treatments depend on the conditions under which they are used. Gains might not be achieved if the treatments do not control established species, germinating species, or are used without previous woody vegetation control. Chopper® herbicide site prep provides a base treatment to control established vegetation prior to HWC. A gradient in quality of vegetation control was observed at Barnett Crossroads (fig. 7) where year 3 volume index was closely related to average total first year cover for site prep treatments with and without year 1 March HWC. Further, of the total percent cover, there was less than 4 percent cover in woody vegetation following chemical site prep and more than 40 percent cover in woody vegetation for treatments without chemical site prep.

Comparing Growth of Operational to Complete Control Studies

Response to vegetation control depends on many factors such as timing and duration of control, level of vegetation that would be present without control, type of competing vegetation (tree, shrub, grass, forb, etc.), and crop tolerance to vegetation control methods. Long-term response research simplified this research problem by estimating maximum potential response to vegetation control using total vegetation control treatments. These long-term studies provide yield estimates under weed free conditions. The study series used for comparison here was more rigorous in understanding stand development in terms of vegetation type and included complete herbaceous control, complete woody control, and complete woody and herbaceous control.

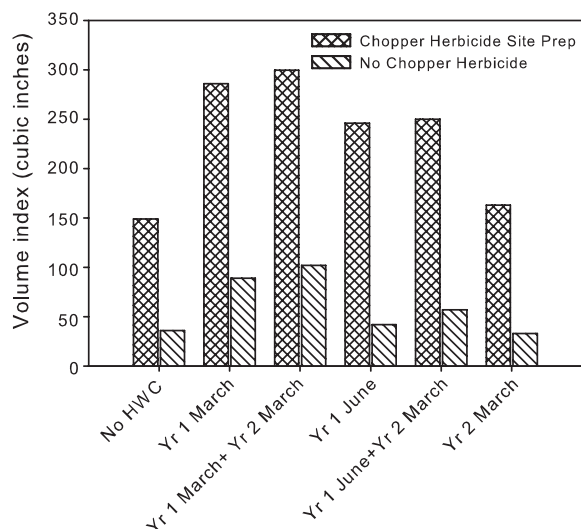


Figure 5—Third year loblolly pine stem volume index compared by herbaceous weed control treatment with and without Chopper® herbicide site prep at Barnett Crossroads, AL. HWC treatments were applications of Arsenal® AC plus Oust® in March or June of the first year (Yr 1) and/or March of the second year (Yr 2).

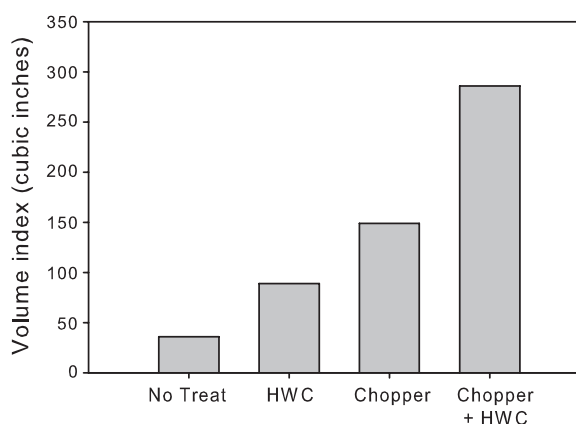


Figure 6—Third year stem volume index at Barnett Crossroads showing a synergistic (more than additive) response to the combined treatment of Chopper® herbicide site prep and HWC. Treatments are rip and bed site prep without additional vegetation control (No Treat), with year 1 March application of Arsenal® AC + Oust® for herbaceous weed control (HWC), with Chopper® herbicide site prep (Chopper), or with both Chopper® and HWC.

Long-term intensive vegetation control studies were intended to provide baseline information by which to judge operational treatments and to judge growth responses in young stands without requiring long-term studies for every potential silvicultural treatment. However, weather patterns, crop tree genetics, nursery practices, and other factors are never constant. Comparisons of “gains” over an untreated check included in both the long-term complete control studies and the younger operational treatment studies will mitigate this problem if gains to vegetation control treatments and these other factors are approximately additive, and are conservative if gains are less than additive.

Treatment definitions—Stand development to complete vegetation control was reported through age 15 by Miller and others (2003). This baseline study included no vegetation control, 4 years of complete herbaceous control, complete woody control, and complete woody and herbaceous control. These treatments are paired with the operational treatments listed in table 3. Operational treatments were one time applications that were most effective based on study results. The woody control operational treatment was 48 ounces per acre July Chopper® herbicide site prep. The herbaceous weed control treatments were either first year March (Barnett Crossroads, Zwolle) or first year June (Crossett) applications of Arsenal® Applicators Concentrate plus Oust®.

Locations compared—The long-term complete control study had eight study locations on Upper Coastal Plain sites. Comparisons were made for the three locations that most closely matched the operational study locations based on soils, competing vegetation, and geographic location. Operational and complete control study locations compared are listed in table 4. Responses are also compared to the average response across all eight Upper Coastal Plain sites.

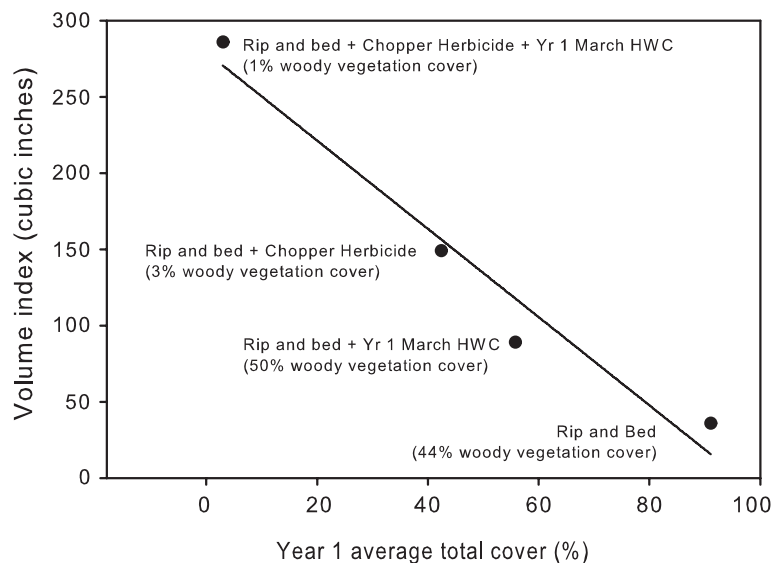


Figure 7—Linear relationship ($R^2 = 0.96$) between third year stem volume index and average first year percent total (woody plus herbaceous) cover of competing vegetation at Barnett Crossroads. Average total cover is average of June and August first year cover assessments.

Comparison of year 3 height gains—Year 3 height gains over the no vegetation control treatment are compared between the operational Barnett Crossroads and complete vegetation control study at Atmore in figure 8. Height gain is used to reduce the effects of factors that differ by study and location. This was only possible for the operational study at the Barnett Crossroads location where all HWC treatments were included without Chopper® site prep. The average gain for all eight Upper Coastal Plain complete control study locations is included for comparison.

The Barnett Crossroads and Atmore locations had similar vegetation of herbs, hardwoods, and gallberry (*Ilex glabra* (L.) Gray.) on similar soils. Year 3 height gains to operational treatments at Barnett Crossroads were similar or greater than

gains from complete control treatments at Atmore. Height gain to Chopper® herbicide site prep with HWC at Barnett Crossroads was 4.2 feet compared to 3.1 feet from complete woody and herbaceous control at Atmore. The 3.1 foot year 3 height gain at Atmore equated to an increase of 1 913 cubic feet per acre (121 percent) in year 15 merchantable volume (Miller and others 2003).

Comparison of year 3 heights—The Zwolle and Crossett study locations did not include HWC treatments without herbicide site prep so comparisons of height gains and isolation of the effects of other silvicultural treatments were not possible. Year 3 heights (fig. 9) following operational regimes of Chopper® herbicide site prep with first year HWC compare favorably or exceed year 3 response observed in complete vegetation control research trials.

Table 3—Definition of vegetation control level for complete control and operational treatment research studies

Vegetation control level	Complete control studies	Operational treatment studies
None	No weed control	No weed control
Herb	4 years complete herbaceous control	Year 1 Arsenal® AC + Oust® HWC
Woody	4 years complete woody control	July site prep with 48 ounce/acre Chopper® herbicide
Woody + Herb	4 years complete vegetation control	July site prep with 48 ounces per acre Chopper® and year 1 Arsenal® AC + Oust® HWC

Table 4—Description of study type (operational or complete vegetation control treatments), soil series, mechanical site prep, approximate level of woody vegetation, and planting method by study location

Location	----- Alabama -----		----- Louisiana -----		----- Arkansas -----	
	Barnett Crossroads	Atmore	Zwolle	Arcadia	Crossett	Warren
Study type	Operational	Complete	Operational	Complete	Operational	Complete
Soils series	Orangeburg/ eroded Troup	Orangeburg	Kirvin/Sacul	Sacul	Bude	Saffell/Stough
Site prep	Rip and bed	Whole tree chip	Pile only	Chop and Burn	Bed	Chop and Burn
Woody vegetation	Low hardwood, moderate gallberry	Low hardwood, moderate gallberry	Moderate hardwood	Moderate hardwood	Low hardwood	Low hardwood
Planting method	Machine	Hand	Machine	Machine	Hand	Hand

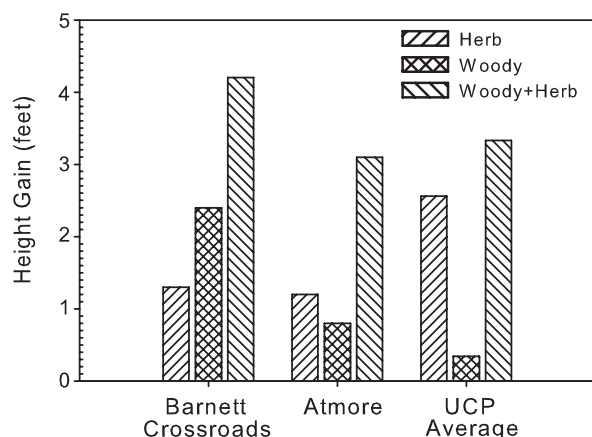


Figure 8—Year 3 loblolly pine height gain (over no vegetation control) for herbaceous, woody, and woody + herbaceous vegetation control for operational treatments at Barnett Crossroads, complete control treatments at Atmore, and complete control treatments averaged across eight Upper Coastal Plain (UCP) sites. Barnett Crossroads and Atmore locations had similar vegetation types. Operational woody control was Chopper® herbicide site prep. Operational herbaceous control was one first year Arsenal® AC plus Oust® application. Complete control was 4 years of complete woody control, complete herbaceous control, or both.

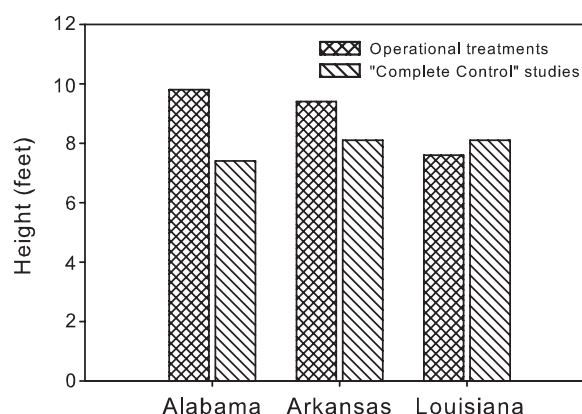


Figure 9—Year 3 loblolly pine height for woody plus herbaceous vegetation control treatments for paired operational and complete control studies. Operational woody control was Chopper® herbicide site prep. Operational herbaceous control was one first year Arsenal® AC plus Oust® application. Complete control studies had 4 years of complete woody control or complete woody and herbaceous control.

CONCLUSION

Examination of 36 different treatment regimes on Upper Coastal Plain sites determined that gains can be made by selecting the rate and timing of Chopper® herbicide and the timing of herbaceous weed control. July Chopper® herbicide applications performed better than October applications. Chopper® herbicide rates of 48 or 64 ounces per acre performed better than 32 ounces per acre. First year HWC was more important than second year HWC but combining first and second year HWC increased growth. Pine response to March HWC was better than June HWC at two of three locations. On a poorly drained silt-loam soil with high water table in Arkansas, June HWC was better than the more traditional March timing.

Operational vegetation management treatment regimes can be used to achieve pine response that either exceeds or compares favorably with pine response observed in intensive vegetation control research trials. The operational treatment used for comparison was an operational rate of Chopper®

herbicide site prep with one herbaceous weed control treatment. This treatment regime was effective because it provided high quality vegetation control of both woody and herbaceous vegetation and provided the same synergistic response observed in intensive vegetation control trials when both woody and herbaceous vegetation were completely controlled.

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