Growth Response and Economics of Herbaceous Weed Control in Loblolly Pine Stand Management

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Introduction

Stand establishment is a very critical decision-making phase in the life of a pine plantation. Site preparation (chemical, mechanical, combinations with or without burning), species selection, seedling genetics, seedling size, weed control, fertilization, and spacing decisions made prior to, during, and soon after planting have long-term effects on stand survival, growth, wood yields, rotation age, and products grown. Site preparation goals include: control of competing vegetation, amelioration of soil conditions that restrict root growth, improving near-term nutrient status, minimizing near- and long-term negative site productivity impacts, and making the site easier to plant. Competition control through site preparation treatments and post-plant herbaceous weed control are intended to enhance seedling survival and growth following planting.

Herbaceous weed control

During the first three years in the life of a pine stand growth is limited mostly by herbaceous weeds (Tiarks and Haywood 1986, Miller et al. 1991). Herbaceous weed control, when using appropriate forest herbicides at the right time and dosage, can increase:

(1) pine seedling survival, especially in droughty growing seasons,
(2) early growth, and
(3) reduce rotation age (Lauer et. al. 1993).

When planning a herbaceous weed control treatment, the landowner, consultant, and applicator should consider the following to ensure maximum benefit of the forest herbicide used:

(1) Crop species (different products and rates for each pine species) and growth phase (active versus resting)
(2) Weed species and stage of weed development
(3) Application method (spot, banded, broadcast, aerial)
(4) Soils (surface texture, pH, percent organic matter, moisture, drainage)
(5) Anticipated rainfall patterns the first 6-9 months after planting (seedling and weed vigor, avoid application during droughty periods, apply early on better drained soils)

In general, loblolly pine will respond to control of herbaceous weeds control with increased height growth the first five to eight years, diameter growth divergence from untreated stands for eight to ten years, and diameter distributions shift into larger product classes (Glover et. al. 1986, Haywood and Tiarks 1990).

Herbicides for herbaceous weed control can be applied over the top of loblolly pine either in a broadcast or banded (5 to 6 feet band is recommended) fashion. The herbicide must be labeled for use on the pine species that is planted. Specific herbicides can be applied pre-, early post, and post-emergent herbicides so timing is critical for optimizing herbicide benefit in controlling herbaceous weeds. Some herbicides such as Envoy, Vantage, and Fusilade are grass control herbicides and are early post-emergent herbicides. Other herbicides are more broad spectrum controlling some grasses and broadleaf weeds (Arsenal, Oust, Velpar).

Study Findings

Lauer et. al. (1993) studied loblolly pine response to herbaceous weed control on eight sites in the southeastern U.S. (five sites in Alabama and one each in Georgia, Mississippi, and Virginia) through age 9-years. Study sites were mostly cut-over mixed pine-hardwood stands except for one bermudagrass pasture and a failed plantation. Site preparation included shearing, raking, windrowing or piling and bedding or disking on five of eight sites and bedding, chop plus chemical or burned (bermudagrass pasture) on the remainder of the sites. Five sites were in the Upper Coastal Plain, and one each in the Lower Coastal Plain, Piedmont and Ridge and Valley physiographic regions. Treatments were: (1) check (no herbaceous weed control), (2) 1-year banded (@ five foot band), (3) 1-year broadcast, (4) 2-year banded, and (5) 2-year broadcast.

Loblolly pine trees per acre, diameter, height, basal area, and volume means were significantly greater (5% alpha level) with herbaceous weed control (HWC) than the non-HWC mean trees per acre through 9-years-old on four of the eight sites. There were no differences in trees per acre due to weed control method (band vs broadcast) or duration (1 vs 2 years, Lauer et al. 1993). Loblolly pine trees per acre (TPA) from the one-year banded HWC treatment (535 TPA) were 11% greater than the control (483 TPA) after 9 growing seasons (Table 1). No HWC compared to HWC survival differences were greatest on the poorer sites or where weed competition was severe. Herbaceous weed control (HWC) loblolly pine heights were significantly greater than the non-HWC heights through 9-years-old on all eight sites regardless of method (banded versus broadcast) or duration (one versus two years). Loblolly pine dominant height from the one-year banded HWC treatment (31.5 feet) was greater than the control (27.9 feet) after 9 growing seasons (Table 1). Herbaceous weed control (HWC) loblolly pine stem rust incidences were significantly greater than the non-HWC stem rust incidence through 9-years-old on three of eight sites. Loblolly pine stem rust incidence from the one-year banded HWC treatment (29 percent) was greater than the control (20 percent) after 9 growing seasons (Table 1). Herbaceous weed control (HWC) loblolly pine d.b.h.s were significantly greater than the non-HWC d.b.h.s through 9-years-old across on seven of eight sites. D.b.h. from the one-year banded HWC treatment (5.4 inches) was greater than the control (4.8 inches) after 9 growing seasons (Table 2) across the eight sites. Herbaceous weed control (HWC) loblolly pine basal area per acre were significantly greater than the non-HWC basal area per acre through 9-years-old on seven of eight sites. Loblolly pine basal area per acre from the one-year banded HWC

treatment (87 ft^2 per acre) was greater than the control (61 ft^2 per acre) after 9 growing seasons (Table 2). Herbaceous weed control (HWC) loblolly pine volume per acre was significantly greater than the non-HWC volume per acre through 9-years-old on seven of eight sites. Loblolly pine volume per acre from the one-year banded HWC treatment (1275 ft^3 per acre) was greater than the control (850 ft^3 per acre) after 9 growing seasons (Table 2). Loblolly pine weed control volumes were

Table 1. Loblolly pine mean trees per acre, dominant height and stem rust incidence by treatment at age 9-years-old (Lauer et al. 1993).

Stand Parameter	**Treatment**	**Treatment mean**
Trees per acre	check	483
	1-year band	535
	1-year broadcast	513
	2-year band	567
	2-year broadcast	540
Dominant height (ft)	check	27.9
	1-year band	31.0
	1-year broadcast	31.5
	2-year band	31.5
	2-year broadcast	31.4
Stem rust incidence (%)	check	20
	1-year band	29
	1-year broadcast	23
	2-year band	28
	2-year broadcast	30

295 to 810 cubic feet greater than the control by age 9-years (Table 2). One year weed control volume gains ranged from 243 to 343 cubic feet per acre where survival was not different between the non-HWC and HWC plots to as high as 715 cubic feet per acre where HWC increased survival.

Loblolly pine volume growth between ages 7- and 9-years was increased with weed control at six of the eight sites. The volume increase attributable to weed control increases ranged from 127 to 340 cubic feet, or 22 to 70 percent more volume production than the check (Lauer et al. 1993). This suggests that volume growth on HWC plots are continuing to diverge

from control plots. The extra volume production on the HWC plots is largely due to higher stand basal area due to increased TPA and d.b.h. rather than tree height gains. Lauer et al. (1993) concluded that HWC in these eight loblolly pine stands reduced potential rotation age by 3 years.

Table 2. Loblolly pine mean d.b.h, basal area, and volume per acre by treatment at age 9-years-old (Lauer et al. 1993).

Stand parameter	**Treatment**	**Treatment mean**
d.b.h (inches)	check	4.85
	1-year band	5.40
	1-year broadcast	5.51
	2-year band	5.53
	2-year broadcast	5.58
basal area (ft^2/acre)	check	61.4
	1-year band	86.6
	1-year broadcast	86.8
	2-year band	95.7
	2-year broadcast	95.5
Volume (ft^3/acre)	check	851
	1-year band	1280
	1-year broadcast	1300
	2-year band	1440
	2-year broadcast	1450

Economic Benefit of HWC

Case I (reduce rotation age by 3 years with HWC)

Assumptions: Loblolly pine, MAI = 2.35 cords/ac.yr for 24 years (good site)

Costs/acre (TMS 1999):

Chem site prep = $95

Site prep burn = $18

Seedlings = $27

Planting = $34

Total = $174 w/ HWC = $205/acre ($31/acre for HWC)

Returns/acre (TMS 1999):

PW @ $15/cd @ 34 cds =	$510
CNS @ $75/cd @ 17 cds =	$1269
ST @ $90/cd @ 2.35 cds =	$211
Total =	$1990

(A) No HWC Solve for Net present value (NPV) @ 8% for 24 year rotation:

$$NPV = Return/(1+i)^{1/yr} - cost = \$1990/(1.08)^{1/24} - \$174 = \$139.82 \text{ per acre}$$

(B) Assume HWC reduces rotation age by 3 years (Lauer et al. 1993):

$$NPV = \$1990/(1.08)^{1/21} - \$201 = \$194.32 \text{ per acre}$$

(C) No HWC Solve for Rate of Return for 24 year rotation:

$$ROR = (return/cost)^{1/yr} - 1 \times 100 = \text{interest rate earned on investment}$$
$$(1990/174)^{1/24} - 1 \times 100 = 10.7\% \text{ over 24 years}$$

(D) Assume HWC reduces rotation age by 3 years:

$$ROR = (1990/201)^{1/21} - 1 \times 100 = 11.5\% \text{ over 21 years}$$

Table 3. Economics of herbaceous weed control (HWC) compared to no HWC using aforementioned assumptions.

Economic decision criteria	No HWC	HWC
Net present value @ 8%	$139.82	$194.32
Internal rate of return	10.7 %	11.5 %

In both these cases in reducing rotation age by three years in loblolly pine stands with HWC is financially attractive using above assumptions.

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