NON-WOODY WEED CONTROL IN PINE PLANTATIONS

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ABSTRACT

The cost and benefits derived from controlling non-woody competitors in pine plantations were reviewed. Cost considerations included both the capital cost and biological cost that may be incurred when weed control treatments are applied. Several methods for reducing the cost of herbicide treatments were explored. Cost reduction considerations included adjustments in chemical rates and the amount of ground area that needs to be treated to increase survival and growth based on soil, plant, climate and chemical characteristics of the site.

Introduction

Most pines are classified as intolerant and thus do not grow well if they become overtopped by competing vegetation. In the first two years after outplanting, much of the competition for light, water and nutrients comes from non-woody type competitors such as grasses and weeds. After this the woody competitors become the major source of competition for the planted pine. The growth performance of the planted pine in years one and two will have an immediate influence on growth but can also impact the growth rate expected for the remainder of the rotation if long term hardwood competitors are left in the stand. This results because pine growth rate in the first few years after establishment will determine the crown position of the conifer relative to the hardwood and thus, the ability to compete for key resources for the remainder of the rotation.

This paper will briefly review the major chemicals available for weed control, the growth benefits that can be expected from non-woody weed control and the cost of these treatments. However, the major emphasis will be on how to control cost.

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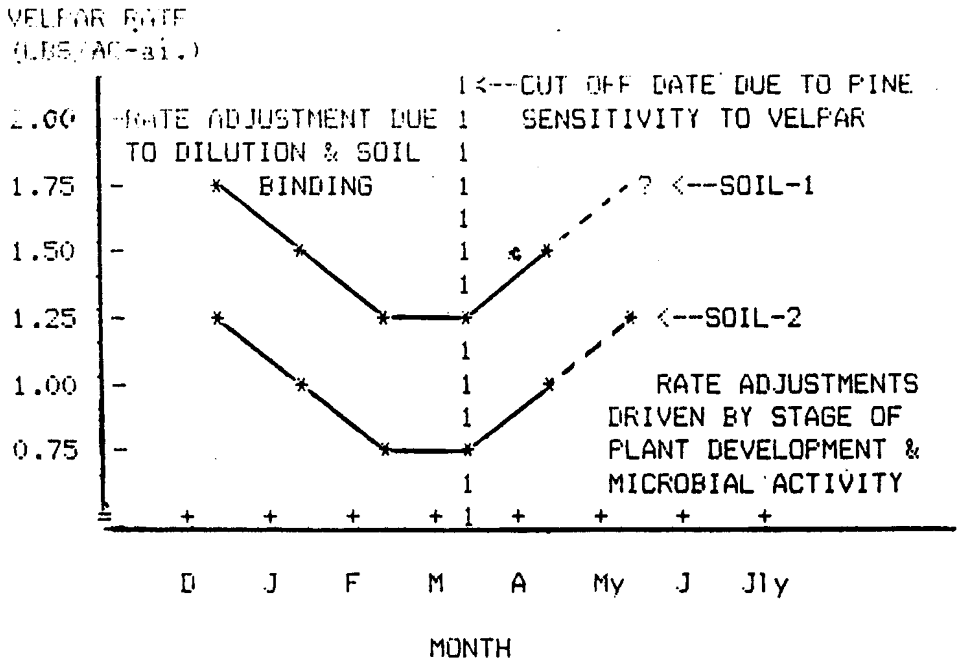
control chemical rates, down further and identifying the basic components of each which influence the rate of chemical needed. This has been done in table 1 and table 2.

As can be seen from tables 1 and 2, there are several factors which influence the rate of chemical that must be applied. Based on empirical data gained from timing x rate trails, it is impossible to say for a particular time of the year which soil, plant or climate component is having the greatest impact on activating or deactivating the applied herbicide. However, the general composite effect on the amount of herbicide needed on two different soils can be illustrated.



This would be a typical trend in the application rate of Velpar needed in the Mid-South (S.E. Okla.-W. Ark. region) for two different soil types. In other parts of the country the entire curve would shift to the right or left depending on whether growth starts earlier or later. Shifts up and down in the curve will also occur if rainfall is more or less than that received in the Mid-South and if the soil texture and organic matter are different. For instance, on soils with a deep decomposed organic horizon it may be necessary to apply later in the season after the competing vegetation is present and uptake rates are high. Otherwise, if applied earlier, the herbicide will be lost or bound up and not be effective unless extremely high rates are used.

Oust would follow a similar trend as those shown for Velpar. Usually the rates needed will vary from two to four ounces of active ingredient (ai.) per acre. For late season (May-June) application when the competing vegetation has developed considerably, it may require as much as six ounces per acre to get reasonable control. In most cases this rate

Chemicals Now Used For Weed Control In Pine Plantations

Several chemicals are now available for controlling weeds in pine plantations. However, the two major chemicals now applied are Velpar and Oust. Both of these chemicals have their advantages and disadvantages. In the following table we have listed the traits for which we have found Oust or Velpar to have an advantage in accomplishing the goals of a weed control program.

Trait	Oust		Velpar
Broad spectrum control	*[1]		
Seedling tolerance			
bareroot seedlings	*		
container seedlings			*
Window for application timing	*		
Foliar activity		?	
Growth promotion			*
Sensitivity to low temperature	*		
Low movement from target			*
Sensitivity to water quality			*
Ease of handling	*		
Storage after batching		?	
Safety	*		*
Rate sensitivity to soil and climate variables	*		

[1] * Indicates which chemical is best for the specified trait.

Oust and Velpar can be mixed and in fact appears to be a better treatment for optimizing vegetation control and pine growth response than using either chemical alone. The rates of each that may be necessary to get the desired results will be discussed in the following section.

Chemical Rates For Weed Control In Pine Plantations

It is generally reported that the rate of chemical required will vary by (1) soil type and (2) time of application. It is worth breaking these two factors, which would be cost prohibitive. With Oust there is no cut off date due to pine bare root seedling sensitivity as was shown for Velpar. The spring-summer cutoff date for Oust is more driven by the stage of development of the weeds and the probability of receiving enough rain to activate it. However, better weed control and pine growth will occur if the application is made prior to April for most areas with mineral soils.

Benefits From Weed Control Treatments

The two major benefits reported for weed control are increased survival and increased growth. Both of these aspects will be reviewed only briefly in the following paragraphs.

Increased seedling survival in the first two years have been reported (Holt et al., 1973 & 1975; Fitzgerald, 1976). Theoretically, one would expect this to be true because weed control significantly improves the seedlings water relations (Wittwer et al., in press; Nelson et al., 1981; Sands and Nambiar, 1984; Carter et al., 1984), nutrient availability (Carter et al., 1984) and undoubtedly their light regime. However, based on our experience with using Velpar with loblolly pine in a large spray program, even when rates and timing guidelines are critically adhered to, survival on the sprayed areas is about equal to that on the non-sprayed areas. This results because the sensitivity of loblolly to Velpar is increased when other agents of stress such as poor planting, poor drainage, or poor seedling quality are present. With Oust the interaction between the applied herbicide and other stress agents is not a severe problem and undoubtly reports of large increases in seedling survival during drought years will be reported in the future from the use of Oust or Oust-low Velpar mixes. For two trials in Southeast Oklahoma which compared survival for seedlings planted in 1985 (a dry year) on areas treated for weed control with Oust or not treated, survival was improved by 15-25 percent. In areas which have a high frequency of droughty years, Oust or Oust-Velpar mixtures will provide major benefits in successfully establishing pine seedlings and promoting early rotation growth.

Pine mortality after the first two years is often more related to competition with woody species than with weeds. Although weed control treatments which differentially accelerate pine growth over that of hardwoods would also probably reduce this mortality. In comparing the response of pine and hardwood clumps to broadcast Velpar weed control treatments (1 lb ai./ac), the hardwood clumps responded to the treatment as well as the pine.

TREATMENT	AVERAGE HEIGHT PINE	AVERAGE HEIGHT HARDWOOD	PERCENT HEIGHT GROWTH PINE	PERCENT HEIGHT GROWTH HARDWOOD
	(meters/ +- S.D.)			
VELPAR	1.78/.3	2.17/.5	26	21
CHECK	1.41/.2	1.8/.6		

It is likely that spot weed control treatments may favor pine growth over the hardwoods and thus also have an impact on pine survival even after ages one and two.

Growth Benefits

Increased height, diameter and volume has been reported for several studies (Knowe et al.; Wittwer et al., Nelson et al.; Glover and Dickens, 1985). Estimated gains of two to five feet in site index (25 years) have been projected. With the larger gains occurring on the better soils. These gains represent roughly a 7-16 percent increase in volume yield. Whether these gains are realized at the end of the rotation will depend on (1) if the projections have been made on a sound basis and (2) if the stand management regime for the remainder of the rotation is such that excessive between tree competition is regulated or not. If initial stocking is high and no intermediate thinnings are performed the entire early growth gain may not be maintained. But if stand density is regulated the gains should be maintained.

Cost of Weed Control In Pine Plantations

The range in cost for weed control is from about $12 to $60 per acre depending on chemical requirements, method of application and labor cost. More specifics about controlling the capital requirements for weed control will be discussed in the following section which addresses how to control cost. The remainder of this section will concentrate on the cost, in terms of higher risk to disease and insect attack, lower stem quality etc., that may result from weed control treatments. Much of this section will be pure conjecture because good studies designed with the objectives of looking at the impacts of weed control on increasing risk to damaging agents or lowering stem quality have not been conducted. The information available is mostly from field observations taken from growth response studies comparing herbicide treated and non-treated areas. One such study in Southeastern Oklahoma with loblolly indicated that tip moth damage for the fall assessment, averaged across twelve spray sites, was 29 percent for the non-sprayed seedlings and 41 percent for seedlings in the areas treated with herbicide. This differential may even be greater for shortleaf pine because it has been suggested to be more susceptible to tip moth than loblolly. The work by Stephen et al. (1982) does show a larger response of shortleaf to insect control than for loblolly.

The incidence of fusiform rust infection has been shown to increase with weed control and other intensive management treatments in a slash pine study in Louisiana (Burton et al., 1985). In this study the expected excess mortality due to rust infection will eliminate or severely reduce any growth gain due to weed control. Rust is not a problem with shortleaf but there may be other diseases that show a similar trend when herbicide is applied. There has been some recent suggestions that the incidence of pitch canker in loblolly may increase in areas receiving more intensive management and that this may be related to the level of tip moth damage. We must keep our eyes open and realize that the early apparent growth gains could be lost to insects and diseases that can increase with intensive management.

A second biological cost could be a reduction in stem quality. Undoubtedly more juvenile wood will be produced but a larger taller tree will also result. The additional volume added will likely far exceed in value any loss in value associated with a larger juvenile core. However, questions about whether increased branch size and frequency that can result from early grass control treatments will reduce wood quality needs to be addressed.

Capital Cost Control Considerations

Although some risks are associated with application of weed control treatments, the growth and survival gains justify considering the treatment if cost can be kept low. The two major costs are chemical cost and application cost. Careful consideration of the factors which control the rate of chemical necessary, as discussed earlier, will be the first step towards controlling chemical cost. Good guidelines which take into account soil, climate and plant factors have been developed by the Auburn vegetation management coop. The second major way of reducing cost is by treating only the ground area that is necessary to give the most economical increase in survival and growth. This aspect has not been investigated enough. The area needing treatment for weed control around each seedling will be largely a function of the type and height of competing vegetation that is expected to develop. This can be correlated with soil type and past land use history for a given geographical area. For instance, in the Mid-South the tallest competing vegetation will develop on high site upland and deep well drained bottomland soils. Competing vegetation on these soils can easily attain 6-7 feet in height. The imperfectly drained and excessively drained upland soils will usually develop a weed population that will be 4-5 feet in height. Sites that are poorly drained or shallow and eroded will normally develop a vegetation type that is only 2-3 feet in height; although the vegetation type that develops on the poorly drained soil will be of a totally different species makeup. On the very best sites which develop a weed population that reaches 6-7 feet in height, a broadcast weed control treatment will probably be required to be effective. On sites where weeds are expected to reach lesser heights, band or spot applications may be sufficient. The typical cost for a broadcast, band or spot treatment is shown in the following table for a plantation with 600 trees per acre, planted at an eight foot spacing between the rows and using one pound (ai.) of Velpar per acre.

METHOD	PERCENT OF EACH ACRE TREATED	ESTIMATED COST RANGE (DOLLARS)
AERIAL BROADCAST	100	30---40
GROUND BROADCAST	100	38---45
STRIP SPRAY	60	29---35
SPOT-4 FOOT DIAMETER	20	14---20

This range in cost represents a considerable savings in dollars spent if a spot treatment will provide almost as good a response as the broadcast treatment.

Weed control offers benefits in both growth and survival. These aspects have been well demonstrated. The major constraint to applying these treatments are cost and social concerns. Developing a better understanding of what method of control (broadcast, band or spot) is needed will help control cost and make weed control treatments more acceptable to the public.

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Table 1. The components embedded in soil type that influence the amount of chemical that must be applied and their impact on herbicide activity

Soil Component	Property	Range of Property	Impact on Herbicide Activity
*Texture (O and A Horizons)	Determines Cation Exchange Capacity	2 - 80 meq/100 g	1. Increased cation exchange capacity "binds" up the herbicide thus immobilizing it and requiring a higher rate of chemical to be applied to get the desired level of control. 2. Could increase the duration of herbicide control by keeping the herbicide within the zone of application.
Organic Matter	- Determines Cation Exchange Capacity	Content in mineral - Soil < 1% - 5% - Organic Soils	same as above
	- Serves as a physical barrier	CEC 100-200 meq/100g	
Soil Drainage	Determines dilution & removal rate	Excessive to Poorly Drained	As drainage decreases, the need for higher rates of herbicides in general increases. This is usually due to several confounding factors; the increase in finer texture component, an increase in organic matter, and a dilution impact due to surface water & suspended organics moving from the point of application.

Table 2. The components embedded in "time of application" which influence the amount of chemical that must be applied and their impact on herbicide activity

Time of Application Components	Property	Range of Property	Impact on Herbicide Activity
1. Stage of development & size of competing vegetation	• Physical barrier to getting the herbicide to the soil - May bind up some of the applied herbicide on the foliage	Pre Emergence - Established Stand (0-100% Ground Cover)	The general trend is to have to increase the rate of herbicide applied as the vegetation gets larger & more dense.
	• Plant sensitivity to herbicides? - Detoxifying capacity? - Foliar uptake capacity? - Root zone concentrated in high zone of herbicide concentration near the surface		
2. Precipitation	• Media for movement of herbicide into the rooting zone	Usually requires 1-2" to effectively move the applied herbicide into the rooting zone	Increases herbicide activity if rainfall is not excessive.

	• Media for diluting & transporting herbicide out of the rooting zone	The amount of rain needed to cause movement out of the rooting zone will be determined by the soil texture, structure, organic matter, antecedent soil moisture, evaporative demand, and properties of the herbicide. Range - low on sandy soils - high on soil with clay	Decreases herbicide activity
3. Temperature	• Increases water mobility	• Low root hydraulic conductivity at soil temperatures near freezing - Increase as soil temperature increases	Increases herbicide activity over the range of temperatures experience from winter to early summer.
	• Increases seedling metabolism & catabolism processes	• At low temperatures, photosynthesis respiration and cell division are minimal. At high temperatures, the demand for the substrate whose synthesis is being blocked by the herbicide increases.	

	• Increase root growth	• e.g. Low at less than 10°C? High at 25°C? (Species Dependent)	
	• Increased microbial processes		• Increases breakdown rate of applied herbicides thus requiring higher rates of application.
4. Evaporative Demand	Increased water uptake capacity	Mid South PET[1/] Dec-Jan- 0-1mm/day PET March-April ≅ 2-3 mm/day	When foliage is present, it probably increases herbicide activity by concentrating more herbicide into the target plants.
5. Pine Seedling Herbicide Sensitivity	Increases after bud break & as temperature begins to average near 20°C (i.e. as pine growth activities & water use increases)		*Requires a decrease in Velpar rates Sensitivity to Oust not a major factor

[1/] PET = Potential evapotranspiration

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