AN INVESTIGATION OF THE FEASIBILITY OF USING THE BACK-PACK MIST BLOWER FOR TIMBER STAND IMPROVEMENT IN EASTERN OKLAHOMA

By

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CHAPTER I

INTRODUCTION

The Southern Forest Resource Analysis Report (1) pointed out that people are increasingly dependent on trees for necessities and pleasures. By the year 2000, the population of the United States is expected to exceed 300 million. To house the population adequately and attend to other material needs, availability of wood products must be doubled. Not only lumber, plywood and other building materials, but also clothing, containers, chemicals, paper and a host of household essentials must be derived from the forests in ever larger volume.

Of the 198 million acres of forestland of the south, 40 million are owned by industry with 17 million in public ownership. For the most part, industrial and public holdings which constitutes approximately 30 percent of the total are well managed and maintain a satisfactory rate of tree growth. The vast majority--141 million acres--belongs to nearly a million non-industrial private owners--mostly in small tracts. In general, this land is either poorly managed or not managed at all.

The quickest, most economical and most effective way to start production on private forest lands is through Timber Stand Improvement, which is badly needed on more than 90 million acres in the Southern Forest Region. Primarily, this process involves removal of cull trees to make growing space available for quality trees.

This ratio of unproductive land to managed land was found to exist in Eastern Oklahoma in about the same proportion. Sternitzke and Van Sickle (2), found that forests occupy 5.5 million acres or 57 percent of the land in Eastern Oklahoma.

Some 4.8 million acres in Oklahoma are presently classed as commercial forest land. The other 0.7 million are regarded as non-commercial, either because they are in some kind of public ownership on which the timber is reserved from cutting or because the timber-growing capacity is extremely low.

The bulk of the commercial forest land in Oklahoma--3.4 million acres--is held by farmers and miscellaneous private owners. Average stand conditions are poorer on lands held by these groups than on public and industry needs. Although the holdings of farmers and miscellaneous private owners make up 70 percent of the commercial forest land, they presently support only 50 percent of the growing stock and 43 percent of the sawtimber. The extensive area in these ownerships makes them of prime importance as a source of future timber supplies.

Nature of the Problem

Timber Stand Improvement has long been a part of forestry practices in North America. Within the last few decades there have evolved three basic methods used in Timber Stand Improvement. Each method requires the use of a herbicide.

The tree injection method has been used commercially and does give good results. The method requires a tree injector and an operator applying herbicide manually at a given rate per tree.

Disadvantages have developed during the last decade in Eastern Oklahoma in the use of the injection method. They are:

1. The shortage of labor for this type work
2. The increased minimum wages
3. The increased herbicide costs
4. The relative long length of time to treat on a percent basis

Aerial application of herbicide for Timber Stand Improvement has developed in the last two decades as a prescribed method. Although good results have been obtained the reliability of the method is questionable. The private landowner would find costs prohibitive using this method if he owned less than 200 acres in one tract and would run the risk of a lawsuit for damages due to drift of the herbicide.

The third method of Timber Stand Improvement using herbicide, ground mist application, has gained much favor with the wood industry landowners in the past 15 years. This method requires the use of a vehicle that is able to navigate through wooded and rough terrain. The ground mist applicator comes in varying styles from a power take-off driven unit to a self-contained tank and motor.

The mounted units are limited to lower heights of hardwoods and limited to certain areas because the transportation unit can not navigate all types of terrain. Initial investments for the two units of equipment are prohibitive for landowners with small tracts of land.

Statement of the Problem

An alternative Timber Stand Improvement method that overcomes the disadvantages of previously used methods and fitted to the needs of small landowners is needed. The small landowners needed a method that

gave satisfactory results with one treatment; required less labor and per acre costs than the current conventional methods; required low initial investment; and was relatively safe from drift damage.

Purpose of the Study

The purpose of this study is to investigate the back-pack mist blower method of herbicide application as a possible practical solution for Timber Stand Improvement on small land ownerships in Eastern Oklahoma.

Research Questions

The following research questions were investigated in this study.

1. Does the back-pack mist blower method of Timber Stand Improvement give satisfactory results?
2. Is the back-pack mist blower method economically feasible for the small landowner?
3. Can the back-pack mist blower method be simplified to the extent that little technical knowledge is required by the landowners for its application?
4. Does drift damage occur with the back-pack mist blower method of herbicide application?

Need for the Study

Many studies have brought out that our country will soon face a shortage of forest products unless all lands capable of producing forest products are put into production. Most public lands and the larger wood industry lands are currently producing at a rate approaching full

capacity. The increased need for wood products will have to be supplied from private ownerships which are primarily in the South.

The quickest, most economical and most effective way to start production on private forest lands is through Timber Stand Improvement. This involves removal of cull trees to make growing space available for quality trees.

Delimitations

The purpose of this study is to investigate the back-pack mist blower method of herbicide application as a possible practical solution for Timber Stand Improvement on private ownerships in Eastern Oklahoma.

Three areas were selected in order to represent average conditions found in Eastern Oklahoma. The conditions of most private forest ownerships are stands of timber with little or no commercial value. Most of these stands overtop pine seedlings, and require removal of the cull timber.

Definition of Terms

Basal Area - The area of a plane or cross-section of a tree in square inches or square feet.

Back-Pack Mist Blower - A gasoline engine powered, air volume fan blower, machine for distributing liquid or dust materials.

Co-dominant Tree - A tree with the top of its crown in full sunlight and competition from other trees from the sides; trees forming the canopy level of a stand of timber.

Cull Tree - A tree with no commercial value.

DBH - Diameter breast high; diameter of a tree at 4 1/2 feet from the ground.

Site Index - A numerical expression representing the potential of a site to product timber.

South - See Southern Forest Region.

Southern Forest Region - The forested area in Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Oklahoma, Tennessee, Texas, and Virginia.

Timber Stand Improvement - The improvement siviculturally of a stand of timber; in general it is the removal of cull timber in order to obtain sunlight, nutrients, and moisture for natural or planted quality trees.

Wedge Prism - A ground piece of glass that bends the light at a specified angle.

2,4-D - 2,4-Dichlorophenoxyacetic acid.

2,4,5-T - 2,4,5-Trichlorophenoxyacetic acid.

CHAPTER II

REVIEW OF LITERATURE

A search of the literature revealed that, of the many methods of Timber Stand Improvement that have been developed, only three methods are now recommended. Each method is concerned with killing cull trees to provide room for quality trees.

Peevy (3), advocated that injection of cull hardwoods with undiluted, 2,4-D amine was a practical and economical method to control hardwoods. His study showed this type of treatment to be highly satisfactory. He indicated satisfactory results when 85 percent of the crowns of the treated trees showed signs of herbicide kill.

Aerial application of herbicide as a technique to control hardwood developed within the last two decades, is of questionable reliability. Brady, Peevy, and Burns (4), attempted to standardize the technique by establishing guidelines for aerial herbicide application. Their study, over a six-year period, did not indicate satisfactory results from aerial application of herbicide. It did indicate a few instances of good results, but over the entire study period the results were too erratic to be conclusive.

Silker and Darrow (5) did find results that indicate aerial application has a place as a sivicultural tool, but with limitations. Their study gave a guideline based on physiographic-plant associations; i.e., only with certain species grouping on certain soil-sites. Even the

recommended aerial application areas are limited if the hardwood understory is dense and of herbicide resistant species.

Peevy and Brady (6), found that the tractor-mounted mist blower was as effective as a high volume ground sprayer or an airplane sprayer for applying herbicides to control hardwoods in two tests in central Louisiana. The mounted units are limited to lower heights of hardwoods primarily because they have a fixed boom and are limited to certain areas because the transportation unit cannot navigate all types of terrain. Also, initial investments for the two units of equipment are prohibitive for landowners with small tracts of land.

Silker (7), in an exhaustive study has given guidelines for Timber Stand Improvement in Eastern Texas and Oklahoma in total site classification by the use of plant indicator sequence. The results of this study gave a listing of the type of area where Timber Stand Improvement using a herbicide would most likely succeed based on the type of plants on the area.

Sternitzke and Van Sickel (2), indicated that the majority of the private ownerships in Eastern Oklahoma exists on lands of site classes producing less than 50 cubic feet of annual growth per year. Consequently, the average height class for hardwood timber on this type of land would be less than 60 feet.

Eaton, Elwell, and Santelmann (8), made a study of the variables influencing commercial aerial application of 2,4,5-T. The study was conducted in Eastern Oklahoma on the predominant species of blackjack oak and post oak. On these species they found the best kill to be some 6 to 8 weeks after the last frost. This study and earlier studies indicate the months of May and June should be the best period for

herbicide application in Eastern Oklahoma. They indicated a good kill when 80 percent or more of the trees showed signs of herbicide kill.

The search of literature revealed that the idea of using back-pack mist blowers was not new and novel. Earlier studies have indicated satisfactory results in other locations and situations similar to that found in Eastern Oklahoma.

Cantelou (9), was one of the first to use a mist blower for hardwood control. He used it on a crawler tractor rather than manually transporting the unit. He found good results up to 40 feet in height.

Seelbach (10), found that he could reduce costs more than one-half that of other methods by using back-pack mist blowers controlling brush on utility line right-of-ways.

MacConnell and Bond (11), performed a study for the purpose of finding a new method of applying herbicide that would overcome the disadvantages found in aerial spraying. These disadvantages were the high drift occurrence, the low understory kill, and the high cost on small areas. They found the back-pack mist blower had good results in 6 of the 7 plots tested. The seventh plot had a crown canopy level of 50 feet above the ground, but even with the higher crowns 48 percent of the hardwoods treated were killed. Some trees as high as 60 feet were reported killed.

Little (12), found the back-pack mist blower to be an ideal tool for the purpose of selective treatments for pine release when some hardwood was desired as part of the stand. He found trees could be killed up to 55 feet in height when they were of the herbicide susceptible species, and that each mist blower could cover about 10 acres each per day.

Coombs and Kenerson (13), did a commercial experiment with the back-pack mist blower. They treated 525 acres of power line right-of-way in a 2 1/2 month period. It was concluded that the high mobility of the back-pack mist blower, the small amount of spray required to cover large areas, combined with the opportunity to vary the volume applied to suit the kind of brush, made that type of operation very versatile for use on power line right-of-way.

Reigner, Sopper, and Johnson (14), in a recent experiment designed primarily to study the degree of stream contamination resulting from the use of a phenoxy herbicide 2,4,5-T on repairian vegetation, found good kill results one year after treatment with a back-pack mist blower. They indicated satisfactory results when 58 to 81 percent of the stems treated were killed.

The pertinent studies have indicated that the back-pack mist blower:

1. Was a practical tool and had been used commercially.
2. Had definite advantages over other methods.
3. Appeared to fit the situation in Eastern Oklahoma.
4. Had good results in hardwood control.
5. Of the current models the method was limited by height of the timber to be controlled.

This study is primarily concerned with results for showing competitive features of labor and cost, i.e., the ability to perform a Timber Stand Improvement project with less fixed costs and labor than other conventional ground operations, and with as good or better results compared to aerial operations on average conditions found on Eastern Oklahoma private forest land ownerships.

CHAPTER III

PROCEDURES AND ANALYSIS OF DATA

Introduction

The major purpose of this study was to investigate the back-pack mist blower method of herbicide application as a possible practical solution for Timber Stand Improvement on private timberland ownerships in Eastern Oklahoma. This chapter consists of the description of the research procedures utilizing in this study.

Procedure

Three areas depicting average conditions found in Eastern Oklahoma were chosen to provide data on the competitive features of the back-pack mist blower. Each area represented a type of condition that would qualify the Timber Stand Improvement.

Study area number 1, known as the Dunn tract, is located in McCurtain County, three miles northwest of Octavia. The area supported a variety of hardwood competition over natural and planted shortleaf pine stock. Site index ranged from 50 to 80 with a mean of 75. Stems of competing hardwood ranged from none in old pasture openings to 2,000 per acre in dense brush clusters.

Study area number 2, the Quaid tract located 10 miles north of Wilburton, was typical of much of private timberland ownerships in Latimer County. It had an extended history of wildfire and unregulated

grazing. Consequently, the area supported scrub brush almost too dense to walk through. Site index for pine was low over the entire area and timber heights were accordingly short for all species. Site index averaged 50 for this tract.

Study are number 3, the Draper tract located 6 miles west of Wilburton, was borderline timberland. This type of land to be suitable for use as pasture or as a pine plantation would require improvement. Usually this type area is cleared for pasture. A few isolated cases exist where landowners have converted these sparse woodlots to pine. Rarely is a seed source available to these areas and planting as well as Timber Stand Improvement is needed. Site index averaged 60 for this tract.

Each area was to receive a currently recommended herbicide formulation, rate of application per acre, and treatment period. Inventory of man hours on each part of the Timber Stand Improvement project was to be kept for each treatment area. Particularly, the time spent mixing formulation, spraying, rest periods, gasoline and chemical refueling, breakdown, and other was to be recorded. Also to be recorded was the daily acreage completed and gallons of formulation used.

Sample plots were to be randomly selected in each study area at the rate of one plot per acre within the study area. Individual trees in each sample plot were to be selected by using a wedge prism ground to an exact ten Basal Area Factor. Only trees of two inches in diameter at four and one-half feet from the ground and larger were to be examined for effectiveness of treatment.

Table I gives a comparison of the study areas.

TABLE I

COMPARISON OF TREATMENT AREAS

Treatment Area	Acreage	Average Short leaf Pine Site Index	Average Stems Per Acre 2"+ at DBH	Treatment Period	Herbicide Formulation Ratio of Gallons 2,4-D : 2,4,5-T : Diesel : Water 1/	Comparative cost of injector application of herbicide per acre 2/	Comparative cost of Aerial application of herbicide per acre 3/
Area No. 1 Dunn Tract	50	75	337	June '70	1-1-5-23	$14	$10
Area No. 2 Quaid Tract	25	50	867	May '71	1-1-0-28	20	10
Area No. 3 Draper Tract	10	60	192	July '71	1/4-0-0-30 1/4-1-0-28	16	10

1/ Area No. 3 received application of dicamba and silvex in the above formulations, respectively.

2/ Cost per acre are average estimates based on a survey of ASCS offices, State Forestry Division Service foresters, and U. S. Forest Service offices in an eight county area in Eastern Oklahoma.

3/ Same survey as above cost estimates.

Statistical Procedures

Each of the study areas were too large to record information on every tree within the respective areas. Sample points randomly selected provided a representation for each area.

Sample point locations were selected randomly on the basis of ten possible selections per each acre in the study area using a table of random numbers. The trees selected at each sample location were on the basis of basal area per acre. Small trees as well as large trees would have an equal opportunity of being selected.

Using a wedge prism to select trees for basal area per acre is a technique called point sampling. The trees selected represent a specified number of other trees on each acre just the same size of diameter as the selected tree.

The selected trees per plot would be the basis for a statistical analysis for a limit of error of the true representation of the herbicide effectiveness of each study area. The following formulas were used to calculate limit of error at a level of accuracy of two times out of three.

X = trees per plot

X^2 = trees per plot squared

$\overline{M}$ = mean of trees per plot

n = number of observations in each study area

$$\text{Variance} = SD^2 = \frac{\varepsilon X^2 - \frac{(\varepsilon X)^2}{n}}{n-1} \qquad \text{Standard Error} = SE = \sqrt{\frac{SD^2}{n}}$$

$$\text{Limit of Error} = LE = \frac{SE}{M}$$

CHAPTER IV

RESULTS

The purpose of this study was to investigate the back-pack mist blower method of herbicide application as a possible practical solution for Timber Stand Improvement on small forest ownerships in Eastern Oklahoma. Results of the data utilized in this investigation are presented in this chapter.

On each study area a Domina Model 300 mist blower was used. Initial investment for this model at the time of this study was $210.00. It is a back-pack, gasoline engine powered, air volume fan blower, for distributing liquids or dust materials. Several brands and models were available during the study period. All were similar as far as air speeds and vertical heights obtainable.

One man can use the back-pack mist blower with only the slight inconvenience of starting the engine. It could be started first before placing in position for use. However, a two-man operation proved the most satisfactory method.

Each of the study areas were treated with the idea that techniques should be used as closely as possible to actual working projects of Timber Stand Improvement rather than a pure clinical approach to the use of the machine for Timber Stand Improvement purposes. A large treatment area would give a better cost comparison than a study of treatment of individual trees. From previous trial efforts, prior to

treatment of the study areas, a two-man operation was formed. One man sprayed herbicide formulation while the partner relayed chemical and gasoline for the blower. Roles were switched at approximately one hour intervals. The "relay partner" kept time and materials-use records during the treatment period.

Treatment "strips" were located by the use of flagging ribbon and toilet paper. At each beginning and ending point of a treatment strip across the study areas a streamer of flagging ribbon was tied at a conspicious point. Intermediate locations were made by pieces of toilet paper placed in the stream of air from the blower. These pieces lodged in the tree crowns thus giving visual evidence of herbicide treatment.

It was found that some wasted motion occurred with a relay partner. Occasionally the relay partner kept well ahead in supply of chemical and gasoline and had time that could not be utilized toward treatment application. A possible alternative technique could be the use of a "relay partner" for two mist blowers.

Table II reports the accumulated costs per treatment areas.

It was beyond the scope of this study to prove the effectiveness of the herbicides used. However, the effectiveness of herbicide could not be completely divorced from the effectiveness of application by the mist blower. Each area was sampled for effectiveness of distribution of herbicide by recording leaf curl, discoloration, wilt or spot, 30 days after completion.

During the sampling of each study area, adjacent timber was inspected for any evidence of drift damage. None was found.

TABLE II

TREATMENT COSTS

Treatment Area	Cost of Man-Hours Spraying 1/	Cost of Man-Hours non-spraying on related on site jobs 2/	Cost of Herbicides Formulation 3/	Other related on site costs 4/	Total on site treatment cost per acre
Area No. 1 50 acres	$34.60	$ 93.40	$142.00	$ 6.75	$ 5.54
Area No. 2 25 acres	56.00	144.00	158.40	11.25	14.79
Area No. 3 10 acres	12.00	8.00	21.45	1.95	4.34

1/ Accumulated time of actual spray operation using a rate of $2.00 per hour.

2/ Accumulated time of non-spraying jobs including mixing, herbicide formulation, carrying formulation and gas to spray operator, rest periods, and maintenance of Back-Pack mist blower.

3/ Herbicides used were 4 lb. acid equivalent esters of 2,4-D and 2,4,5-T. Cost rates were, respectively, $2.85 and $9.60 per gallon. One gallon each of Silvex and Dicamba was used in the herbicide formulation for area #3. The chemical was obtained for experimental purposes and could not be obtained by the private landowner at the time of this study. The rate, $9.60, of the comparable chemical 2,4,5-T was used as the per gallon cost factor for these herbicides.

4/ Costs include gasoline and oil for the mist blower, spark plugs, flagging ribbon, and toilet paper for strip location.

A statistical analysis of the trees per sample plot indicated a limit of error of ± 9.3% for area number 1; ± 11.1% for area number 2; and ± 13.2% for area number 3.

Results were considered satisfactory as evidenced by herbicide effect noted on sample trees. Table III shows the results of treatment effectiveness of the back-pack mist blower method in Timber Stand Improvement.

TABLE III

TREATMENT EFFECTIVENESS

Treatment Area	Composition % by species 1/			Average Total Height in feet of co-dominant trees 2/	Average Height in feet of Noticeable Herbicide effects 3/	Average % of live crown effected 4/
	Hd.	Int.	Easy			
Area No. 1	15.7	73.6	10.7	45.8	29.6	87.8
Area No. 2	21.2	74.9	3.9	19.2	18.1	97.4
Area No. 3	30.5	54.9	14.6	28.7	20.3	82.1

1/ Species are grouped according to susceptibility to herbicide. Groupings are based on past studies of species susceptibility. For this study the groupings are: Hard to kill--hickory, maple, winged elm, and thornapple; Intermediate to kill--post oak, white oak, red oak, and blackjack; Easy to kill--honey locust, black locust, and sweetgum.

2/ The average height in feet of the main crown canopy. The average obtained from measured co-dominant trees in sample points.

3/ The average height in feet of herbicide effect on all trees 2 inches in diameter and larger at 4 1/2 feet from the ground. The average of all noticeable herbicide effect in tree crowns on sample points. Effect recorded as leaf curl, leaf discoloration, leaf wilt, and leaf spot.

4/ The average percent of noticeable herbicide effect of total live crowns on all trees 2 inches in diameter and larger at 4 1/2 feet from the ground found on sample points.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The problem with which this study was concerned was the need to develop a practical method for Timber Stand Improvement on small forest ownerships in Eastern Oklahoma. This chapter includes a summary, conclusions, and recommendations of the investigation of the back-pack mist blower method in Timber Stand Improvement.

Summary

The purpose of this study was to investigate the back-pack mist blower method of herbicide application as a possible practical solution in Timber Stand Improvement on private forest ownerships in Eastern Oklahoma.

Four research questions were considered in the study and are stated as follows: (1) Does the back-pack mist blower method of Timber Stand Improvement give satisfactory results? (2) Is the back-pack mist blower method economically feasible for the small landowner? (3) Can the back-pack mist blower method be simplified to the extent that little technical knowledge is required by the landowners for its application? (4) Does drift damage occur with the back-pack mist blower method of herbicide application?

Data used in considering the research questions were collected from three study areas which represent a range of conditions found in

Eastern Oklahoma. Each area received a recommended herbicide formulation, rate of application, and treatment period. Cost items and effectiveness of herbicide application were kept for each study area.

Findings Related to the Research Questions

Answers to four research questions were sought in this study. In an attempt to obtain answers to the four questions, data were collected from three study areas.

Research Question 1

Does the back-pack mist blower method of Timber Stand Improvement give satisfactory results? It is concluded that the back-pack mist blower method did give satisfactory results on three study areas in Eastern Oklahoma.

Research Question 2

Is the back-pack mist blower method economically feasible for the small landowner? From evidence gathered in this study, this method was less expensive than the standard methods of Timber Stand Improvement on the three study areas in Eastern Oklahoma.

Research Question 3

Can the back-pack mist blower method be simplified to the extent that little technical knowledge is required by the landowners for its application? Only simple tasks were required in obtaining satisfactory results.

Research Question 4

Does drift damage occur with the back-pack mist blower method of herbicide application? No drift damage was found on adjacent timber following treatment of the three study areas in Eastern Oklahoma.

Conclusions

The study indicates the back-pack mist blower can be used as a practical Timber Stand Improvement method in Eastern Oklahoma on three study areas. More work, however, needs to be done to improve the techniques of herbicide application and herbicide formulation.

Many factors contribute to the success or failure of herbicide treatment of hardwood for Timber Stand Improvement purposes. It was not within the scope of this study to find evidence to support any conclusions other than the feasibility of using the mist blower as a tool in Timber Stand Improvement. Variables such as herbicide, season of application, and type of species, are limiting factors for the use of the mist blower. Past studies have given some guidelines and current studies should resolve questions unanswered at the time of this study. Height of timber is a definite limiting variable. More work needs to be done to establish a guideline for use of the mist blower as far as height of timber is concerned.

As compared to currently acceptable Timber Stand Improvement methods the back-pack mist blower can be used as a practical Timber Stand Improvement tool when not limited by height, season of application, species, nor herbicide.

Recommendation

It is recommended that the small forest landowners in Eastern Oklahoma consider the back-pack mist blower method of Timber Stand Improvement as a practical method of applying a herbicide when confronted with a forestry problem of removing cull trees.

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