INNOVATIONS IN SEED ORCHARD MANAGEMENT
IN THE SOUTHERN APPALACHIANS

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Abstract -- Three recent innovations in seed orchard management are described. Prescribed fire was found to be an effective replacement for chemical control of the white pine cone beetle in a clonal orchard. A seed collection method which retrieves seed after it drops on netting spread over the orchard floor can be used in pine seed orchards located on sloping sites. British tree shelters enhanced both survival and height growth of planted oak seedlings.

Additional Keywords: prescribed fire, insect control, seed collection, net retrieval, *Pinus strobus*, *P. echinata*, *P. virginiana*, tree shelters, *Quercus* spp., hardwood regeneration.

The USDA Forest Service Beech Creek Seed Orchard and clone bank complex is a breeding and seed production facility located near Murphy, N.C. It began operation in 1965 and now provides most of the seed used for reforestation of national forest lands in the southern Applachians. The complex includes clonal orchards of shortleaf pine (*Pinus echinata* Mill.), Virginia pine (*P. virginiana* Mill.),and eastern white pine (*P. strobus* L.), with clone banks of black cherry (*Prunus serotina* Ehrh.), black oak (*Quercus velutina* Lam.), chestnut oak (Q. *rp inus* L.), northern red oak (*Q. rubra* L.), white oak (*Q. alba* L.), and yellow-poplar (*Liriodendron tulipifera* L.).

Although most of the operation resembles that of other tree seed orchards throughout the the South, there are a few special management requirements due to a combination of the species characteristics, age and size of ramets, geographic location, and orchard topography. Three examples of recent innovations in the management of this complex are: the use of prescribed fire as an integrated pest management substitute for the application of insecticides; a seed collection system adapted to sloping orchard sites; and the use of British tree shelters to enhance survival and growth of oak seedlings.

PRESCRIBED FIRE

Both fire and insecticides are valuable pest management tools when properly applied. Burning of felled, infested trees was among the earliest control measures recommended for use against the southern pine beetle,

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Dendroctonus frontalis (Zimm.) (Hopkins 1911). Miller (1978) used fire to control cone insects in natural red pine (P. resinosa Ait.) stands. On the other hand, prescribed fire is seldom used in seed orchards. Aside from vegetation control in isolation strips, fire of any type has been excluded because of the risk of bole, root, or crown damage. This risk may be especially high in clonal orchards of thin barked species such as eastern white pine.

Application of insecticides also has risks, both real and perceived, but it is an important management practice in almost all seed orchards. For example, a systemic insecticide was used to control the white pine cone beetle, Conophthorus coniperda (Schwarz). This insect can destroy an entire white pine cone crop if left unchecked. Proper insecticide treatment can be very effective but extreme caution must be exercised during application due to its toxicity to humans, birds, and fish.

Over the past two years, prescribed fire has been used as a white pine cone beetle control measure in place of an insecticide. This substitution is feasible if the fire is used at the right time under strictly controlled conditions. The efficacy of the treatment is linked to the insect's behavior. The beetle spends a major portion of its life cycle in dead cones. Immature cones are attacked and killed during the spring and early summer. By late summer, these cones drop to the ground and the beetles remain in the cones over the winter. During this time, they are vulnerable to control if sufficient heat is applied to the cones (DeBarr 1988).

Methods

In March, 1987, a 2.2 acre area of the white pine orchard was burned as a trial (Barber et al. 1987). A year later (March, 1988), 61 acres were burned. Seven acres were set aside as an unburned control.

The white pine orchard straddles a large ridge and topography ranges from gently sloping to moderately steep. Due to the size of the area, virtually all aspects are represented. The main road for the orchard complex follows the top of the ridge and bisects the white pine orchard along some of the steepest sites.

Ground vegetation is largely grass which is mowed two to three times each year. At the times of burning, the grass was less than six inches tall and just beginning to grow.

In addition to the grass cover, other fuel consisted of a light to moderate accumulation of needles and dead cones with a few twigs and small branches. Total fuel was estimated to be between 2000 - 3000 lbs. per acre.

Fuel, soil, and weather conditions were almost ideal for the 1987 burn. Winds were light and steady with temperatures in the 60's. Fuel was dry enough to carry a fire but the soil/litter interface was moist. Relative humidity ranged around 50%. Somewhat drier conditions were present for the

1988 burn but they were within acceptable limits.

Site preparation consisted of raking the needles and other debris from a three foot circle around the base of each tree. Where possible, the access roads were used as fire breaks. The rest of the areas to be burned were surrounded with an eight foot wide area which had been drenched with a mixture of water and surfactant. This fire barrier or "wet line" was created with a tractor pulled, 500 gallon capacity, hydraulic sprayer.

A backing fire was used for initial ignition at the top of the slopes. Then, strips were ignited every 15 to 30 feet down the slope and allowed to run uphill. Where the fuel was heavy and the relative humidity fell below 30%, only backing fires were allowed with no stripping.

Results

Both burning operations virtually eliminated the cone beetle population in the treated areas. In the untreated areas, the beetle populations were high and cone damage was heavy.

Most trees showed little or no fire damage but about 15% had crown scorch. The amount of the damage ranged from 20% to 80% of the crown. Approximately 10% of the trees had bole damage but it was usually confined to less than a quarter of the circumference. Root damage was not apparent from the 1987 burn. It is too early to evaluate root damage in the 1988 burn and there may be some confounding with the effects of the drought that started shortly after the burn.

The total cost of burning was approximately $40 per acre.

Discussion

The burning technique appears to be a viable alternative for controlling the white pine cone beetle. Although the dead cones were not consumed by the fire, sufficient heat was generated to be lethal to the insects. This level of mortality was seldom attained with insecticides.

A comparison of costs also favors the use of fire. In contrast to a $40 per acre burning cost, chemical control may run as high as $400 per acre. A further reduction in costs may be possible in subsequent burns on the same area since there will only be a one-to two-year fuel accumulation.

After observing the 1988 burn, a fire expert had several recommendations for acceptable conditions before and during the burn (Wade 1988). He recommends air temperatures under 50 ^{o}F to help prevent crown scorch, although higher temperatures can be tolerated. The ideal range for relative humidity is 30% to 50%. Lower humidity can be acceptable as long as spotting is not a problem. Winds should be steady and not exceed 10 mph.

Wade (1988) also stresses the importance of moisture at the soil - duff interface. The tree roots are close to the surface and must be insulated from the fire. Complete consumption of the duff layer is not neecessary nor desirable. If this condition is encountered during a burn, it is a strong indicator that the burning boss should consider extinguishing the fire.

Although the burns were highly successful, the risks associated with such an operation should not be ignored. If it is to be done safely and effectively, the entire burning operation must be planned by a team having expert knowledge in prescribed fire, seed orchard management, and pest control. The area to be burned should be well defined and measures taken to prevent escape and minimize damage to individual trees. Soil and weather conditions should be monitored both before and during the burn. The orchard manager should be prepared to delay or halt the burning if wind, temperature, relative humidity, soil moisture, or other critical factors are not within acceptable limits. If unacceptable conditions continue, he should be prepared to use chemical control in order to preserve the health and productivity of the orchard.

SEED COLLECTION

Many different cone and seed collection methods have been used in pine seed orchards with varying degrees of success. Weather, crop size, species characteristics, orchard topography, tree height, and available manpower are among the most important factors in determining the feasibility of a given collection method. As orchard trees grow taller and cone crops get larger, standard collection methods may become unworkable.

Seed collection after the cones have opened is an old idea but there have been many problems associated with the mechanics of recovering the seed once they are shed. One method was to allow the seed to to drop onto material spread over the orchard floor. A variation of this basic concept was developed by the Georgia Forestry Commisssion (GFC) to collect loblolly pine (*P. taeda* L.) seed. They spread a netting, which is normally used as carpet backing, over the entire orchard floor to catch the seed. After the cones open, a tree shaker is used to shake out as much seed as possible. The seed and other debris on the netting are then raked into piles and fed into a peanut combine which separates the seed from most of the debris.

Methods

The GFC method was further refined and mechanized through a cooperative effort of the Southern Region and the Missoula Equiment Development Center, USDA Forest Service. A machine was designed that could retrieve the netting, roll it, and collect the seed at the same time. The netting is normally 16.5 feet wide and it may be as much as 900 feet long. As the netting is pulled in, the seed and debris are deposited on a moving belt. The belt carries it to a seed separator which partially cleans the seed. The first models of this machine worked well on level terrain, but due to their size and lack of leveling devices, they were difficult to use on slopes. Current models have been made more compact by installing the seed separator within the frame of the retrieval machine. The machine used at Beech Creek has been equipped with outriggers which enables it to be operated on sloping terrain.

Results

General Operation - Net retrieval has had mixed results as a seed collection method. With the combination of heavy duty outriggers, proper layout of netting, and experience in machine location and setup, this method works well on all areas regardless of slope. Where the slope is too great for uphill retrieval, the netting can be pulled down the slope.

Since the retrieval machine must be level and stable during operation, there are limits on the slope of the site on which the machine is to be set. Even with heavy outriggers, it should not be set up on slopes that exceed 20%.

Species differences - The combined effects of weather patterns and species characteristics may limit the choice of species that can be effectively collected with netting. For example, white pine is an excellent species for net collection because it's cones mature in the late summer when typical weather conditions are hot and dry. As a result, cone opening and seed fall take place in a relatively short period. A tree shaker can be used to improve seed fall if the operator avoids bole damage and excessive shaking.

Shortleaf and Virginia pine may be collected with netting but there are some problems. The cones mature in the fall when weather conditions are much more variable. Wet or cool conditions may interfer with cone opening and extend the period of seed fall well into winter. During these times, the seed is more subject to damage and depredation.

Yellow-poplar is the only hardwood species that we have attempted to collect with the net retrieval system. Seed fall normally occurs in September or October and the duration of the fall is fairly short. As with white pine, care must be taken when using a tree shaker and the duration of the shaking should not exceed five seconds.

Discussion

Operation - Net retrieval will provide excellent flexibility for collection if the orchard is well maintained. Orchard floor maintenance is especially critical. No woody vegetation can be tolerated and ground cover vegetation must be mowed prior to laying out the netting.

Timeliness of operation is also essential. Grass growth through the netting may interfer with retrieval if the netting is allowed to stay in place too long. Cone opening must be monitored closely because seed depredation by birds can be a problem both before and after seed fall.

Safety - Net retrieval is among the safest of the large-scale methods commonly used to collect pine seed or cones from standing trees. This factor becomes even more important on sloping terrain where safe operation of many types of machinery such as lift trucks is very limited.

TREE SHELTERS

A major obstacle in the genetic improvement of oak and certain other hardwoods is the inability to get good survival and growth with planted seedlings. This serves to hinder the establishment of seedling seed orchards, progeny tests, clone banks, clonal orchards and the eventual use of genetically improved stock in operational regeneration.

Marquis (1977) tested several types of protective devices to prevent damage from deer browsing. Most of these were tubelike devices made from wire or plastic mesh. Tall (five feet or more) tubes made of small plastic mesh or chicken wire were most promising. Seedlings in yellow plastic tubes grew slightly taller than those in other devices. Light quality measurements revealed that the proportion of far-red to red energy inside the tube was nearly three times higher than in full sunlight. Light that is high in far-red simulates stem elongation and this may explain the differences in growth.

A similar technique using solid plastic tubes over recently planted, broadleaf trees was developed in Britain (Tuley 1984). Early testing was started in 1979 and the results were so promising, wide-scale use in operational plantings began in 1983. The tubes (shelters) appear to create a favorable microclimate around each tree by acting as individual greenhouses. The results are enhanced height growth and in some cases, improved survival. The tubes also protect against damage by small animals such as rabbits or roe deer, but they are not tall enough to protect against browsing by larger animals. Chemical control of competing vegetation is easier, safer and more effective.

Kelty and Kittredge (1986) found shelters in general use with all hardwood species planted in Britain. Applications included establishment of oak seedlings beneath shelterwood overstories, hardwood plantations after clearcutting and patch regeneration of hardwoods for wildlife habitat within conifer stands.

In order to evaluate the utility of this technique for regenerating upland oak species in the southern Applachians, a small plantation was established in May, 1986. Several types of shelters were used to protect the seedlings.

Materials

The plantation site is located within the Beech Creek complex. It is gently sloping with west to southwest aspects. Soils are mixed alluvial of granitic origin and belong to the Hayesville series. Ground cover is a fescue sod which was scalped away from each planting point immediately before planting. A total of 66 1-1 oak seedlings were planted. Of these, 34 were white oak, 12 chestnut oak, 19 northern red oak, and 1 unknown.

All shelters used in this evaluation were manufactured in Great Britain. Each consisted of a transparent or translucent plastic tube which could be placed over the seedling after planting. Primary differences between the various types were height, color, and shape of the tube as shown in Table 1.

Table 1.-- Shelter Names and characteristics [1]

Name	Tube Characteristics		
	Height	Color	Shape
	-Inches-		
Sheltatree	47.2	Brown	Hexagonal
Sheltatree	59.1	Green	Hexagonal
Sheltatree	47.2	White	Hexagonal
Rabbit Guard	23.6	Brown	Square
Rabbit Guard	28.9	Brown	Square
Gro-Cone	29.2	Brown	Round
Sheltashrub	23.6	Brown	Hexagonal
Sheltashrub	47.2	Brown	Hexagonal

Methods

The size, composition, and design of the planting were limited by the availability of shelters and suitable planting stock. With the exception of Gro-Cones, only a few of any one type of shelter were available. Thus, the representation is not well balanced between types. This situation was further complicated by imbalances in species representation.

The seedlings were hand planted in a completely random, block design without regard to individual height or species. Immediately after planting, the total height of each tree was measured to the nearest 0.1 inch. This initial height data is shown in Tables 2 and 3 as "YR-0".

After the entire planting was completed, shelter types were randomly assigned and installed. Wire or wooden stakes were used to hold the tubes in place. Of the 66 trees planted, 16 had no shelters, 9 had Sheltatree tubes (3

[1] Mention of trade names does not constitute endorsement by the USDA to the exclusion of other, similar products.

each type), 6 had Rabbit Guards (3 each type), 29 had Gro-Cones and 6 had Sheltashrub tubes (3 each type).

All vegetation within a two foot circle around each seedling was chemically controlled approximately two months after planting. Survival and total height were measured after the first and second growing seasons.

<u>Results</u>

Sheltered trees had higher survival and better height growth than those without shelters (Roland 1988). Results were consistent regardless of shelter identity (Table 2) or species (Table 3).

Top die-back occurred on both sheltered and unsheltered trees. In most cases, new growth was more vigorous on sheltered trees and resulted in a net gain in total height for the year. Net losses in height were found on almost all unsheltered trees after the first growing season.

Table 2 -- <u>First and Second Year Mean Survival, Total Heights, and Net Growth</u>

Shelter	No. Trees	Survival		Total Height			Net Growth	
		YR-1	YR-2	YR-0	YR-1	YR-2	YR-1	YR-2
		--Percent--		---Inches---				
Sheltatree	9	100	100	17.7	27.6	38.7	10.1	11.1
Rabbit Guard	6	100	100	14.6	25.7	38.7	11.1	13.0
Gro-Cone	29	97	93	17.2	25.8	34.2	8.6	8.4
Sheltashrub	6	83	83	16.3	20.3	28.2	4.0	7.9
None	16	56	31	14.6	8.8	8.6	-5.8	-0.2
All-Sheltered	50	96	94	16.9	25.4	34.3	8.5	8.9
All-No Shelter	16	56	31	14.6	8.8	8.6	-5.8	-0.2

Table 3 - Survival, Total Height, and Net Growth by Species

Species/ Shelter	No. Trees	Survival YR-1	Survival YR-2	Total Height YR-0	Total Height YR-1	Total Height YR-2	Net Growth YR-1	Net Growth YR-2
		--Percent--		----------Inches----------				
Chestnut Oak								
No Shelter	2	50	50	13.5	11.0	19.5	-2.5	8.5
Sheltered	10	100	100	13.8	22.0	32.5	9.2	10.5
N. Red Oak								
No Shelter	6	67	17	16.0	8.3	3.8	-7.7	-4.5
Sheltered	13	92	92	19.2	30.6	40.6	11.4	10.0
White Oak								
No Shelter	7	57	43	13.9	9.7	10.9	-4.2	1.2
Sheltered	27	96	93	16.8	24.2	32.0	7.4	7.8

Discussion

All the types of shelters appear to have beneficial effects on survival and height growth. Although some types (particularly the white Sheltatree tubes) seem to provide better results than others, the small number of observations for any single type does not provide a good basis for evaluation.

Both survival and growth were very close for all species. The most surprising performance was exhibited by chestnut oak. Although this species is usually represented by slow growing, poor quality trees on low sites, it had best survival and second best height growth among the sheltered trees.

CONCLUSIONS

Prescribed fire - The white pine cone beetle can be controlled effectively with proper application of this method. Cost may be as little as 10% of equivalent chemical control measures.

Seed collection - Net retrieval offers a safe and effective way of collecting large seed crops in mature pine seed orchards. With proper equipment and training, this method can be utilized on sloping terrain. Weather conditions and species characteristics can strongly influence the efficacy of the collection process.

Tree shelters - Two year results indicate that shelters have a positive effect on oak seedling survival and height growth. Further evaluation will be required to determine differences between the various types of shelters.

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