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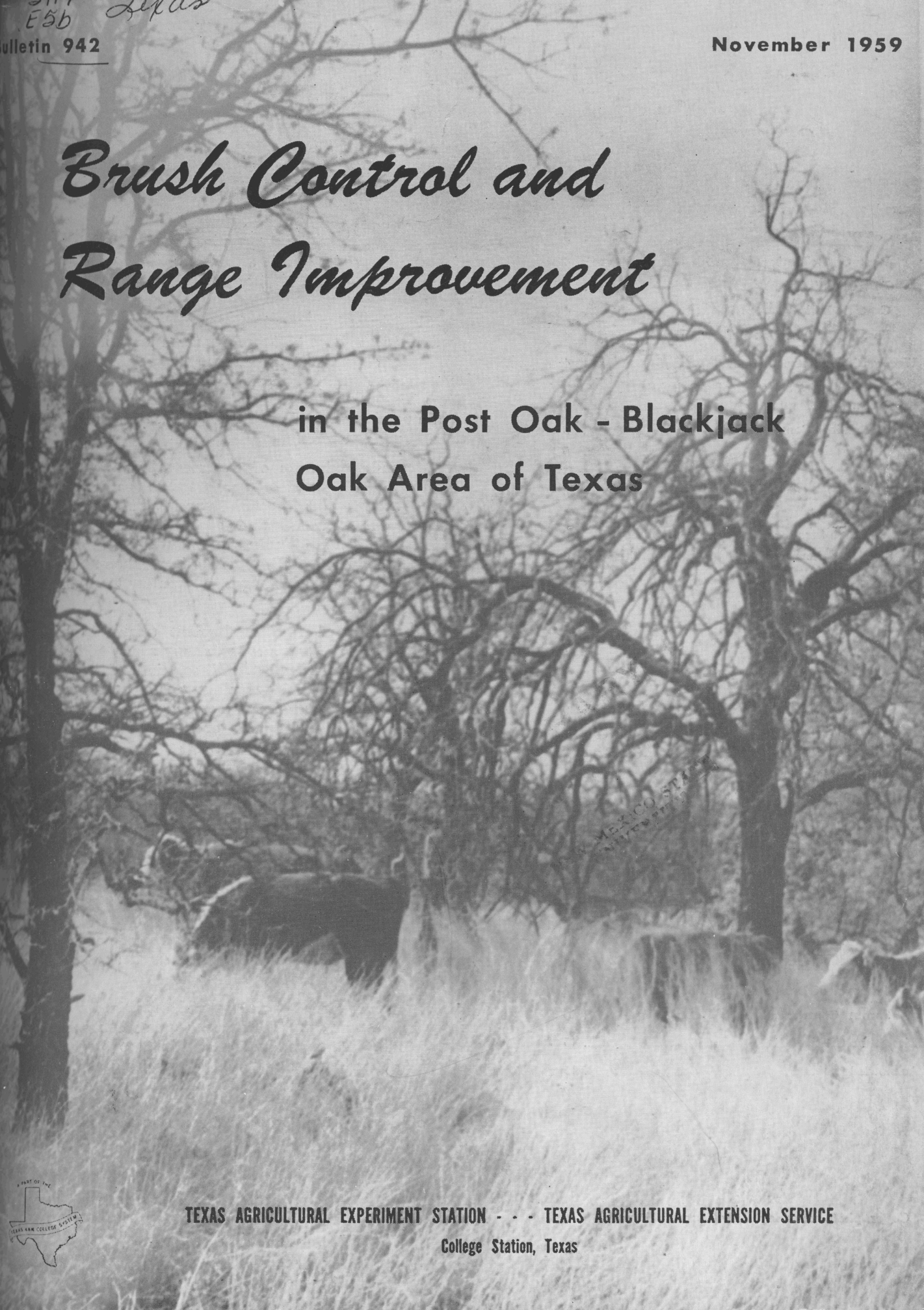
Brush Control and Range Improvement

in the Post Oak - Blackjack Oak Area of Texas



TEXAS AGRICULTURAL EXPERIMENT STATION - - - TEXAS AGRICULTURAL EXTENSION SERVICE
College Station, Texas

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Cover photo courtesy Soil Conservation Service

Summary

Significant increases in forage and livestock production are possible in the post oak-blackjack oak area of Texas by integrating brush control into a range management program. The acreage occupied by post oak-blackjack oak in the East and West Cross Timbers, the Central Basin and the East Texas post oak belt, a portion of the East Texas timberlands, is slightly greater than 11 million acres.

Methods and costs of treatment by various mechanical, chemical, burning and grazing practices are described for the control of oak and associated species. Mechanical practices suitable for small areas include girdling, cutting and mowing; for large areas, chaining is effective provided sprout growth can be controlled. Bulldozing is effective in medium-textured soils in upland sites or in bottomlands preparatory to establishment of pastures.

Recommended individual plant treatments with herbicides include basal trunk spray, stump spray, frill spray, trunk injection and soil injection. Oil solutions of 2,4,5-T ester are effective for all individual plant treatments. Water suspensions of monuron or fenuron may be used in the soil-injection method. Ammate as crystals or in solution may be applied to freshly cut stumps, cups or notches and in frills.

Broadcast applications of herbicides for oak control include foliage or aerial spraying with 2,4,5-T or silvex esters and soil surface application of fenuron pellets. The 2-year aerial spray program is recommended for large-scale treatment of areas lacking crops susceptible to hormone-type herbicides. Fenuron pellets are adapted for oak control on sandy textured soil on areas with crop hazards which prohibit the use of hormone-type sprays.

Goat grazing is an effective and economical method of sprout and underbrush control on cleared areas with suitable fencing and other facilities.

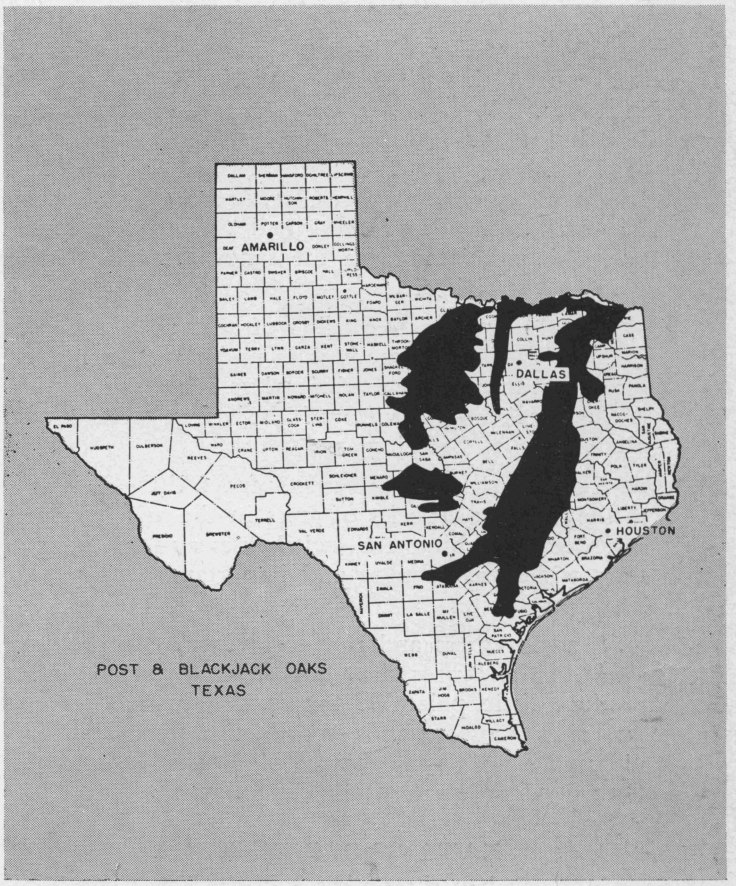
Under proper management, reduction in the woody plant cover in the post oak-blackjack oak area will result in marked increases in forage production within 2 to 3 years following control. Overstory removal on a range with good cover resulted in a five to sixfold increase in total herbage production in 2 years. Costs of treatment amounting to $27.23 per acre were paid off in slightly more than 4 years on the basis of hay production.

Broadcast chemical control treatments such as aerial spraying give the additional benefit of weed control and reduced competition with forage grasses.

Brush Control and Range Improvement

IN THE POST OAK-BLACKJACK OAK AREA OF TEXAS

Robert A. Darrow
and
*Wayne G. McCully**



THE POST OAK-BLACKJACK OAK WOODLAND of the Cross Timbers, Central Basin and East Texas area has a high potential carrying capacity for grazing livestock. During the past several decades, the increase and continued spread of such brushy plants as post and blackjack oaks, haw, smilax and yaupon have converted the original open woodland or savannah into brushy or dense woodland stands. With this increase in brush, the ground cover of desirable forage grasses such as bluestems, beaked panicum, the paspalums, Indiangrass, switchgrass, the dropseeds and other good grasses has been reduced materially. Intensive brush clearing and other control measures coupled with suitable grazing management are necessary to reduce this cover of undesirable brush and to obtain the continuing benefits of forage production.

Woody vegetation of the region consists largely of unmarketable or poor quality trees having little or no commercial value for lumber. Post oaks are used locally for fence posts and a limited amount of wood is cut for fuel and charcoal. On the non-crop lands of the region, livestock production is the principal source of revenue. Throughout the East Texas area and in parts of the Cross Timbers, large areas were cleared initially for cultivation. Some areas previously in cultivation have now reverted to scrub oak or brushy areas and often are subject to accelerated erosion.

This publication discusses methods of clearing or controlling woody plants for the establishment of crops and pastures and in the improvement of native range in the post oak blackjack oak area.

Area of Distribution

The post oak-blackjack oak area of Texas occupies four regions: (1) West Cross Timbers and adjacent fringe area; (2) East Cross Timbers; (3) Central Basin; and (4) East Texas post oak belt of the East Texas Timberlands (see map). A considerable acreage of forest dominated by post and blackjack oaks also occurs in the pine-hardwood type east of the boundary shown on the map. The total acreage occupied by the oak area in Texas is estimated at 11 million acres.

Annual precipitation in the oak area varies from 25 inches in the western portion to 45 inches along the eastern limits. Rainfall is heaviest during April and May with a secondary rainfall maximum in September and October. Summers are relatively hot and dry.

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WEST CROSS TIMBERS

The West Cross Timbers occupy unconsolidated sandy materials with rolling and sloping topography in Erath, Montague, Wise, Somerville, Comanche, Eastland, Hood and Parker counties. A fringe area, distinguished by Dyksterhuis (1948), includes outlying areas of oak brush in Clay, Archer, Jack, Young, Throckmorton, Palo Pinto and Stephens counties, and it is associated with the sandstone soils of the North Central Prairies.

Woody vegetation consists of post and blackjack oaks with a limited amount of underbrush and such associated species as greenbrier, live oak and mesquite. A distinguishing feature of the fringe area is the abundance of buffalograss.

Early settlers in the area report little bluestem as the principal species of grass in the original open savannah; big bluestem, switchgrass and Indiangrass were widely distributed and important on sandy or sandy loam sites.

Sand lovegrass and purple lovegrass are common south of the Brazos river but these secondary grasses produce little palatable forage. Productive bottomland sites support stands of oaks, elm, pecan and bois d'arc with a forage cover of bluestems, Indiangrass, Canada wildrye and other climax species.

EAST CROSS TIMBERS

The oak belt characteristic of the East Cross Timbers occurs on sandy loams and loamy sands in gently rolling topography. Vegetational components closely resemble those of the West Cross Timbers, but affinity with the East Texas Post Oak Belt is shown by a greater number of such associated woody species as winged elm, hickory and haw and by the presence of panicums and paspalums in the forage cover.

CENTRAL BASIN

Post and blackjack oaks characterize the sandy, noncalcareous soils of this heterogenous area derived from granites, limestones, schists and sandstones. Live oak, mesquite and juniper occupy the medium and heavy-textured soils. In the adjacent Edwards Plateau, particularly in Kerr and Gillespie counties, post and blackjack oaks occur on soils derived from flintrock.

Desirable grasses include purpletop, sand lovegrass, plains lovegrass, cottontop and pinhole bluestem, in addition to the bluestem dominants.

EAST TEXAS POST OAK BELT

The western portion of the East Texas Timberlands was characterized originally by a savannah-type vegetation consisting of an open woodland of oaks with a dense forage stand of little bluestem, beaked panicum, paspalums, dropseeds and such. Continued grazing pressure and a reduction in the incidence of fires have led to a marked increase in the density of oak and underbrush. Associated woody species included hickory winged elm, eastern red cedar, yaupon, French mulberry, parsley haw, chittamwood and coralberry.

In the pine-hardwood area east of the main post oak belt, savannahs of post and blackjack oaks are common on well-drained sites and are subject to similar brush control and management practices.

Woody Plant Control Measures

Regulation of the woody plant cover to permit maximum forage production is the goal of rangeland management in the post oak-blackjack area. For satisfactory economic returns in most of the area, dense woodlands or brushy stands should be converted to a tree-grass vegetation with scattered trees making up not more than 25 percent of the cover.

The presence of varying amounts of underbrush such as yaupon, greenbrier, haw, winged elm and other species may greatly influence the choice of methods used in control. Where underbrush is present, it may increase rapidly in size when the overstory is removed or deadened. Many kinds of underbrush cannot be controlled with existing methods. The methods chosen for brush control should be part of an overall management program and should provide for a continued treatment of sprout regrowth and maintenance of optimum tree-grass cover relationships.

FACTORS IN THE SELECTION OF A SUITABLE CONTROL MEASURE

Selection of a suitable control measure for a specific area may take into account several factors:

1. Nature of the brush problem—woody cover consisting of mature trees, brushy growth or sprouts with or without underbrush; woody plants in fence rows, scattered stands or continuous blocks; amount and character of residual forage grasses.

2. Size and topography of the area to be treated.

3. Availability of local or contract labor and of mechanical or spray equipment and other facilities adapted to specific control measures.

4. Relationship of area to land use pattern, particularly with reference to the location of crops susceptible to hormone-type herbicides which may limit the use of aerial spray applications.

5. Anticipated duration of clearing or control programs, for example, whether work is to be done in a single operation or in yearly or seasonal increments.

6. Economics of expected cost-benefit ratios of clearing operations. Investments as for goatproof fencing.

7. Projected use of area to be cleared or controlled.

8. Changes in existing management practices as for goats, deferments and such.

9. Provision for maintenance of treated area if excessive regrowth should develop.

10. Entire pasture unit should be treated since livestock prefer cleared or treated areas.

MECHANICAL CONTROL

Girdling

Girdling by hand ax or mechanically powered girdlers such as the Little Beaver Girdler will effectively deaden trees of post oak, blackjack oak and several other kinds of hardwood (Figure 1). Trees in excess of 8 to 10 inches in diameter are treated most effectively in this manner; smaller trees are subject to basal sprouting, particularly if the girdles are placed above ground-line height. Hickory, sweet gum, water oak, elm and bitter pecan sprout basally following girdling and supplemental control measures may be needed to control sprouting.

Girdling is efficient and economical for thinning woodland stands of light or moderate densities. The method may be used by individual landowners for intermittent operation at all seasons on small-area clearing with local or owner labor.

Costs of girdling vary from $1.50 to $10 or more per acre depending on stand density, tree size and labor costs.

Cutting

Cutting by hand ax or with mechanized chain or tractor saws is effective for clearing small areas of woodland with light or moderate amounts of underbrush.

Trees with diameters less than 8 to 10 inches are subject to sprouting when cut either at ground level or at convenient stump heights for chopping. Effective management on cutover areas will provide for control of sprouts by chemical treatment or freshly cut stumps, by grazing with goats, or by subsequent maintenance mowing.

Figure 1. Girdles cut in early spring when the bark is slipping give relatively wide bands of exposed wood and minimize natural grafting over the cut. ***Photo Courtesy of Soil Conservation Service.***

Figure 2. Motor-driven saws are effective in rapid clearing of small woodland or brush areas.

Costs of cutting and sawing vary widely with local conditions. Typical operations with power saws may cost from $6 to $15 per acre for complete woodland clearing. In recent years the use of tractor-driven or self-propelled circular saws (Figure 2) has declined in preference to the more adaptable chain saw.

Mowing

Heavy-duty mowers or shredders can be used for initial clearing and for cutting sprout growth with stem diameters not exceeding 3 to 4 inches. Regular mowing is necessary because oaks and most associated species are aggressive stump sprouters.

Costs of initial mowing may range from $3 to $7 or more per acre; subsequent maintenance mowing may be less expensive.

Bulldozing

Bulldozing to clear oak woodland in sandy or sandy loam sites has been practiced extensively in clearing land preparatory to establishing temporary crops such as watermelons and tomatoes, or for temporary pastures. In general, bulldozing in sandy sites for brush removal should be followed by an immediate establishment of a cover or pasture crop to minimize soil erosion.

Bottomland hardwoods in the post oak-blackjack oak type often are cleared by bulldozing in the establishment of tame pastures on these highly productive soils. On upland areas, clearing for improvement of native forage stands without overplanting should be limited to the medium-textured soils.

Costs of bulldozing vary with the density of tree and brush cover and intensity of treatment from $10 to $75 or more per acre.

Chaining

In recent years chaining with heavy anchor chains drawn by pairs of heavy-duty bulldozers has been used extensively in brush clearing operations in the oak type. Effective results have been obtained on sandy or medium-textured upland sites in medium-aged or mature stands relatively free of oak reproduction and underbrush.

In the West Cross Timbers and in parts of the East Texas Post Oak Belt, goating pastures before and after chaining has provided effective and profitable control of sprouts and underbrush (Figure 3). In areas in which goat grazing or sprout control by chemical methods is not feasible, piling or windrowing chained brush may allow for subsequent sprout control by the use of rotary mowers.

Costs of chaining range from $5 to $10 per acre.

Root Plowing

Root plowing has been given limited trial for brush clearing in the post oak-blackjack oak area. Recommendations are not currently available for the practice nor for the reseeding practices essential for forage stand improvement following root plowing. The practice appears to be adaptable to young to medium-aged stands of brush in medium-textured soils.

GOAT GRAZING

Goats have been used extensively in the Cross Timbers area and more recently in the East Texas Post Oak Belt for the control of underbrush and sprouts of post oak and blackjack oak following mechanical or chemical treatment (Figure 4). The use of goats for this purpose requires that suitable fencing facilities are available for management and protection of the goat herd. Spanish-type goats are preferred in the East Texas area but Angora goats are used widely in the Cross Timbers and other western areas. In Leon and Freestone counties 30,000 to 40,000 goats are currently used for brush clearing and control of regrowth in post oak areas (Polk, 1958).

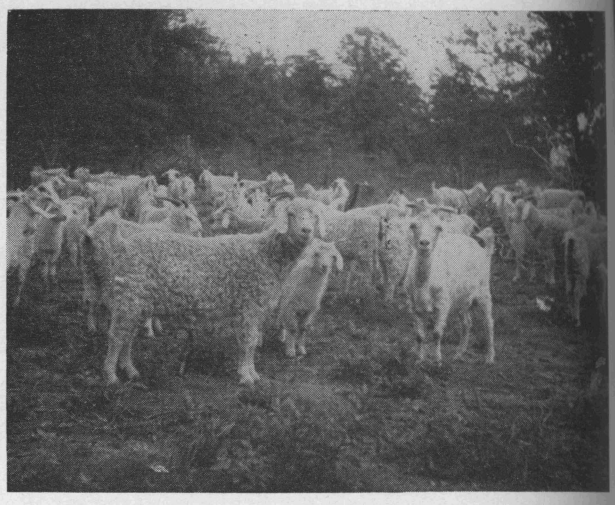

Figure 4. Grazing with goats is an effective and profitable method of brush control in oak areas. *Photo Courtesy of Soil Conservation Service.*

Mohair-producing goats have an economic advantage over other control measures in providing a source of income during the control operations. In some instances, goats may yield a higher net return than a cow operation and serve to improve the range conditions at the same time. Combination stocking with goats and cattle probably is the most economical.

Stocking rates commonly used are one goat to 2 to 3 acres on areas subjected to chaining or girdling and cutting. By using large numbers of goats for short periods in a rotation system on fenced units, animals will consume large amounts of brush with little damage to grasses. With continued stocking at heavy rates, goats may overutilize grasses and cause deterioration of the forage stand. Goating should precede or follow immediately after mechanical clearing or deadening operations in order to control sprouts ade-

Figure 3. Girdling, bulldozing or chaining followed by goating in the West Cross Timbers has given effective control of brush and excellent stands of forage under suitable management.

Figure 5. Excellent grass recovery may be secured on areas in which intensive grazing by goats is used for control of underbrush and oak seedlings. Indiangrass production 2 years after girdling of large trees and summer deferment of cattle. *Photo Courtesy of Soil Conservation Service.*

Figure 6. Periodic burning followed by a year's deferment has resulted in a pure stand of little bluestem on this oak area. Proper burning and management are essential for this control measure. *Photo Courtesy of Soil Conservation Service.*

quately. For the first 2 or 3 years following brush control, optimum conditions are provided for growth and improvement of native grasses provided suitable deferment or light stocking is practiced (Figure 5).

At present prices of mohair, gross annual sales of $8 to $10 per goat may be realized. According to economic studies by Magee (1957) in the Grand Prairie region, the returns from Angora goat operations repaid within a 5-year period the cost of stock, fencing and brush control costing an average of $7.23 per acre. Careful handling and livestock management is necessary in an economical operation.

BURNING

Controlled or prescribed burning has been given limited trial for the control of woody plants in the oak woodland type. Small-diameter oaks and some underbrush apparently can be rootkilled by properly handled ground fires in situations with an adequate supply of grass stubble for fuel.

Bluestem grasses and some associated species are relatively tolerant of fall or early spring burning. Areas such as railroad rights-of-way which have been burned periodically show a predominance of fire tolerant grasses, notably little bluestem (Figure 6).

Yaupon and other kinds of underbrush common to the East Texas area show marked reduction in stand density with systematic burning (Goddard, 1954).

CHEMICAL CONTROL

Hormone-type chemicals or other herbicides may be applied in individual plant or broadcast treatments for control of woody plants.

Basal Trunk Spray

Basal spray applications of oil solutions containing 2,4,5-T ester or water suspensions of monuron powder are recommended for control of post and blackjack oaks with diameters of less than 5 to 6 inches. Oil sprays containing 16 pounds acid equivalent of 2,4,5-T ester in 100 gallons of diesel fuel or kerosene give effective control of oak in dormant season or early summer applications (Figure 7). Basal spray applications of 2,4,5-T ester have proved more effective than treatments of silvex and the related 2-(2,4-DP) ester or 2,3,6-TBA (Table 1). Monuron in suspensions containing 8 to 10 pounds of wettable powder per 100 gallons of water is effective in applications made at any season. The mixture in the spray tank should be kept well agitated to insure uniform delivery.

Care should be taken in basal trunk spraying to thoroughly wet the lower 8 to 12 inches of stem to the point of runoff. Applications can be made most effectively with a knapsack sprayer. Species associated with post and blackjack oak such as gum elastic, honey locust, red haw, bitter pecan and bois d'arc can be controlled with basal sprays of 2,4,5-T ester at 8 pounds in 100 gallons of diesel fuel.

Cost of treatment with oil sprays of 2,4,5-T ranges from 3 to 5 cents per tree. One gallon of spray will treat from 25 to 40 trees of 3-to 6-inch diameter. A minimum of one fluid ounce of spray solution per inch diameter of tree should be applied.

HERBICIDES TESTED IN THE CONTROL OF OAKS AND OTHER WOODY SPECIES

Phenoxy-type herbicides

(Available as low-volatile esters or amines)

2,4-D	2,4-dichlorophenoxyacetic acid
2,4,5-T	2,4,5-trichlorophenoxyacetic acid

Combinations of 2,4-D and 2,4,5-T are commonly known as brushkillers

Silvex or 2-(2,4,5-TP)	2-(2,4,5-trichlorophenoxy)propionic acid
2-(2,4-DP)	2-(2,4-dichlorophenoxy)propionic acid
4-(2,4-DB)	4-(2,4-dichlorophenoxy)butyric acid
4-(MCPB)	4-(2-methyl-4-chlorophenoxy)butyric acid
MCPA	2-methyl-4-chlorophenoxyacetic acid

Other herbicides

Ammate	Ammonium sulfamate
Monuron	3-(P-chlorophenyl)-1,1-dimethylurea
Fenuron	3-phenyl-1,1-dimethylurea
2,3,6-TBA	2,3,6-trichlorobenzoic acid
PBA	Polychlorobenzoic acid

TABLE 1. PERCENT ROOTKILL OF POST AND BLACKJACK OAKS OBTAINED FROM WINTER AND SUMMER BASAL SPRAY APPLICATIONS OF OIL SOLUTIONS OF 2,4,5-T AND OTHER HERBICIDES, 1952-57

Treatment	Number of tests	Percent rootkill		Relative rating[1]
		Winter (December-March)	Summer (June-August)	
2,4,5-T ester				
8 pounds ahg[2]	17-17	57.7	44.7	100
16	17-17	65.3	61.3	
24	17-17	71.6	67.3	
2-(2,4,5-TP) ester				
8 pounds ahg	5-3	30.8	22.7	58
16	5-3	56.2	29.3	
24	5-3	54.6	20.3	
2-(2,4-DP) ester				
8 pounds ahg	3-2	34.3	44.0	81
16	3-2	56.3	25.5	
24	3-2	60.0	79.5	
2,3,6-TBA acid				
8 pounds ahg	4-3	28.7	26.7	52
16	4-3	31.0	29.7	
24	4-3	37.7	36.0	

[1]Based on 2,4,5-T as standard at all rates.
[2]ahg means acid equivalent per hundred gallons.

Soil Injection

Rootkills averaging 75 percent or more have been obtained on post oak, blackjack oak, winged elm, honey locust, and gum elastic by injecting an herbicide solution into the soil at the root collar zone. Soil fumigant equipment such as a Mack's Anti Weed Gun (Model 44AX) may be modified for this purpose (Figure 8). The chemical solution should be released at a depth of approximately 4 inches below the soil surface at opposing sides of the root collar.

Oil solutions of 2,4,5-T ester containing 8 pounds acid equivalent in 100 gallons of diesel fuel or water solutions containing 6 to 8 pounds active ingredient of either monuron or fenuron powder per 100 gallons of water are recommended. Two fluid ounces of herbicide solution should be injected for each inch of trunk diameter on trees up to 8 inches. Applications of 2,4,5-T ester should be made in spring or early summer when the soil is moist and plants are growing actively (McCully, 1956). Monuron and fenuron powder probably can be applied at any season.

The method is adapted for treatment of individual plants in fence rows and small areas in stands relatively free of underbrush. Costwise, the method is cheaper than the basal trunk spray method as reduced amounts of herbicide are required. Labor requirements for the two methods are nearly identical.

Stump Spray

Freshly cut stumps of post oak, blackjack oak, hickory, winged elm, yaupon and most associated species may be sprayed with oil solutions containing 16 pounds acid equivalent of 2,4,5-T ester for effective control of sprouts (Figure 9). Stump spray treatment is effective at any season.

In the East Texas area, post and blackjack oaks on upland sites may be controlled by application of ammate crystals or water solutions containing 2 to 4 pounds of ammate per gallon to freshly cut stumps. This method is most effective when used during fall and winter.

When applying solutions of ammate or 2,4,5-T, the exposed wood and bark of stumps should be thoroughly wet to the point of runoff. Ammate crystals should be concentrated where bark and wood join. Oil solutions of 2,4,5-T should be applied within a few hours after cutting or sawing. For effective control, ammate crystals or solutions should be applied immediately to cut surfaces.

Cost of treatment including labor and chemical ranges from 3 to 8 cents per stump, depending on size.

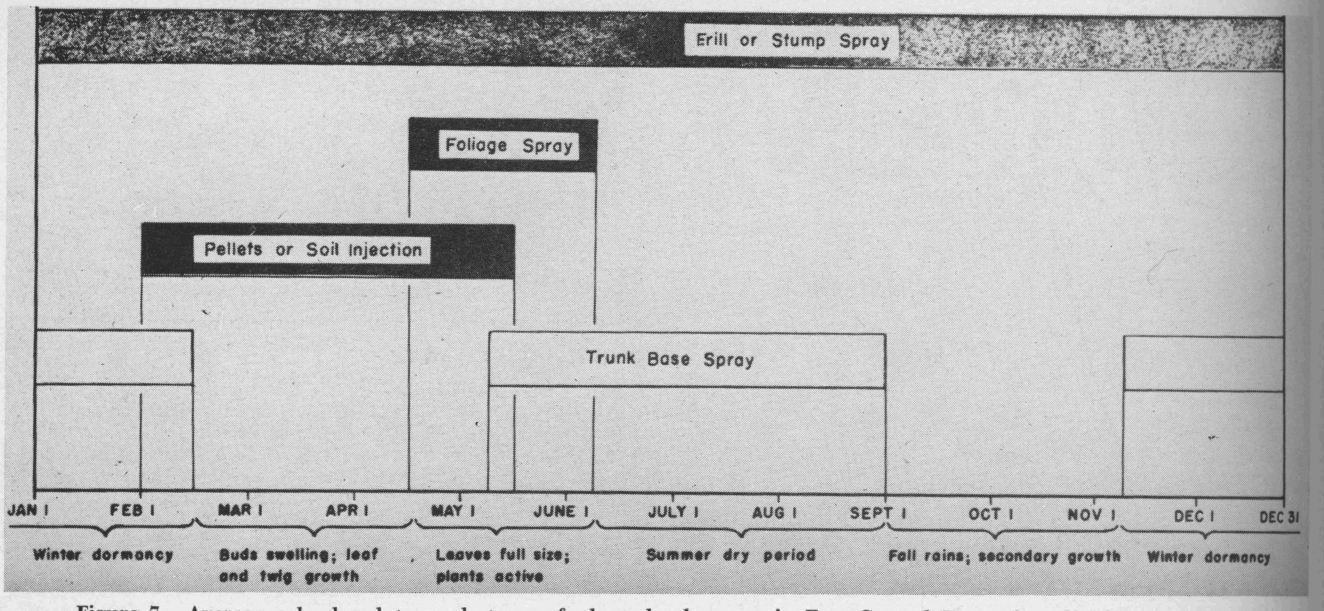

Figure 7. Average calendar dates and stages of plant development in East Central Texas for effective control of post and blackjack oak.

Frill Spray

Standing trees with diameters exceeding 3 inches may be deadened by applications of an oil spray of 2,4,5-T esters or by a water solution of ammate in single ax frills which completely encircle the trunk (Figure 10). Frill treatments should be used in preference to basal trunk sprays for trees larger than 5 to 6 inches in diameters.

For control of post oak, blackjack oak, hackberry, red oak, ash, elm and many bottomland hardwood trees, oil solutions should contain 16 pounds of acid equivalent of 2,4,5-T ester in 100 gallons. Effective control may be obtained with dormant season or mid-summer frill spray treatment.

Ammate solutions containing 1 to 3 pounds of ammate per gallon of water may be applied in frill or cup treatment of upland oaks in the East Texas Post Oak Belt. Fall and winter treatments are most effective.

Cost of frill treatment with ammate or 2,4,5-T for the average 10-inch tree ranges from 3 to 7 cents per tree.

Trunk Injection

Individual trees may be deadened by means of a trunk injector such as the Cornell Tree Tool or Little Tree Injector. These implements consist of a 1½-3 inch cylinder for herbicidal solution fitted with an incision blade and a valve mechanism for release of the solution into the incision.

For control of oaks and most hardwood species, solutions containing 1.5 pound acid equivalent of 2,4,5-T ester in 4½ gallons of diesel fuel or kerosene have been effective from February to August. During the remainder of the year, a brushkiller mixture of 2,4-D and 2,4,5-T esters at 2 pounds acid equivalent may be used in place of 2,4,5-T ester.

Incisions should be made at intervals of 2 to 4 inches apart completely around the trunk base. Ash, hickory elm, hackberry and other resistant species require close spacing of incisions. The amount of chemical solution released should be sufficient to soak the incision thoroughly without excess runoff.

Costs of the tree injection method are comparable to those of the frill spray method in terms of amount of herbicide and labor required.

Foliage Spray

Foliage spray applications with ground equipment may be used for the control of young oaks and sprouts three or more years in age. The volume of spray solution required for complete coverage generally limits this practice in rangeland brush control to scattered stands of brush not exceeding 6 to 8 feet in height.

Livestock sprayers equipped with hand-gun nozzles or tractor-mounted tank sprayers with boomless cluster-jet nozzles may be used for spraying open stands of brush. For boomless, swath-type spraying,

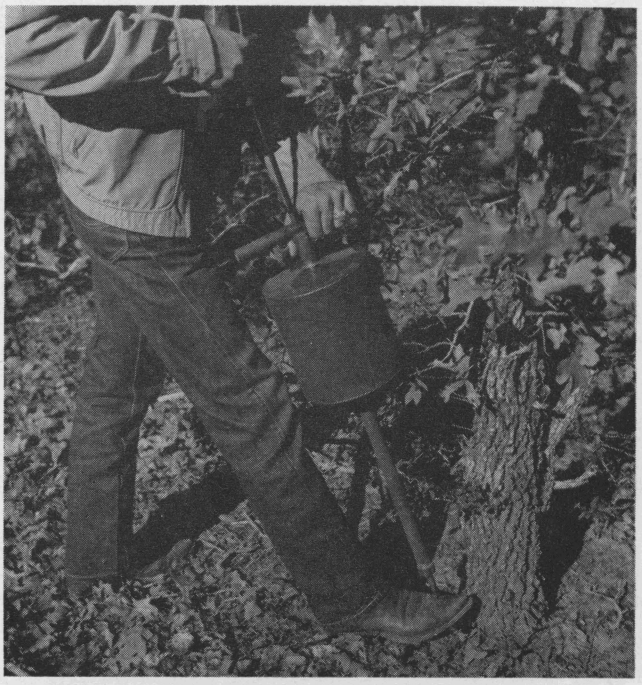

Figure 8. Soil injections of oil solutions of 2,4,5-T or water suspensions of monuron powder placed next to the root collar will effectively control trees up to 8 inches in diameter.

a minimum volume of 20 gallons per acre is required. For right-of-way maintenance and clearing in dense brush, power spray applications at volumes of 60 to 150 or more gallons per acre are used. Dense brush stands should be wet to the point of runoff and special care taken to insure complete coverage.

Ester formulations of 2,4,5-T, 2-(2,4,5-TP) or silvex, and mixtures of 2,4-D and 2,4,5-T esters, as well as ammate are generally used in foliage spraying of oak and other deciduous brush. Silvex is most effective in post oak stands. 2,4,5-T or brushkiller mixtures of 2,4-D and 2,4,5-T esters are useful in mixed brush stands. Ammate at 1 to 2 pounds per gal-

Figure 9. Sawn or cut stumps should be sprayed with oil solutions of 2,4,5-T ester immediately after cutting to prevent sprouting.

Figure 10. Single ax-frilling and application of oil solution containing 2,4,5-T ester give effective control of oaks and other hardwoods. *Photo Courtesy of Soil Conservation Service.*

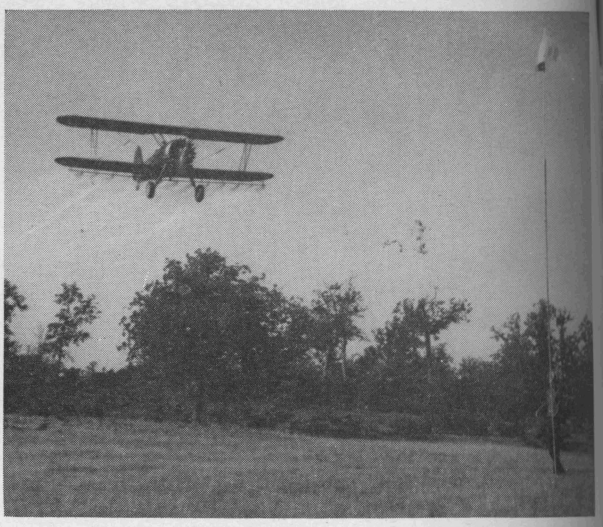

Figure 11. Aerial spraying with 2,4,5-T or silvex esters is probably the most effective and economical method of oak control for large acreages.

lon in water sprays is effective for right-of-way clearing in areas with susceptible crop hazards.

Silvex 2,4,5-T and brushkiller mixtures should be used at rates of 2 to 4 pounds acid equivalent per 100 gallons of water or in 10 gallons of diesel oil and 90 gallons of water. June applications of these three herbicides at College Station during 1953-56 on 4-to 6-foot sprouts have given 40 to 50 percent rootkill of post oak and 25 to 60 percent rootkill of blackjack oak (Table 2).

Effective control can be obtained from applications made from early May to early July. Spraying in late summer or during periods of drouth has given poor results.

Preliminary tests of invert emulsions of 2,4,5-T ester have given initial defoliation and topkill equivalent to that of standard emulsion sprays. Invert emulsions are water-in-oil emulsions with ratios of one part of oil to four or five parts of water. Their mayonnaise-like consistency requires the use of modified or special centrifugal disc equipment for application.

TABLE 2. PERCENT ROOTKILL FROM FOLIAGE SPRAY APPLICATIONS MADE IN JUNE WITH 10 PERCENT OIL EMULSION SPRAYS AT 50 TO 100 GALLONS PER ACRE, 1953-56

Treatment	Percent rootkill	
	Post oak	Blackjack oak
2 pounds ahg[1]	49	44
2,4,5-T ester	49	44
2-(2,4,5-TP) ester	44	28
3 pounds ahg		
2,4,5-T ester	39	39
2-(2,4,5-TP) ester	44	25
2,4-D/2,4,5-T esters	46	61
4 pounds ahg		
2,4,5-T ester	50	28
2-(2,4,5-TP) ester	43	27
2,4-D/2,4,5-T esters	46	28

[1]ahg means acid equivalent per hundred gallons.

Herbicides which have proved ineffective or uneconomical for foliage spray application on oak under Texas conditions include: amitrol, 2,3,6-TBA, PBA, 2,4-D ester, 2,4-D amine, 2,4,5-T amine, 4-(2,4-DB), 4-(MCPB). 2-(2,4-DP) or 2,4-D propionic, closely related to silvex, has given excellent control of post and blackjack oaks.

Precautions in the Use of Chemicals for Brush Control

Special care should be taken in foliage spraying and aerial applications of 2,4,5-T and silvex to avoid damage to nearby crops. Injury due to drift may occur if spraying is done during periods of appreciable wind movement. Cotton, alfalfa, tomatoes, clovers, peanuts, watermelons and other broadleaf crops are extremely sensitive to small amounts of these herbicides.

Spray equipment for herbicides may be safely used for livestock sprays but should not be used for applications of insecticides or fungicides on cultivated or ornamental plants.

Applications of hormone-type herbicides for the control of oaks and other brush and weeds should be made in conformity with the Herbicide Regulations of the State Department of Agriculture. Information on the use of these chemicals may be obtained from your county agricultural agent or from the Texas State Department of Agriculture, Austin, Texas.

Aerial Spraying

Aerial spray application of herbicides for the control of post and blackjack oaks is adapted to the treatment of large acreages of upland sites with varying topographic situations (Figure 11). Aerial application of herbicides is limited principally by the proximity of broadleaf crops such as cotton, tomatoes, peanuts, and other desirable vegetation sus-

TABLE 3. PERCENT ROOTKILL OF POST AND BLACKJACK OAKS FROM SINGLE AERIAL SPRAY APPLICATIONS OF 2,4,5-T AND SILVEX ESTERS, 1951-57

Treatment pounds per acre	Post oak		Blackjack oak	
	Number of tests	Percent kill	Number of tests	Percent kill
2,4,5-T ester				
1.0	8	43.1	6	14.3
1.5	13	49.7	6	25.3
2.0	20	52.4	15	23.1
Silvex				
1.0	18	48.6	12	32.1
1.25	20	37.4	14	30.9
1.5	22	53.9	13	31.6
2.0	7	70.1	5	32.6

TABLE 4. PERCENT ROOTKILL OF POST AND BLACKJACK OAKS FROM REPEATED AERIAL SPRAY APPLICATIONS OF 2,4,5-T AND SILVEX ESTERS, 1952-57

Treatment pounds per acre	Number of tests	Post oak	Blackjack oak
2,4,5-T ester			
1.0 + 1.0	3	51.0	0
1.5 + 0.75	6	64.5	32.7
2.0 + 0.75-1	12	77.5	51.3
Silvex			
1.0 + 0.75	7	60.2	41.0
1.25 + 0.75	8	75.1	37.7
1.5 + 0.75	13	82.4	71.6

ceptible to drift from hormone sprays during application.

Low-volatile esters of 2,4,5-T and 2-(2,4,5-TP) or silvex are recommended in a 2-year spray program aimed at a high degree of rootkill and improvement of forage production (Figure 12). Increasing effectiveness is obtained with rates up to 4 pounds per acre. Consistently better controls have been obtained on post oak than on blackjack oak (Table 3).

For relatively pure stands of post and blackjack oaks, as in the Cross Timbers, Central Basin and western portion of the East Texas Post Oak Belt, initial applications of 1.25 pounds per acre of silvex or 1.5 pounds per acre of 2,4,5-T should be followed by a repeat application 1 or 2 years later consisting of 0.75 pound per acre of silvex or 1.0 pound per acre of 2,4,5-T (Table 4). Rootkills of 65 to 75 percent on post oak and 35 to 60 percent of blackjack oak are obtained with this 2-year program at a total cost of $10 to $12 per acre. In relatively pure stands of post and blackjack oak, silvex may be used to advantage (Figure 13).

In the main East Texas area, brushy or woodland stands of post and blackjack oaks with appreciable mixtures of winged elm, hickory, red oak, yaupon and other underbrush should be treated initially with 2,4,5-T ester at 2 pounds per acre and re-treated the following year with 1 or more pounds per acre (Figure 14).

Volumes of 4 or 5 gallons of spray solution per acre appear to be adequate for control of post and blackjack oaks. Emulsions containing one part of oil to three or four parts of water are generally more effective than oil solutions. Care should be taken in the use of emulsions to insure thorough mixing and emulsification at the time of application.

Applications of 2,4,5-T and silvex esters give best control when made from early May to early July. Plants in full leaf in an active growing condition show the best response to aerial spray application.

The size and character of oak brush may influence the degree of control obtained. Relatively mature trees and pole size stands, less than 6 inches in diameter in vigorous growth, show the best response. Sprout regrowth less than 6 feet in height is readily controlled with 1.0 to 1.5 pounds per acre of either silvex or 2,4,5-T. Plants in deep-soil, valley sites respond better to 2,4,5-T applications than trees or brush on shallow rocky slopes or ridge crests.

Broadcast Granular Application

Soil surface applications of a pelletized herbicide, fenuron, are recommended for broadcast or indi-

Figure 12. Aerial applications of silvex or 2,4,5-T ester can convert dense stands of oak brush to desirable forage cover accessible to range livestock. *Photo Courtesy of Soil Conservation Service.*

TABLE 5. PERCENT COMPOSITION OF FORAGE IN 1951 AND 1954 IN WOODLAND AREA PRIOR TO AND 3 YEARS AFTER OVERSTORY REMOVAL (from Koshi, 1957)

Forage species	Percent composition					
	Undisturbed		Medium thinning		Complete removal	
	1951	1954	1951	1954	1951	1954
Little bluestem	70	66	82	61	81	51
Paspalum and panicum	10	20	7	20	6	30
Other perennial grasses	18	9	10	16	6	10
Forbs and annual grasses	2	5	1	3	7	9

vidual tree treatment of post and blackjack oaks. The method may be used in areas in which proximity of susceptible crops prohibits the use of hormone-type spray herbicides. Chemically, fenuron is a substituted urea herbicide and is available commercially in pellets containing 25 percent active ingredient (Figure 15). For broadcast applications, 4 pounds of active fenuron or a total of 16 pounds of pellets per acre should be distributed uniformly over the area to be treated (Darrow and McCully, 1958).

Small areas can be treated effectively by hand using a common method of broadcasting seed. Cyclone seeders or similar devices for scattering seed or granular materials may be used to secure uniform distribution in stands relatively free of underbrush. Scattered trees in fence rows and small areas may be treated individually by applying 1 to 2 tablespoons of pellets around the base of each plant.

Agricultural aircraft, equipped with seed or dust distributors may be used for broadcasting pellets on large areas (Figure 16). Equipment should be calibrated carefully to insure uniform delivery of 16 pounds of pellets per acre over a uniform swath.

Fenuron pellets should be applied between early February and mid-May to insure adequate soil moisture for maximum uptake by the plant roots. Most effective results are obtained on sandy or sandy loam soils. Applications should not be made in places where the herbicide will be absorbed by roots of desirable plants or washed from the area of application by hard flooding rains. Application of pellets on soil saturated from previous rains should be avoided to minimize leaching and possible surface washing.

Post oak, blackjack oak and winged elm are killed readily by fenuron (Figure 17). Aerial applications in April 1956 of 16 pounds per acre of fenuron pellets gave 80 to 95 percent rootkill of post and blackjack oaks at four out of five locations, as evaluated in July 1958. Although some variations in effectiveness have been noted with the amount of spring moisture received, rate studies conducted in 1955-58 support the recommended rate of 16 pounds of pellets per acre on sandy or medium-textured soils.

Yaupon is intermediate in susceptibility, but haw, greenbrier and French mulberry usually are not damaged by the recommended treatment.

Deep-rooted desirable perennial grasses such as bluestems, paspalums and gramas are more tolerant of fenuron than short-lived, less desirable forage grasses. Marked increases in volume of little bluestem take place after fenuron treatment in oak sites, but the increase in growth is slower than that following spray application of 2,4,5-T ester. Applications from December to April at rates up to 12 pounds of active fenuron per acre showed little or no reduction in forage yield on sites with little bluestem, sideoats grama and brownseed paspalum. Partial control of annual grasses and forbs has been obtained by fenuron treatment (Darrow, McCully, Hughes, 1959).

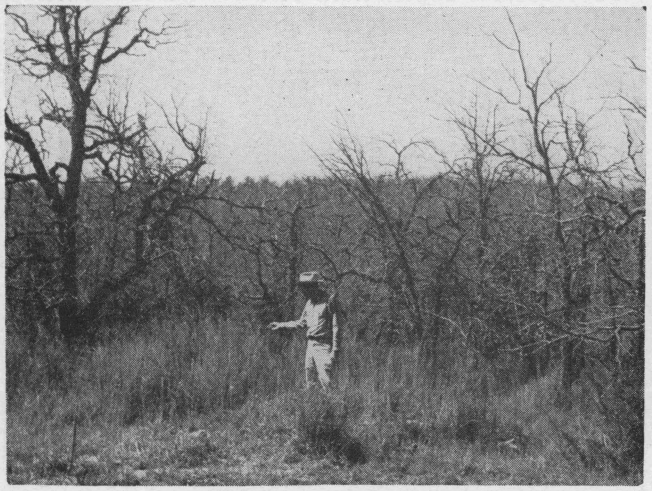

Figure 13. Pure stands of post and blackjack oaks (in the Cross Timbers) show rapid recovery of forage grasses with control of oak by aerial spray applications of silvex or 2,4,5-T low-volatile ester.

Figure 14. Woodland with mixture of post and blackjack oaks, hickory, winged elm and dense underbrush may be controlled with a 2-year aerial spray program with 2,4,5-T ester at 3 pounds per acre.

Effects of Control Measures on Vegetation and Soil Conditions

VEGETATIONAL COMPOSITION

Removal of competing brush vegetation by methods which minimize soil and site disturbance will permit rapid improvement in composition and density of the forage cover under suitable management. Heavily infested brush areas in the oak savannah type often support only scattered stands of the desirable forage grasses such as little bluestem, paspalums, panicums, and gramas. Overstory removal releases soil moisture, light and nutrients to this forage cover and results in increased vigor and establishment of the long-lived perennial grasses. Deferment during the growing season following control treatment is essential on most areas to permit adequate recovery.

Evaluations of forage plant response to overstory removal has been made in a mature oak woodland in Robertson county during 1951-54 (Koshi, 1957). Range condition prior to treatment of woody plants was rated as good. Little bluestem comprised 70 to 85 percent of the total herbaceous vegetation. Other grasses included panicums, paspalums, dropseed and purpletop.

Five thinning treatments made by basal spray and frilling treatments reduced the woody overstory from an initial cover of 65 percent to 39 percent canopy on the medium-thinned treatment and 13 percent canopy on the complete removal. Overstory removal resulted in a decrease in the relative amount of little bluestem as compared to an increase in basal area density of panicums and paspalums equally desirable as forage (Table 5).

Aerially sprayed areas show comparable increases in density and proportion of desirable grasses following treatment, provided suitable management practices are used. Residual plants of little bluestem, Indiangrass, dropseed, panicums and paspalums make rapid growth with removal of brush competition. Areas treated by broadcast application of fenuron pellets have shown definite increases in the percentage of desirable forage grasses but annual grasses and weeds may be killed in the season of treatment. The retarding effect of fenuron on the short-lived plants disappears by the end of the first growing season after treatment. In contrast, the 2-year aerial spray program with 2,4,5-T or silvex provides weed control for 2 years.

FORAGE AND LIVESTOCK PRODUCTION

Control of post and blackjack oaks is important in securing improved forage and livestock production in the Cross Timbers and East Texas forest areas. For example, in Brazos county, clearing a dense stand of second-growth oak 8 to 30 feet in height resulted in a fourfold increase in total density and a thirteenfold increase in total herbage production over a 2-year period (Young, 1952). In a mature oak woodland with a forage cover in good condition, complete overstory removal resulted in a fivefold to sixfold increase in total herbage production after 2 years (Koshi, Darrow and McCully, 1953). Data from this study (Table 6) show that the fivefold increase was maintained for a 3-year period (Koshi, 1957).

TABLE 6. FORAGE YIELDS (POUNDS PER ACRE OF OVEN-DRY FORAGE) FROM WOODLAND AREAS SUBJECTED TO PARTIAL AND COMPLETE OVERSTORY REMOVAL (FROM KOSHI, 1957)

Date	Forage yield		
	Undisturbed	Medium thinning	Complete removal
1951 (prior to treatment)	453	385	545
1952	212	419	1168
1953	247	610	1597
1954	209	484	1106

Complete removal by individual basal and frill treatments cost $27.23 per acre in this test. By converting 50 percent of the total herbage produced over the 3-year period to hay valued at $25 per ton, the increase in forage production from complete removal of woody overstory could be valued at $6.67 per acre. Thus the initial cost of treatment could be amortized in slightly more than 4 years. Areas with less initial forage will require careful management for a longer period.

Marked gains in livestock production have resulted from the forage improvement from removal and control operations in the oak savannah type. Spectacular livestock gains have been obtained on aerially sprayed areas, for example on the Crownover Ranch in Montague county. Aerial spray applica-

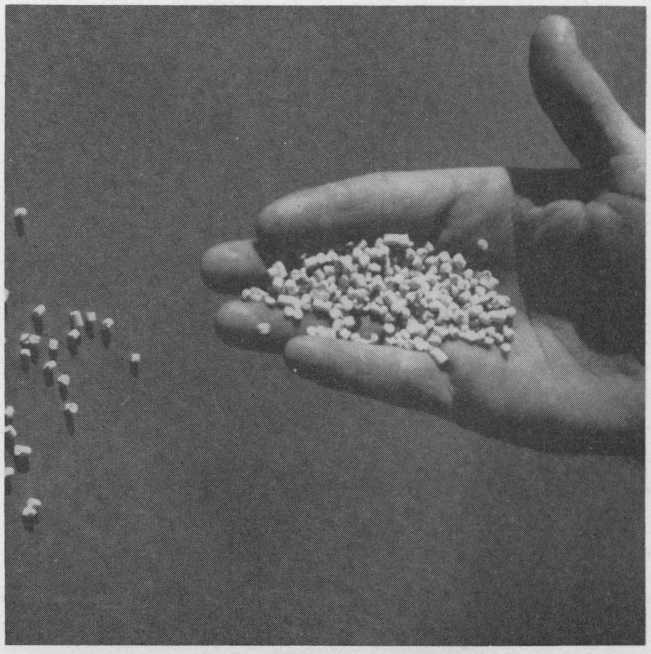

Figure 15. Fenuron pellets are an easily applied herbicide for oak control. Pellets may be scattered broadcast at the rate of 16 pounds per acre or used on individual trees in fence rows or open stands.

Figure 16. Fenuron pellets may be applied aerially in post and blackjack oak areas aerially during the spring growing season. Seeding and fertilizing equipment may be modified to release 16 pounds of pellets per acre.

tion of 2,4,5-T and silvex in research tests conducted in 1954-55 on 320 acres of this 663-acre tract resulted in an increase in calf weight of 100 pounds at weaning time and an increase from 34 to 50 mother cows by 1958. Total feed bills for cottonseed cake supplement were cut in half following the brush clearing operation.

SOIL CONDITIONS

Control methods vary in their effects on soil and site conditions with the general nature and intensity of treatment. Chaining, bulldozing and other mechanical measures result in soil disturbance and may cause temporary tillage effects on soil-moisture penetration. Burning in oak woodland may modify moisture infiltration and plant-soil-water relationships by the temporary removal of litter and ground cover. Individual or broadcast applications of herbicides result in minor disturbance and changes in the physical characteristics of the soil.

Figure 17. Post and blackjack oak brush to the right of the stake in the foreground was treated with 16 pounds per acre of fenuron pellets.

Removal or deadening of competing woody cover will release soil moisture and nutrients for the grass and herbaceous cover. Woodland areas in Robertson county subjected to complete removal and medium thinning by Koshi (1959) showed marked differences in moisture availability to forage plants between thinned and undisturbed areas. During a 16-month period, complete overstory removal reduced the period in which moisture was unavailable to plants in the surface 6 inches by 42 days, at the 6 to 12-inch depth by 24 days, and at the 12 to 24-inch depth by 99 days. Thus, removal of woody overstory increased the amount of water available for growth by the herbaceous cover by reduced losses through transpiration, particularly in the subsoil layer.

Soil moisture contents were consistently highest on cleared areas, intermediate in thinned areas and lowest in undisturbed stands (Koshi, 1959). Differences in physical properties of the soil 2 years after clearing, such as lower percent of aggregation and lower capillary pore space in the subsoil and a higher bulk density of the surface soil, could have been caused by increased trampling of livestock attracted to the improved forage and possibly to reduced organic matter incorporated in the soil.

Management of Improved Stands

GRAZING DEFERMENT

Grazing should be deferred for at least one and preferably two growing seasons following brush control by either chemical or mechanical methods in order to secure maximum recovery and growth of residual grasses. Winter utilization by livestock should be moderate to insure adequate recovery.

Livestock tend to congregate on areas cleared or defoliated by various methods. Cattle are attracted to aerially sprayed units shortly after application of herbicide and tend to utilize forage heavily. Where control operations are carried out on only a portion of a single pasture, it is advisable to fence off the treated portion temporarily, reduce the rate of stocking, or remove stock from the entire unit to prevent excessive use by livestock. Wherever possible, complete pasture units should be treated at one time to facilitate grazing deferment.

REMOVAL OF DEAD STANDING TIMBER

Oak trees or brush deadened by girdling or chemical control measures disintegrate readily and may be left standing for rapid decay. Broken branches and litter from standing trees furnish a continuing increment of organic matter as well as partial protection of rejuvenated grasses. Deadened brush may be knocked down easily by bulldozers or by chaining if cleared pastures are desired. Dead brush should be left standing for at least 2 years following aerial application of heribicides to insure the effective action of the chemical.

SPROUT CONTROL

Sprout regrowth and underbrush on cleared areas may be controlled or maintained by periodic mowing with rotary mowers, by heavy utilization with goats, by burning, by bulldozing with a light tractor or by hand cutting. Goating underbrush areas is probably the most efficient and economical method of sprout control in pasture units with suitable fencing and facilities for handling.

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METHODS OF OAK CONTROL FOR SPECIFIC AREA, SITE AND VEGETATION CONDITIONS

Condition	Control program: Mechanical	Chemical	Other methods
Small areas			
Scattered trees, fence rows, etc.	Hand cutting, girdling, bulldozing	Basal spray, frill spray, pellet broadcast or individual tree application, tree injection, soil injection	
Dense sprout growth	Rootplowing, bulldozing, in medium-textured soils	Foliage spraying with 2,4,5-T or ammate; pellet broadcast	Goating, prescribed burning
Mixed stands of trees and underbrush	Chaining, bulldozing, sawing or hand cutting	Basal spray or frill treatment of trees; bulldozing and cutting underbrush; fenuron pellet broadcast	Goating Girdling or deadening trees and burning underbrush
Large areas			
Oak dominant; woodland or brush type with little underbrush	Chaining, with goating or other sprout control; bulldozing, girdling	Aerial spray application of silvex or 2,4,5-T; aerial fenuron pellet application	Goating (with adequate pasture division fencing)
Mixed oak and hardwood species with moderate or dense underbrush	Chaining, with goating or subsequent sprout control	Aerial spray application of 2,4,5-T or fenuron pellet broadcast on upland sites	Goating (with adequate fencing)
Bottomland sites	Girdling; bulldozing and reseeding with temporary grain or pasture crop	Basal or frill treatment with 2,4,5-T in oil sprays; aerial spray application of 2,4,-D/2,4,5-T esters in areas lacking crop hazards	

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