



Prescribed Range Burning

in the Rio Grande Plains of Texas

The Texas A&M
University System



**Texas
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Cover Photos:

Front - Prescribed burn in previously herbicide treated mesquite-whitebrush near Cotulla, Texas, February 26, 1979.

Back - Vegetation response May 1979 following the prescribed burn of February 26, 1979, near Cotulla, Texas. Note the openness of brush and excellent response of California cottontop (Digitaria californica).

PRESCRIBED RANGE BURNING
IN THE
RIO GRANDE PLAINS OF TEXAS

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INTRODUCTION TO PRESCRIBED RANGE BURNING IN THE RIO GRANDE PLAINS

Larry D. White

It is truly a pleasure to welcome you to the first Symposium on Prescribed Burning in the Rio Grande Plains. Today's program is an effort to present and compile the most up-to-date knowledge and art of one of man's earliest used range management tools. The excellent speakers, researchers, and secretarial staff have made today's effort possible. They are to be congratulated.

Our number one objective in this symposium and future educational programs is to provide information and training for the safe and controlled use of fire. Even though fire has been a natural factor in this resource area and many ranchers prescribe burned in the early 1900's, the vegetation and complexity of land management has changed. These changes in biological, social, and political circumstances dictate a more careful and well-planned application of fire for successful results. Fire is not a cure-all for poor range management; rather, it is a tool that has much potential if carefully planned, conducted and managed in view of the total ranch ecosystem. Improper use can result in extensive damage to property and life as well as result in political and social pressures to restrict or eliminate its future use. At all times, observe burning regulations and common courtesy with neighbors, the volunteer fire department, the sheriff's department and other concerned individuals.

Why Burn?

Interest in prescribed burning for range improvement and especially brush control appears to be increasing due to the high cost of alternative control practices, recent research results, and the increased restriction or potential elimination of chemicals for future use. Prescribed burning is not without cost. Burning costs include forage that could be used for grazing, manpower, equipment, firelane construction, insurance, training, grazing deferment, etc. Fire may be cheaper than alternative practices, but the risk can be greater if improperly used. Many ranchers have experienced damage from wildfires and may be skeptical about prescribed burning. Yet, we believe that prescribed burning is designed to produce benefits while reducing detrimental effects not desired and cannot be compared to past bad experiences with fire. A rancher must approach prescribed fire in an objective manner comparing alternative techniques and/or combinations.

Ranch Considerations

There are a number of questions each rancher must ask when considering prescribed fire as a range management tool:

1. Is prescribed burning a viable practice on my ranch? Are alternative practices more viable than fire?
2. Do I and my employees have sufficient training and experience to be able to plan and conduct a successful burning program?

3. On what site and/or pastures would it most benefit the total operation?
4. What will be the objectives for using fire in these areas?
5. How will I evaluate the successfulness of planning and conducting the burns?
6. What results or level of accomplishment must be achieved for the practice to be considered successful? Are these levels of expectation realistic?
7. Will repeated fires be necessary to accomplish these objectives? If so, what conditions will determine the frequency?
8. Should fire and other practices be incorporated to increase benefits to the total ranch program?
9. What are the disadvantages and potential problems?
10. What should my management program be before burning, during burning, and after?
11. What preparations are necessary for a successful burn?
12. Under what conditions (humidity, wind speed, fuel quantity, soil moisture, etc.) should burning be performed?
13. What burning techniques should be employed to achieve specific objectives (including control of fire) relative to site and pasture conditions (fuel quantity and distribution, topography, changes in fuel type, trails, creeks, fences, facilities, power lines, etc.)?
14. What will be the cost to benefit ratio to the total operation?
15. What equipment and manpower will be needed?
16. What are the legal and community restrictions on using prescribed fire (neighbors, Texas Air Control Board, etc.)?

Many of these questions can only be answered by you; however, each of the following papers will help evaluate potential responses, but these must be considered in light of your ranching enterprise.

Developing a Burn Program

The following papers present specific research results on vegetation, livestock, wildlife, prescribed burning techniques, legal liabilities, and practical ranch considerations. This information should serve as a basis for evaluating potential use of fire and the necessary considerations in developing a burning plan. Generally, research is not extensive enough to define specific responses or techniques, especially in relation to long-term effects; after all, each ranch is slightly different. Information appears to be inadequate for soil, watershed, and economic analyses. The research results and rancher use to date are encouraging; however, additional knowledge and experience is needed before wide-scale use of fire is adopted. In addition, many ranchers will not be able to use fire as a viable tool until they achieve better range condition. These ranches have little forage produced even in good years; therefore, sufficient grass production is not available for fuel to adequately carry a fire.

Ranchers who initiate prescribed burning programs should develop a well planned effort of documentation to improve the knowledge available, thereby improving their decision-making process. Before a rancher initiates a burning program, I strongly recommend that at least two seasons of demonstration burns and careful study of weather conditions precede any larger scale efforts. Training, observation, and experience are a must. Since fire can move rapidly, judgment is the key to decisive and proper actions, before, during, and after the burn. A prescription is a guideline that can seldom be met precisely; hence, flexibility is important as long as the individual is trained to make proper decisions. Also, I would caution each and every one that over-optimism is dangerous. Always provide for the unexpected. Play the game of "What if?" before it happens.

During the conduct of a prescribed burn, the basic "Ten Fire-Fighting Rules" should be applied.

1. Keep informed on fire weather conditions and forecasts. As a matter of principle, I strongly suggest that each rancher purchase a fire weather kit and assign a conscientious person to collect, record, and disseminate local weather conditions at regular intervals and when changes occur. Generally, forecasters provide good information on regional conditions which seldom describe your local situation but will affect future fire behavior.
2. Know what your fire is doing at all times; observe it personally. Fire behavior is the culmination of wind, relative humidity, fuel, etc. acting on the oxidation process. Observation of fire behavior must be used in making quick decisions so that decisive action can be undertaken to prevent escape, human and/or property damage, etc. Before a large fire is set, always ignite a small test fire that can easily be put out. Once the larger fire is ignited you will have to live with the plan which should include provisions for putting the fire out if it is not behaving properly. This on-the-ground local experience that day can improve your prediction of what is likely to happen if the larger fire is ignited. Each day will be different as well as morning versus afternoon.
3. Base all actions on the current and expected behavior of the fire. Something is wrong if the fire is behaving different than expected, even if all conditions in a prescription are met and the weather forecast is perfect. In order to properly evaluate these circumstances, it is not possible to over-emphasize the need for training and experience to make these decisions. An experienced prescribed burner can maintain an objective evaluation knowing when the fire is behaving properly while less experienced people may be terrified or just awed by the entire spectacle. A safe prescribed fire should work for you and with you, not against you.
4. Plan escape routes for everyone and make them known. Rehearse safety precautions and how people should react under certain critical situations. Before igniting the fire, identify potential escape points for the fire as well as hotspots. These should be carefully watched by a standby crew or individuals as necessary. Always be on the

alert for spot fires and hindrances to control. Unlock gates and discuss the entire burn site with each crew member. Each crew should have a map of the area with reference points well identified and commonly known by each person. The best escape tool is a match. If fire is rapidly approaching an individual, fire can be used to burn out an area for escape from the approaching fire front. Headfires are difficult to out-run for any distance. Always evaluate the rate-of-fire spread to judge a safe distance. Be alert, always watching the fire and smoke column for keys to behavior.

5. Post a lookout where there is possible danger. Also, position control equipment at strategic points allowing rapid maneuverability.
6. Be alert, keep calm, think clearly, and act decisively.
7. Maintain prompt communications with your men, your boss, and adjoining forces. Know at all times where you are and keep your fire boss informed of your position. It is easy to become disoriented in dense smoke. Avoid being trapped. Wind direction can lead you into the fire as the fire front approaches. CB radio communications should be maintained among all individuals. Portable CB's are a must for ground crews. In addition, all control equipment, pickups, etc. should maintain contact with the fire boss. Do not tie up the communications system; someone else may be in trouble.
8. Give clear instructions and information and be sure they are clearly understood.
9. Maintain control of your men at all times.
10. Fight fire aggressively, but provide for safety first.

In addition to the above considerations, personnel and equipment must be in good working condition. People who panic or have health problems are a serious liability. "Buck fever" is not desirable on the firing line. They can be used as lookouts, weathermen or simply leave them tending the ranch. Equipment that will not start easily is a handicap. Also, people and equipment must have the necessary protective devices to reduce ignition. Oil, diesel, or gasoline leaks are certainly a hazard where open flame and sparks are concerned. People should wear flame retardant clothing such as cotton. A synthetic coat that melts or ignites can cause serious bodily harm. Equipment operators should know their machinery.

The best control tool available is fire. Fire can be used to burn out areas with less intensity in front of approaching headfires. Naturally this should have been completed before igniting the headfire; however, being capable of effectively igniting fuel rapidly is a must for burning under prescribed conditions as well as for regaining control of a fire. If necessary planning, evaluation, and precautions are done, a fire out of control should not be a serious problem. But just in case, be prepared. If you need assistance, obtain it before you strike the first match. In turn, assist your neighbors with their burns thereby gaining experience and confidence. However,

when everything goes well many people assume it's easy, but they do not realize the careful planning that preceded the burn. In one day a fire may culminate one year's planning plus several seasons of experience.

These words of caution have been presented not to discourage you but rather to convince you of the need for training, planning, experience, assistance, etc. I believe prescribed fire will be used on many ranches in the Rio Grande Plains for brush control, improving forage and browse quality, speeding succession towards more desirable forage species, etc.

Summary

Today's papers will serve as the basis for developing and using prescribed fire on ranches in the Rio Grande Plains. Many ranchers will remain skeptical or unwilling to devote enough time to learn how to use this important range management tool. Perhaps professional prescribe burn contractors will develop, easing the problems of individual ranch application. However, due to the limited number of desirable burning days many ranchers must learn to depend upon their own abilities. Those not willing to follow the necessary steps for successful use of fire should simply resign themselves to other alternatives and never strike a match. Ranchers who initiate a fire without proper planning, etc. are running a high risk and potential lawsuits due to negligence. Smoke on a highway followed by a tragic automobile accident could cost you your ranch and someone else his life. Fire is not as dangerous as many people think, but you must learn how to handle it.

This symposium is the beginning of several training and educational activities being initiated by the Texas Agricultural Extension Service on prescribed fire. Those of you interested in learning to use fire must avail yourself of each opportunity to learn and contribute knowledge. Demonstration burns are being established in several counties in cooperation with county Extension agents, Soil Conservation Service range conservationists, and ranchers. One thing is certain--each fire is slightly different, and even after many burns I continue to learn from each one.

The way to success is to learn and to apply those integrated activities that match your total ranch ecosystem. Again, I am very pleased with your attendance at this symposium and am sure that you will leave with excellent information, challenged ideas, and probably highly pro or con to prescribed fire.

FIRE AND RANGE VEGETATION OF THE RIO GRANDE PLAINS

C. J. Scifres

Highlight

Pristine grasslands of the Rio Grande Plains were maintained in equilibrium with climate, edaphic and biotic influences, and fire. Suppression of fire by man and his other activities (fencing, enforcement of overgrazing, etc.) allowed woody plants to increase in stature and density and form the excessive woody plant cover which now typifies the South Texas "brush country." Prescribed burning, properly applied to selected range sites, has potential to shift the vegetative balance back to grasses and other herbs representative of grasslands and of primary importance as forages. Use of an effective fire plan under the correct growing conditions and with proper attention to post-burn grazing management are the keys to successful prescribed burning.

Introduction

Although modern man generally views fire applied to natural resources in a negative sense, interest has increased during the last decade relative to the potential of prescribed burning, particularly for management of rangeland and forests. In my opinion, this interest has been stimulated by:

- (1) Rising costs of energy, heavy equipment, herbicides and other tools used for vegetation management, particularly brush control.
- (2) Advantages of fire in improving livestock distribution, increasing forage utilization, suppressing parasites, and other benefits not characteristic of chemical, mechanical or biological methods.
- (3) Compatibility of fire with habitat needs of wildlife. Fire is a natural thinning agent for woody plant stands which have developed excessive canopy covers, and converts low-value, decadent stands to a ready supply of highly nutritious browse.
- (4) Improved understanding of the role of fire in natural resources evolution and maintenance, and acceptance of prescribed burning as a "legitimate" range management tool of considerable potential.

A review of the literature¹ concerning the role of fire under pristine conditions has caused this researcher to conclude that:

- (1) Fire in conjunction with climate has molded and shaped our grasslands; and its withdrawal, combined with grazing abuse and man's activities, has resulted in the shift from grassland to brushland.

¹The comments are based on a recent review of literature on file by the author in conjunction with a graduate course, "Fire and Natural Resource Management," Texas A&M University.

- (2) Man and fire have been inseparably linked through evolutionary time and that tie has been an ecological force of overwhelming magnitude relative to development of present-day vegetation systems. There is good reason to believe that fire served to adapt man to the grassland environment. Man is one of the few primates not restricted to tropical jungles and forests. He possesses no ecological adaptations (speed, coloration, fangs, tough skin, etc.) that adapts other animals to the relatively harsh grassland environment. His ability to reason, to use tools such as fire, and his upright posture are considered to be the adaptations primarily responsible for man's association with grasslands.
- (3) Fire has great potential as a management tool, but its use must be approached with an open mind and an understanding of its strengths, weaknesses, and proper application.

By understanding the past role of fire in vegetation development, and the mediation of that role by man and his activities, we can gain insights as to the potential of harnessing fire as one of the most powerful tools available for management of selected renewable natural resources.

Historical Role of Fire on the Rio Grande Plains

It is generally accepted that pristine vegetation of the Rio Grande Plains was open grassland with scattered woody plants dotting the landscape, and occurring in greatest amounts along the streams and on lowland areas. There is also general agreement that the shift from grassland to brushland is the result of those woody plants moving into the grassland and increasing in density and stature to form the dominant cover of woody plants now present (Johnston 1962). This change has apparently occurred during the past 150 years or so, and is attributed primarily to changes induced by man and his activities (Scifres 1979).

The observations of Bray (1901) concerning Texas vegetation at the turn of the century offers some interesting insights to individuals interested in grassland ecology and fire. He referred to the "pigmy" forests of "chaparral" on the Rio Grande Plains as not yielding to mesophytic forests because of low rainfall. In rationalizing the general dominance of woody plants instead of grassland, he stated "The temperature conditions are of significance to vegetation in the province but only indirectly do they react upon the character of the grass formation. This indirect control consists chiefly in permitting the occurrence of woody species that require high annual temperatures (Mimoseae,² for example), which, with certain artificial barriers removed, the burning of grass notably (underlines mine), are capable of waging a successful struggle against grass vegetation..." "With respect to the relations of grass formations to woody formations in the Rio Grande Plains, the encroachment of the latter has been so vigorous as practically to destroy continuous areas of open grass formation. Much of the province is covered by impenetrable thickets of chaparral."

²The representatives of Mimoseae referred to by Bray are now in the plant family Leguminosae and include species such as blackbrush acacia, guajillo, catclaw acacia, twisted acacia and honey mesquite.

Bray attributed the vegetation changes in South Texas primarily to the "human agent" feeling that under the "reign of equilibrium" (dominance of grass because of periodic fire), the trend was decidedly toward establishment of solid grass formation making the region one of open grass prairies and plains. The trend in Bray's time (and still operative today) is toward establishment of woody vegetation, primarily shrubby in nature, with a coincident "driving out of sun loving species (especially grasses) and favoring the shade tolerant species." He cites the "unanimous testimony of men of long observation" that most of the "chaparral" and mesquite covered country was once open grass prairie. Apparently, the open prairie was maintained by more or less regularly occurring prairie fires. Once the equilibrium was destroyed, "everything conspired to hasten the encroachment of chaparral", i.e., droughts, overgrazing, trampling, and spreading of seeds.

Obviously, actual eyewitness accounts of the vegetation change are relatively few. Scifres (1979) cited the following account, (originally courtesy of W.T. Hamilton) by Mr. Ernest Holdsworth, Sr. of the Crystal City (Zavala Co.) area "...In 1887 the first wire fences were built. Some of these were promptly cut, as some of the people didn't appreciate any of the country's being fenced. They were rebuilt and not very much trouble developed. Up to about this time, or the preceding year, the country was very much as Nature made it, but during the drought many cattle were moved in from farther east, and it was soon tramped out, has never since been like it was before and never will be again. It is rather hard to describe at this time, but I will do my best. At that time there was considerable prairie, especially among Loma Vista. This was all dotted with mesquite mottes. The grass was fairly solid on the hills; and in the hollows, which are mesquite thickets now, the grass was up to the stirrups in riding through. Some kinds of grass aren't seen here any more; the sedge and black-beard were a solid mat and were sometimes cut for hay. As the country burned off periodically and the grass was so heavy, there was very little timber in the hollows and flats. Farther west there was quite a lot of open country in what was known as the Bell Prairie. It was covered with smooth mesquite grass, and though there was a bush here and there, you could see a coyote a quarter of a mile away. The brush country was not as thick as it is now, except for the blackbrush hills. The mesquite were what we called "gotch"--you could see under them for some distance. There weren't many "switches" as now. The creeks had good-sized waterholes and small lakes that generally had water. The Leona and Nueces were running streams except in very severe droughts.

That is the country as God made it. There are few living who saw it as it was then, and none will ever see it again..."

As so aptly stated by Mr. Holdsworth, we will never see the prairies of the Rio Grande Plains as they once were because, in my opinion, the interaction of climate/fire/grazing animals will never be perfectly reinstated (and should not be reinstated from the standpoint of economic efficiency). However, by understanding the former role of fire we are better equipped to begin exploiting its management potential for range improvement.

Prescribed Burning

The first consideration in fully understanding the potential management role of fire is differentiating between wildfires and prescribed firing of

vegetation. Pristine fires were wildfires occurring primarily during drought conditions following a series of years which promoted fuel buildup. There are accounts of such fires burning literally millions of acres of grassland. In 1894, a wildfire burned an area 20 miles wide and 60 miles long on the XIT Ranch of north Texas, and another 470,000 acres burned in 1895 (Jackson 1965). These accounts of massive, devastating burns give us cause to respect the potential of fire but should not cause us to fear fire so deeply that we fail to accept its management potential. The potential of fire in range resource management lies in the proper use of prescription or prescribed burning. Prescribed burning is the "systematically planned firing of land when weather and vegetation favor a particular method of burning that can be expected to maximize benefits. It considers all known factors affecting burning effectiveness..." (Vallentine 1971). In contrast to wildfires, prescribed burns are usually applied during wet years. Moreover, whereas wildfires generally magnify drought stress and result in harmful effects on vegetation, prescribed burns generally produce beneficial results and fire plans are available for their proper application (Wright 1974).

Most burns in the Rio Grande Plains can be classified by objective as maintenance or reclamation efforts. Maintenance burns are applied with the objective of suppressing invading woody plants, removing "rough" vegetation, removing excessive litter, etc., whereas reclamation burns are usually applied to reduce a heavy brush cover. Maintenance burns may be relative cool fires initiated under high (>70%) relative humidities and low wind speeds. An excellent example of the potential of maintenance burning will be discussed by Mr. Wayne Hamilton during this symposium. His research illustrates excellent potential of dormant-season, maintenance burns for suppressing woody plants invading buffelgrass (Cenchrus ciliaris) pastures. Once fully developed, this use of fire could have widespread impact in South Texas.

Reclamation burns are harsh, hot fires applied under low relative humidities (<30%) and relatively high wind speeds (>10 mph) to ensure movement of the fire front across the fine fuel and into the woody plant crowns. The initial reclamation burn is usually not uniform because of the lack of fine fuel and discontinuities in the fuel load. However, damage to the brush canopies results in herbaceous plant release and an improvement in fuel load and continuity for the second burn. With proper management, the second or third burn may be expected to proceed uniformly, and result in maximum herbaceous plant release. After that burn, maintenance burning may be used to suppress woody plant regrowth and promote range condition improvement.

Vegetation Change Following Burning

Development of techniques for effective application of prescribed burning to South Texas rangeland is still in the formative stages. Therefore, most of the remainder of this discussion is general and subjective, primarily the results of my observations during the past five years. The woody plant responses to burning depend, to a great extent, on the species burned and its ability to sprout after damage to the aerial portions as well as its size, age and "state of health" at the time of the fire. Woody plants which are not capable of sprouting from "crowns," roots or rhizomes and small enough to be totally engulfed by the fire front are most susceptible to burning. Plants capable of

sprouting vigorously after top removal which, unfortunately, includes the majority of woody plants in the Rio Grande Plains mixed-brush stands, are usually not killed by fire unless they are relatively small (seedlings and plants 1 or 2 years old). The same generalizations hold for broadleaved, herbaceous species. Those forbs which produce solely from seed are usually removed by the fire, if applied during their growing season, whereas those which can develop vegetatively usually send up new sprouts from the roots or rhizomes. However, time of burning greatly influences the potential for a "weed" population. Spring burns generally greatly reduce the populations of warm-season forbs, whereas winter burns damage cool season forbs but usually result in a "flush" of warm-season forbs the subsequent spring. Some species of forbs, especially legumes, drastically increase in abundance following winter or early spring burns. The first season following dormant season burns near Encinal, bundle-flower (Desmanthus sp.) was the most obvious forb on fired areas (Hamilton and Scifres, unpublished data).

Because the growing points occur at or just below ground line, perennial bunchgrasses are particularly tolerant of burning. Thus, a well-managed burning program will have the general effect of promoting perennial grasses.

Dodd and Holtz (1972) evaluated burning of South Texas brushlands after mechanical pretreatment (shredding or roller chopping). Summer burns (August) were evaluated after two years and supported a herbaceous cover with higher percentage of climax grass species, such as sideoats grama (Bouteloua curtipendula) and little bluestem (Schizachyrium scoparium), than undisturbed, brushy areas. The increase in perennial native forage species resulted in an increase in basal cover of grasses by one-third, a doubling of herbage production, and an increase of five times the amount of grass produced after the second growing season. Although total herbage production was no different on areas mechanically treated only and those mechanically treated and burned, a large percentage of production on unburned plots was composed of forbs and sedges whereas the vegetation on burned areas shifted to predominantly perennial grass production.

Although the mechanical treatment + burning decreased the number of live brush plants, the stem density was increased following two consecutive burns (Dodd and Holtz 1972). The relative proportion of blackbrush (Acacia rigidula), hog plum (Colubrina texensis), live oak (Quercus virginiana) and lime prickly-ash (Zanthoxylum fagara) stems increased while the proportion of lotebush and Texas persimmon (Diospyros texana) decreased. However, the stature of the woody plants (height and probably canopy cover) were decreased. These results indicate the need for application of a well-designed, long-term burning program to initiate decreases in live stem numbers of woody plants. However, where the goal of management is to suppress woody plant growth and shift the vegetation to a predominantly herbaceous cover, prescribed burning has considerable potential.

We have conducted several burns on sites which, before deferment for fuel production, were characterized by hooded windmillgrass (Chloris cucullata), threeawns (Aristida spp.), red grama (Bouteloua trifida), coast sandbur (Cenchrus incertus), fall witchgrass (Leptoloma cognatum), tumble windmillgrass (Chloris verticulata), gummy lovegrass (Eragrostis curtipedicillata) and other

low-value forage species with only scattered, mostly low-vigor, perennial bunchgrasses. By 3 to 5 years after initiating the burning program (generally the growing season after the second burn) with higher than average annual precipitation, and under sound grazing management, the sites have been dominated by species such as plains bristlegrass (Setaria macrostachya), four-flowered false chloris (Trichloris pluriflora), little bluestem, pink pappusgrass (Pappophorum bicolor), longspike silver bluestem (Bothriochloa saccharoides var. longipaniculata), Arizona cottontop (Digitaria californica), vine mesquite (Panicum obtusum), and other native forage species of good to excellent grazing value. Of course, the particular species which occurs after burning depends on the range site and the rate of improvement depends on rainfall conditions the year of and subsequent to burning. However, the critical factor regulating range improvement is grazing management. Not allowing adequate deferment from grazing after burning will result in a disproportionate use of the more palatable grass species. Deferring grazing use until the grasses have developed 4 to 8 true leaves and then not utilizing more than 50% of the top growth usually does not differentially affect grass species present on the burned area. One of the keys to a successful burn is the postburn grazing management--graze carefully, especially for the first growing season.

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SUPPRESSING UNDESIRABLE PLANTS IN BUFFELGRASS RANGE WITH PRESCRIBED FIRE¹

Wayne T. Hamilton

Highlight

Cool-season, maintenance burns for suppression of undesirable plants are being studied near Encinal and Laredo, Texas on rangeland that was rootplowed and seeded to common buffelgrass (*Cenchrus ciliaris*) at least ten years earlier. A single burn installed in February 1977 near Encinal promoted forage utilization by livestock following the burn and a cumulative forage production increase of 570 lbs/acre after 30 months. However, woody plant canopy reduction was short-lived. Canopy cover of the two major species, honey mesquite (*Prosopis glandulosa* var. *glandulosa*) and blackbrush acacia (*Acacia rigidula*), recovered to preburn values in 5.4 and 13 months, respectively. There was no significant difference in buffelgrass foliar cover caused by a single burn or by two consecutive burns compared to the unburned area. December and February burns near Laredo resulted in 42 and 44% mortality of common goldenweed (*Isocoma cornopifolia*), respectively, and reduced weed canopy cover as much as 91% at 10 months after the fires. Buffelgrass production was increased by 730 lbs/acre by 10 months after the December burn and by 285 lbs/acre at 8 months after the February burn. The rate of pelleted herbicide (picloram and tebuthiuron) required for satisfactory weed control was reduced from 1.8 lbs/acre to 0.9 lb/acre by the single burns. It appears that cool-season burns are useful in temporarily relieving woody plant and perennial weed competition and releasing buffelgrass production. There is no evidence that mortality of the woody plants will be significant, even after two, consecutive cool-season burns.

Introduction

Reinfestations by undesirable plants of rangeland seeded to buffelgrass following mechanical brush control is a well-known problem of the Rio Grande Plains. These reinfestations reduce herbaceous forage production (Mayeux and Scifres 1977a) and limit use of the areas for seed harvest or hay, even when the original land clearing operation was intensive enough to allow establishment of a buffelgrass monoculture. Although woody plant regrowth presents the most severe management problem overall, common goldenweed has recently become a problem in the same area (Mayeux, Drawe and Scifres 1979) with some pastures now supporting both brush and common goldenweed infestations (Fig. 1).

Dr. Scifres has already presented several reasons for interest in the use of prescribed fires for control of undesirable plants on rangeland. The research that Dr. Scifres, Dr. Mayeux and I are conducting on buffelgrass is aimed primarily at developing systems inclusive of fire as a potential means of extending the life of high-cost, original mechanical land clearing and seeding practices. Repetition of the mechanical practices used to initially

¹Data presented in this paper are preliminary only and will be published later in final form.



Fig. 1. Heavy infestation of common goldenweed in Webb County buffelgrass pasture.

clear land is probably economically prohibitive to most commercial operations. Herbicides, on the other hand, are expensive because of the rates required for satisfactory control of many brush species and have proven erratic or ineffective on common goldenweed at conventional application rates depending upon available soil moisture (Mayeux, Drawe and Scifres 1979).

Burn Conditions

Conditions for the first burn near Encinal on February 7, 1977, were marginal at best. Standing fine fuel load was only 1016 lbs/acre or about 30 to 50% of that considered adequate when wind velocities are 8 mph or lower (Scifres 1979). However, the woody regrowth had severely retarded buffelgrass production, and there was little likelihood of building significant heavier fuel loads even with extended grazing deferments. Relative humidity was 89% and fuel moisture content was 23% at the time of ignition. Good reserve soil moisture promoted rapid greenup of buffelgrass following the fire.

Conditions for the second burn near Encinal on February 9, 1979, applied on the same area burned in 1977, were more favorable for burning. Fine fuel load averaged 2967 lbs/acre (2181 standing crop and 786 mulch), and fuel moisture content was only 14%. Wind velocity was 5 mph, and relative humidity was 40%. Soil moisture averaged about 13.5% to 18 inches deep, again adequate to promote buffelgrass greenup quickly after the burn.

The December 1977 and February 1978 burns near Laredo for common goldenweed control were conducted with similar fine fuel loads (2940 to 3400 lbs/acre) and fuel moisture contents (11-18%). Soil moisture was very low for these burns, averaging only about 4% from 0 to 18 inches deep. Regrowth following the burns was limited until rainfall occurred in May and June 1978 (Table 1).

Table 1. Fuel load, fuel and soil moisture content, environmental conditions and maximum fire temperatures for the burns near Encinal and Laredo.

| Conditions | Location and Date | | | |
|---------------------------------------|-------------------|-----------|-----------|-----------|
| | Encinal | | Laredo | |
| | Feb. 1977 | Feb. 1979 | Dec. 1977 | Feb. 1978 |
| Fuel load (lbs/acre) | 1016 | 2967 | 2940 | 3400 |
| Fuel moisture (% wet wt.) | 23 | 14 | 18 | 11 |
| Soil moisture (% wet wt.) | 16-19 | 13.5 | 3.3 | 4.0 |
| Wind speed (mph) | 8 | 5 | 16-21 | 0-9 |
| Wind direction | SE | ENE | N | NE-SE |
| Air temperature ($^{\circ}$ F) | 61 | 57 | 52 | 75 |
| Soil temperature ($^{\circ}$ F) | 57 | 51 | -- | 70 |
| Relative humidity (%) | 89 | 40 | 46 | 42 |
| Max. fire temperature ($^{\circ}$ F) | 437 | 433 | 572 | 474 |

Results and Discussion

In view of the negative factors for a successful burn near Encinal in 1977 (low fine fuel load and wind speed, high humidity and fuel moisture, and discontinuous fuel), the results were surprising. The fire covered approximately 80% of the area, and the live tissue of most woody plants was reduced to ground level. The major problems during the 1979 burn were low wind velocity and discontinuous fuel. However, most of this area also burned well, and woody plants were again reduced to ground level. The major limitation for the burns near Laredo was discontinuous fuel where the common goldenweed was thick enough to prevent development of buffelgrass.

While we would not recommend burning under the conditions described for research burns near Encinal in 1977 and would consider the 1979 burns questionable because of the low wind velocity, it should be noted that these fires had a positive impact on forage production.

Buffelgrass Production

Results from the 1977 burn at Encinal indicate the importance of reserve soil moisture to forage production following a late winter burn. The burned area had an accumulated production of 4205 lbs/acre by May 24, approximately 4 months after the burn, while the unburned area had produced only 2174 lbs/acre. In addition to adequate soil moisture at the time of the burn to promote forage recovery, 12 inches of rain fell by May 24. During the next 2.5 months, however, there was only 1.6 inches of additional rainfall, and the unburned area produced more buffelgrass forage than the burned area. In July the unburned area had produced an additional 2450 lbs/acre while the burned area

produced only 1817 lbs/acre. The high production during the first four months following the burn apparently depleted available soil moisture more quickly than on the unburned area, which remained slightly more productive until the fall of 1978 when soil moisture was restored. The burned area again produced more buffelgrass in the fall (October), 1568 compared to 1426 lbs/acre, and supported more buffelgrass in the winter (December) 1978, 1176 compared to 214 lbs/acre. The same production pattern occurred during the dry spring and summer of 1979; the unburned area produced more forage than was produced on the area burned in 1977. However, cumulative production for 30 months following burning was still 570 lbs/acre greater than that from the unburned. The second burn also produced more buffelgrass than the unburned and once burned areas by May 1979.

The burns near Laredo resulted in similar production responses with both the areas burned outproducing the unburned area by 285 lbs/acre with 780 lbs/acre, respectively, after 8 and 10 months (Fig. 2).

Buffelgrass Cover

Cool-season burns did not significantly affect the foliar cover of buffelgrass plants. However, there was a trend toward a higher foliar cover of buffelgrass on the burned areas compared to that on the unburned plots. Buffelgrass crown densities on the burned plots near Laredo were unchanged compared with unburned areas.

Buffelgrass Utilization

Utilization of buffelgrass was evaluated only on the experiments near Encinal burned in February 1977 until June 1978 when the area was deferred to build fuel for the second burn. Utilization, like production, was measured by the "paired plot" method (Scifres, Durham and Mutz 1976). Grazing was determined by the difference between the weight of forage in the caged plots (ungrazed) and a representative clipping of unprotected plots (grazed) at each sampling period. These studies confirmed many other reports that grazing animals strongly favor forage on burned areas over that on adjacent unburned areas (Oefinger and Scifres 1977). This is a major concern to ranch management in the use of prescribed burning and will be addressed several times during the symposium. Cumulative utilization on the burned area was 5600 lbs/acre, or 88% of cumulative production for the 17-month period; while on the unburned area, it was 4668 lbs/acre or 69% of the amount of forage produced. The greatest difference occurred during the first 4 months following the burn where the fresh, succulent forage on the burned area was utilized 2.7 times more heavily than on the unburned area (3208 compared to 1247 lbs/acre).

Brush and Weed Canopy Reduction

A primary objective of these experiments was to evaluate the efficacy of prescribed fires for suppression of undesirable plants in buffelgrass. Cool season burns applied under the burning conditions described for experiments near Encinal have a short-term impact on brush canopy. Prediction equations were developed using percent canopy of the preburn values as the dependent variable and months following the burn as the independent variable. These

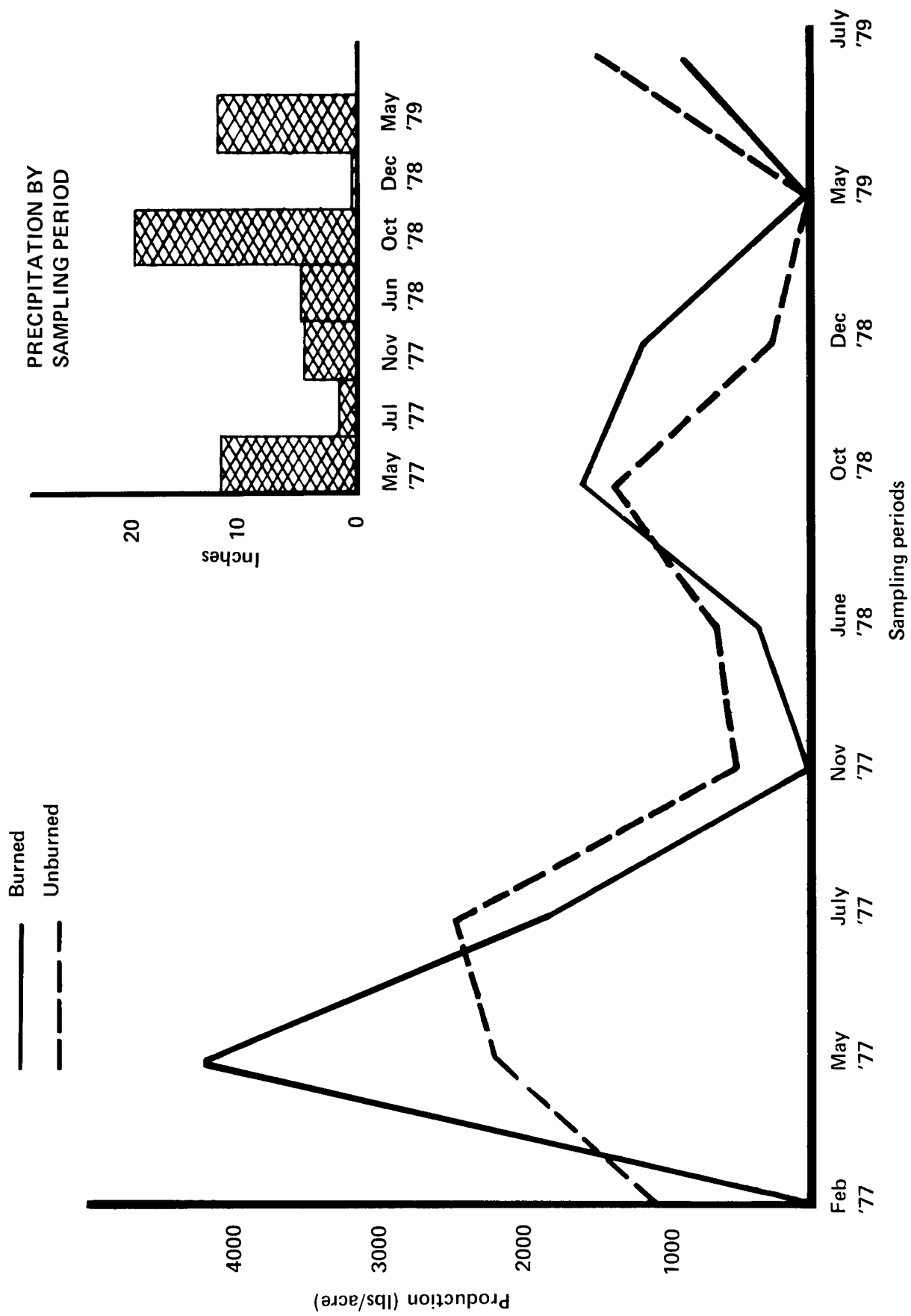


Fig. 2. Buffelgrass production following the single burn near Encinal, Texas.

projections indicated that honey mesquite would replace its preburn canopy cover in 5.4 months, blackbrush acacia in about 13 months, twisted acacia (*Acacia tortuosa*) in about 8 months, and all other brush² in about 6 months. The regrowth rate of these crown sprouters following the fire was obviously high; however, even though canopy cover had recovered to preburn levels in a relatively short period, canopy cover of woody plants on the unburned area had also been steadily increasing. Thus, after 30 months there was still a significant difference between woody plant canopy covers on the burned and unburned areas. For example, the canopy cover of honey mesquite on the burned area was 106% of that on the unburned area prior to the fire in February 1977 but was only 88% of that on the unburned area in May 1979.

Near Laredo, common goldenweed canopy was reduced by 91% at 10 months after the December burn and by 85% at 8 months after the February burn. During the same period, common goldenweed canopy cover increased by 32% on the unburned area. The significant reduction in common goldenweed vigor apparently resulted from the fire killing buds that would have provided canopy regrowth (Fig. 3).

Brush Height

Generally, woody plant heights recovered more slowly following the burns than canopy cover. The relationships between canopy and height after 30 months on the single burned area, expressed as a percent of preburn values, are as follows: blackbrush acacia, 138 and 121; honey mesquite, 264 and 220; twisted acacia, 219 and 165; all other brush 127 and 111. The average difference between canopy cover and height recovery for the period was 33%.

Brush and Weed Mortality

With the exception of blackbrush acacia the number of live plants of the woody species was not reduced by the single burn near Encinal. The reduction in blackbrush acacia live plants was only a trend and not significantly different than preburn values. While data from the second burn near Encinal have not yet been statistically analyzed, there appears to be a reduction in live plants of blackbrush acacia and of all other brush.

Common goldenweed mortality was significant following both the December and February burns near Laredo. These burns resulted in 42 and 44% mortality of common goldenweed, respectively (Fig. 4).

Burn Herbicide System

A potential system using prescribed burning and pelleted herbicides is being studied in experiments near Laredo. Control levels of common goldenweed

²All other brush includes lotebush (*Zizyphus obtusifolia*), spiny hachberry (*Celtis pallida*), guayacan (*Porlieria angustifolia*), leatherstem (*Jathropa dioica*), desert yaupon (*Schaefferia cuneifolia*), whitebrush (*Aloysia lycioides*), wolfberry (*Lycium berlandieri*), guajillo (*Acacis berlandieri*), and tasajillo (*Opuntia leptocaulis*).



Fig. 3. Twisted acacia regrowth from basal sprouts five months following a cool season burn.



Fig. 4. Prickly pear with apparent severe damage two weeks after the fire was not killed.

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by pelleted herbicides applied at 0.9 lb/acre active ingredient in conjunction with burning were about twice that when herbicides were applied at the same rate to unburned areas. Tebuthiuron plus burning killed an average of 73% of the weeds while either the 5 or 10% formulation of picloram resulted in 100% control. At 1.8 lbs/acre of herbicide active ingredient, burning plus tebuthiuron pellets removed 73% of the common goldenweed while picloram (either formulation) gave complete control. In this experiment burning alone (no herbicide) removed an average of 31% of the common goldenweed. The lower percent mortality by fire only as compared to those reported earlier (42 and 44%) is attributed to lower fine fuel loads on this study site.

These data from a single year indicate that a cool-season burn plus moderate rates of pelleted herbicides may have potential as a systematic approach to goldenweed control with advantages over either method, burning or herbicides, as individual treatments.

Conclusions

Cool-season, maintenance burns suppressed woody plant regrowth and common goldenweed infestations in buffelgrass and increased forage production. While there appears to be little chance of significantly reducing live woody plant numbers with such burns, the temporary reduction in brush canopy gave a competitive advantage to the herbaceous species. A large part of this advantage was manifested in the first few months of the growing season following the burn and is apparently related very closely to soil moisture conditions. The flush of growth following the burn apparently utilizes available soil moisture at an increased rate over unburned areas causing plants to show moisture stress during the summer and subsequently lower production as conditions remained dry. However, increased production by the burned area again occurred when favorable moisture conditions returned 20 months following the fire.

It is obvious from the literature that waiting until many of the woody plants reinfesting seeded areas are ten or more years old diminishes the chances for plant mortality caused by the prescribed fire, especially maintenance type burns (Glendening and Paulsen 1955, Wright and Bunting 1973). Summer reclamation burns were installed on three pastures near Catarina in August of this year to compare with the earlier cool-season fires. Physical damage to the brush was more obvious although it is too early to fully assess impacts of these burns. Delaying the use of fire also diminishes the likelihood of adequate fuel loads because of woody plant competition, especially in the area covered by the canopy where fuel load is most critical for damage to these plants.

Prescribed cool-season burning of buffelgrass shows promise as a tool for management of pastures infested with common goldenweed. Burning appears to be an excellent weed control measure when used in combination with selected herbicides. Again, fire should be employed early enough to permit adequate fuel loads and continuity. The use of cool season burns, with adequate soil moisture to promote spring greenup, offers a low-risk brush and weed management alternative.

Grazing must be controlled following such burns or livestock will severely overuse the burned areas (Fig. 5).



Fig. 5. A cool-season maintenance burn being applied in buffelgrass near Encinal, Texas.

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LIVESTOCK PRODUCTION ON PRESCRIBED BURNED RANGES IN TEXAS¹

Allan McGinty

Introduction

Rangelands comprise some 60% of the land area of Texas. These lands often have relatively low per unit area productivity and the most efficient means of harvesting their primary production to provide useable products is by the use of grazing animals. Since productivity is low, management inputs must be of a type that will balance management and conservation of resources with economic considerations.

Fire has received increased attention in the past decade as a relatively low cost range management tool for increasing livestock production from rangelands. Increased gains by cattle following burning has been documented for the Flint Hills of Kansas (Anderson, 1960; Anderson, 1964; Woolfold et al., 1973; Owensby and Smith, 1979), for the Longleaf Pine Belt (Greene, 1935; Wahlenberg 1939) and in Georgia (Hilmon and Highes, 1965), Mississippi (Greene, 1929) and Florida (Kirk and Hodges, 1970). To date, there has been only limited burning in Texas, and little or no work in any area of the country which describes response of other classes of livestock to prescribed burning.

Status of Present Research in Texas

Although at present there is little or no published research data pertaining to livestock production following burning in Texas, there are at this time three ongoing or completed studies by the Department of Range Science at Texas A&M University investigating cattle response following burning for various areas of the state. Mr. Don Kirby and Dr. Jerry Stuth are working in the Post Oak Savanna just outside College Station, Texas, while Dr. M. M. Kothmann has research in progress on the Coastal Plains just south of Victoria, Texas. Both of these studies are still in progress. The bulk of this paper will pertain to a study by Mr. Allan McGinty and Dr. Fred Smeins in the Edwards Plateau near Sonora, Texas. This study is completed although not published at this time.

One way in which burning can influence livestock performance is through effects on utilization and grazing distribution. Wright (1972) found spring burning in west Texas increased utilization of tobosagrass from 121 lb/ac to 1847 lb/ac. In a later study Heirman and Wright (1973) reported the increased utilization of tobosagrass following burning was effective in shifting grazing pressure from buffalograss to tobosagrass in the spring and fall thus leaving more buffalograss for summer and winter feed. Winter burning near Amarillo, Texas, increased utilization of weeping lovegrass by 53% during the spring and summer (Klett et al., 1971). In a study conducted on the Gulf Coast Prairie near Victoria, Texas, utilization of forage prior to burning was restricted to

¹Data presented in this paper are preliminary only and will be published later in final form.

the vicinity of existing roads and cleared fencelines due to a heavy infestation of Macartney rose (Durham, 1975). Following burning, grazing distribution improved significantly across the pasture. In the study at Sonora, Texas utilization was evaluated following spring burning with no conclusive differences found between burned and unburned areas due primarily to extreme variation in the areas.

There are no known published data on cattle diet composition and quality as well as cattle gain following burning available for Texas. Remarks concerning these parameters will be restricted solely to the study at Sonora, Texas.

The burn at Sonora was applied as a headfire on March 1, 1977 following a three month deferment (Fig. 1). The study area was then deferred for an additional three months following the fire (until May 28) at which time the study area was then stocked with cattle at a year-long rate of 16 ac/A.U. for five months. Standing crop at the start of the grazing period varied from 890 to 1780 lb/ac. Diet composition and quality was determined using esophageally cannulated steers. Weight gain following the burn was evaluated by weighing at monthly intervals eight yearling Hereford heifers within each of the burned and unburned areas.

The percent of browse in the steer diets was very similar between the burn and control except during the month of June, at which time percent browse in the control diet significantly exceeded the burn (Fig. 2). During June 97% of the diet in the burn was composed of grass. Grass during this month in the burn was higher in crude protein and percent green forage as compared to the control and was apparently highly selected. In July when percent grass in the diet for the burn and control were approximately equal, the crude protein content of grass in the burn and control were also similar. As the crude protein level of the grass in the control began to exceed that on the burn with advancement of the grazing period, so did the percent of grass in the control diet.

Percent forbs in steer diets from the control significantly exceeded the burn during June, July and August. During these months forb availability in the burn was greatly reduced following the fire. Percent forbs in both the burn and control diets decreased almost linearly as the growing season advanced beyond July.

Percent prickly pear cactus in the control diets never exceeded 1%; however, in the burn prickly pear cactus constituted 22% of the diet in September and October. It was observed during these two months that steers utilized primarily fire-killed prickly pear cactus. Steers would graze randomly across the pasture until one of the animals discovered a fire-killed plant, at which point all steers would converge on the plant and consume all of the available prickly pear.

The grass component of diets on both the burn and control areas was composed primarily of common curlymesquite and Texas wintergrass. Common curlymesquite constituted the majority of the grass fraction in the burn and control during the dry summer and fall months. This was probably due to the



Fig. 1. View of one of the burned pastures on the George Brockman Ranch near Sonora, Texas, one week (top) and three months (bottom) following the fire.

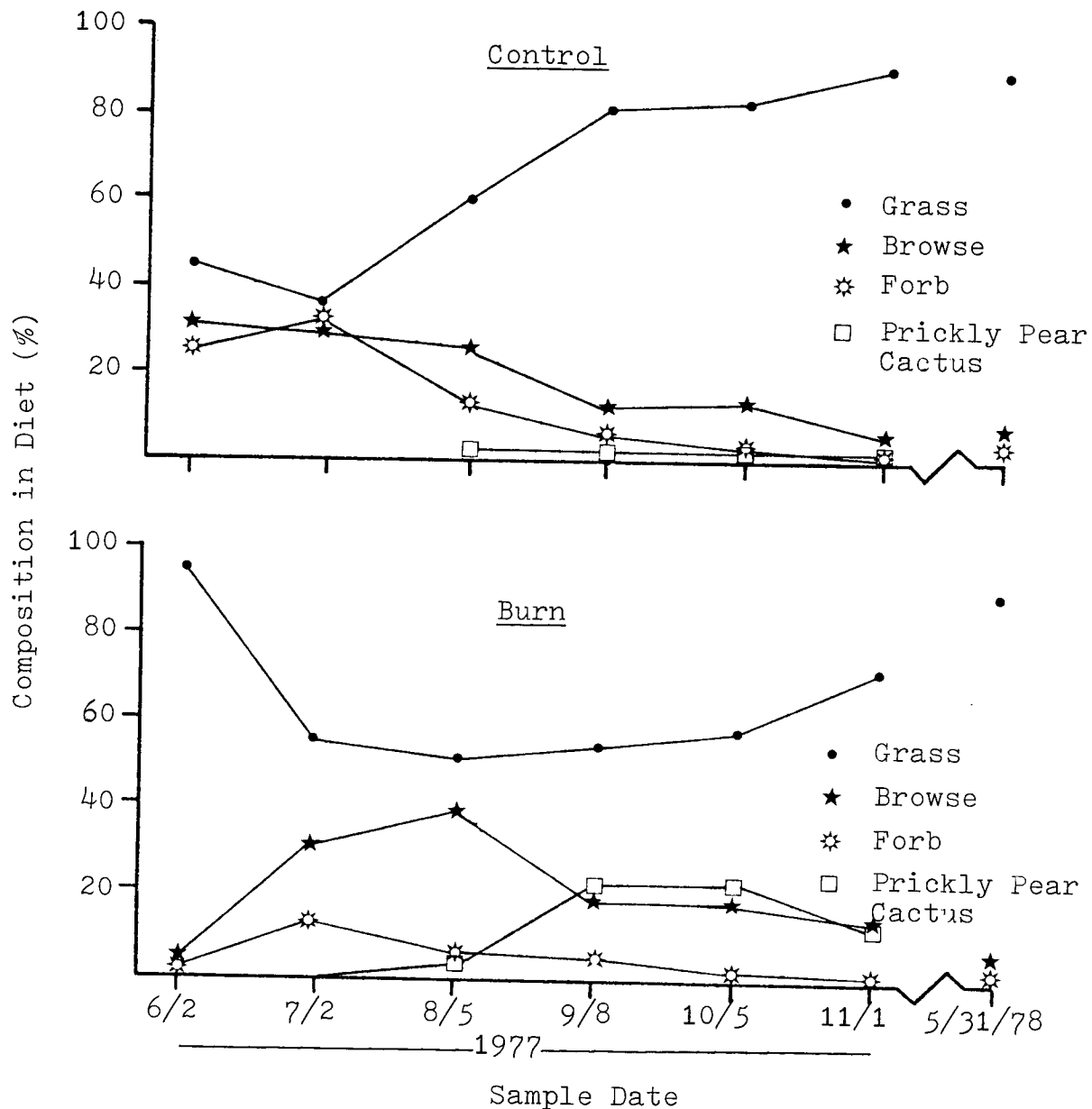


Fig. 2. Percentage grass, forb, browse and prickly pear cactus in steer diets from the burn and control.

fine texture of dead curlymesquite forage and greater availability as compared to the other grass species. During the spring, Texas wintergrass became the dominant grass species in diets on both the burn and control areas. At this time, percent crude protein and availability of Texas wintergrass was extremely high. Threeawn never constituted more than 4% of the diet in the burn or control although availability and crude protein of this species was very high at certain seasons. Low utilization of threeawn was probably due to the growth form and unpalatable nature of this grass.

Total percent live plant material in steer diets from the burned area exceeded the control until mid-September, due primarily to the removal of dead material in the burn by the fire (Fig. 3).

Ash content of steer diets in the burn significantly exceeded the control during September, October and November (Fig. 4). This increased ash content in the burn corresponds to the increased prickly pear cactus in the diet during these months.

In vitro digestible dry matter (IVDDM) in the diets on the burn significantly exceeded the control during June, September, October and the following May (1978). The significant increase for IVDDM in the burn during June and May (1978) was probably due to the increased percentage of live material as compared to the control. The higher IVDDM in the burn during September and October was due primarily to increased prickly pear cactus consumption.

In vitro digestible organic matter (IVDOM) showed relatively the same seasonal trends as IVDDM although values for IVDOM were 5 to 9% less as compared to IVDDM (Fig. 5). If the assumption is made that percent IVDOM is directly comparable to percent TDN, a value of 55 and 52% IVDOM is required for the maintenance of a 550 lb yearling heifer or a 1000 lb dry pregnant cow, respectively. Using these values the TDN requirement for a 550 lb yearling heifer and a 1000 lb dry pregnant cow was never met in the control during the 155 day grazing period. TDN requirements for both the yearling heifer and the dry pregnant cow were met in the burned area during June, with TDN deficient for both animals during the remainder of the grazing period.

Percent crude protein content of steer diets in the control significantly exceeded the burn during September, October and March (Fig. 6). Crude protein levels of 8.5 and 5.9% are required as maintenance for a 550 lb yearling heifer or a 1000 lb dry pregnant cow, respectively. This requirement in the burn or control for a yearling heifer was never met during the grazing period, while the percent crude protein requirement for a dry pregnant cow in the burn and control was only met during June, July and August.

Heifers showed positive rates of gain in the burn from June through September, while gains in the control were positive only in June, July and September (Fig. 7). Rate of gain in the burn significantly exceeded the control during June and August, and when averaged across the 155 day grazing period (0.62 and 0.11 lb/head/day, respectively). The fact that both the burn and control exhibited a positive rate of gain during the period from July to September, although crude protein and TDN requirements were never met during this period, may indicate increased intake by the animals. Also, since heifers in the burn gained significantly more as compared to the control in June and August and for the total grazing period, although crude protein was generally lower and TDN was only slightly higher, tends to indicate greater intake in the burn as compared to the control.

Summary

The study at Sonora, Texas indicated that burning may be used as a range management tool to increase cattle production from Edwards Plateau rangeland.

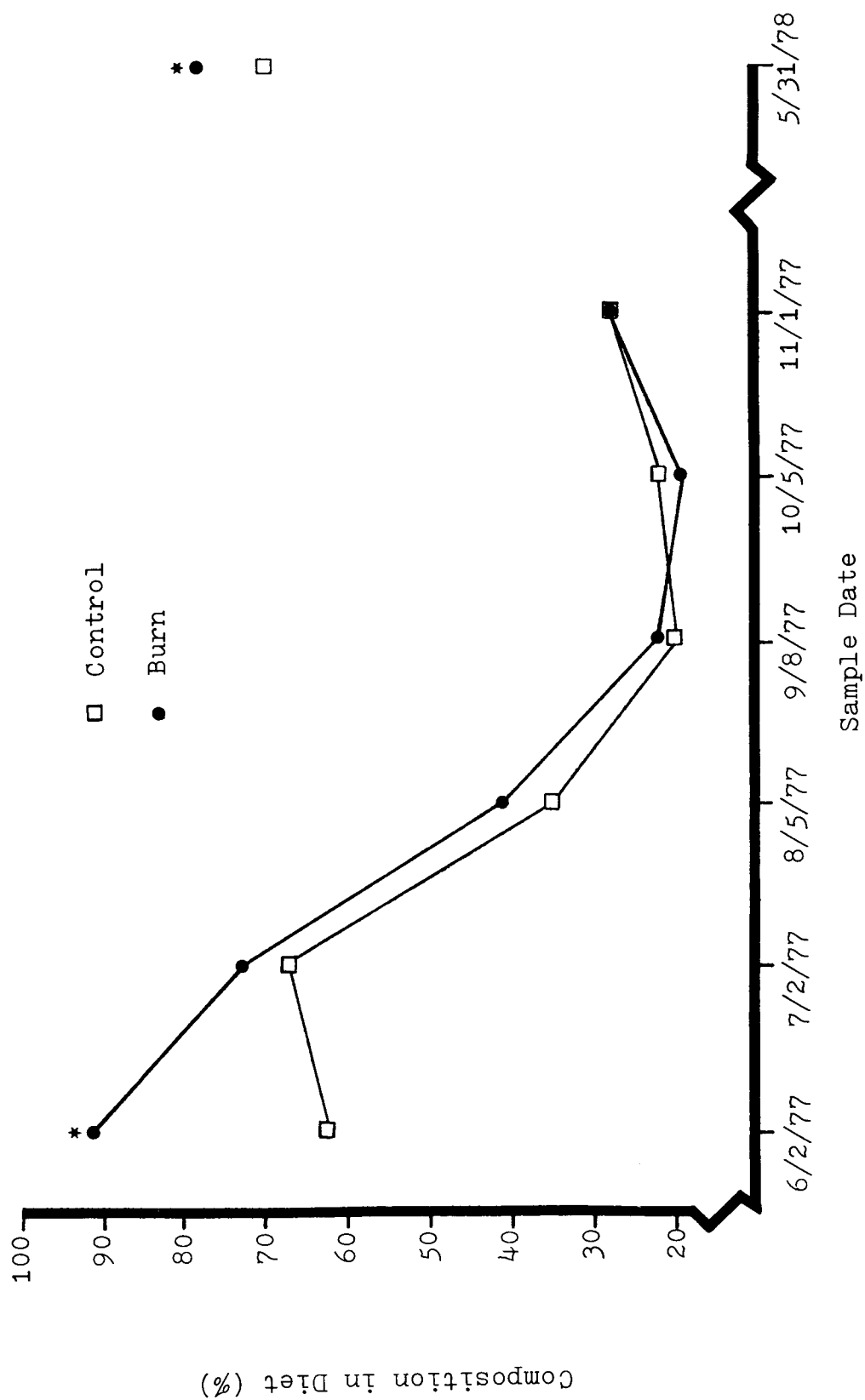


Fig. 3. Comparison of percentage live plant material in steer diets from the burn and control. Significant differences at the 0.05 level of probability between the burn and control are indicated by an asterisk.

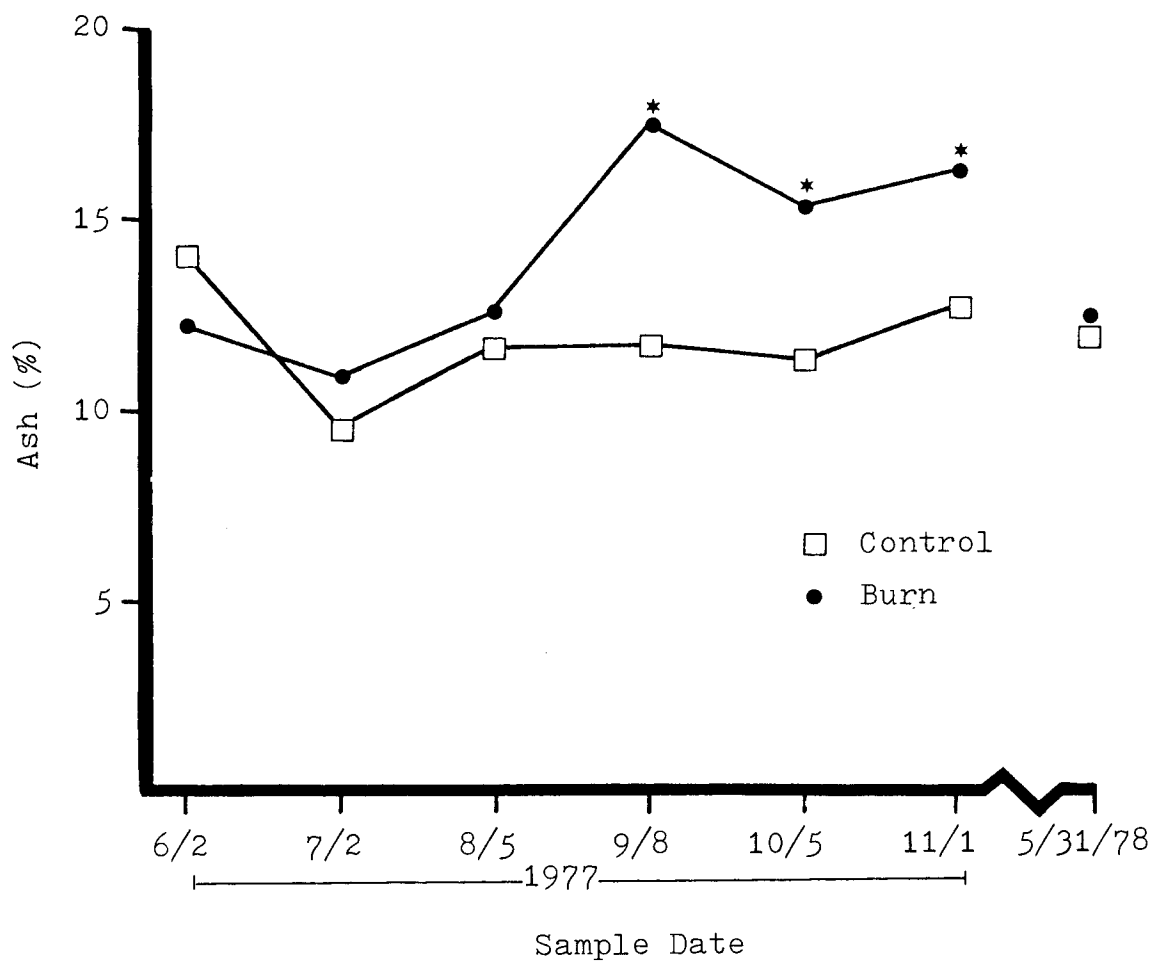


Fig. 4. Comparison of ash content (%) of steer diets in burn and control. Significant differences at 0.05 level of probability between burn and control for a particular date are indicated by an asterisk.

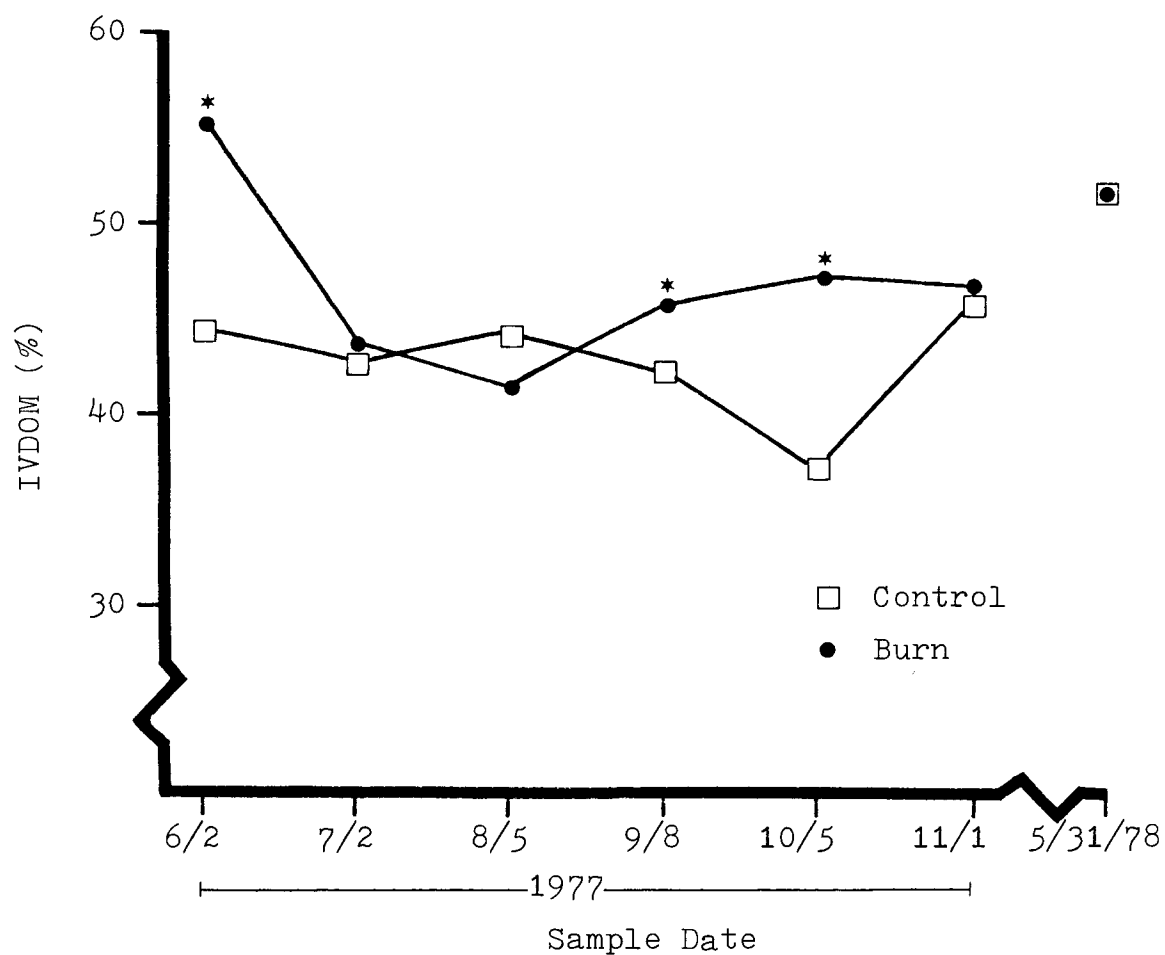


Fig. 5. Comparison of In vitro digestible organic matter content of steer diets in burn and control. Significant differences at 0.05 level of probability between burn and control for a particular date are indicated by an asterisk.

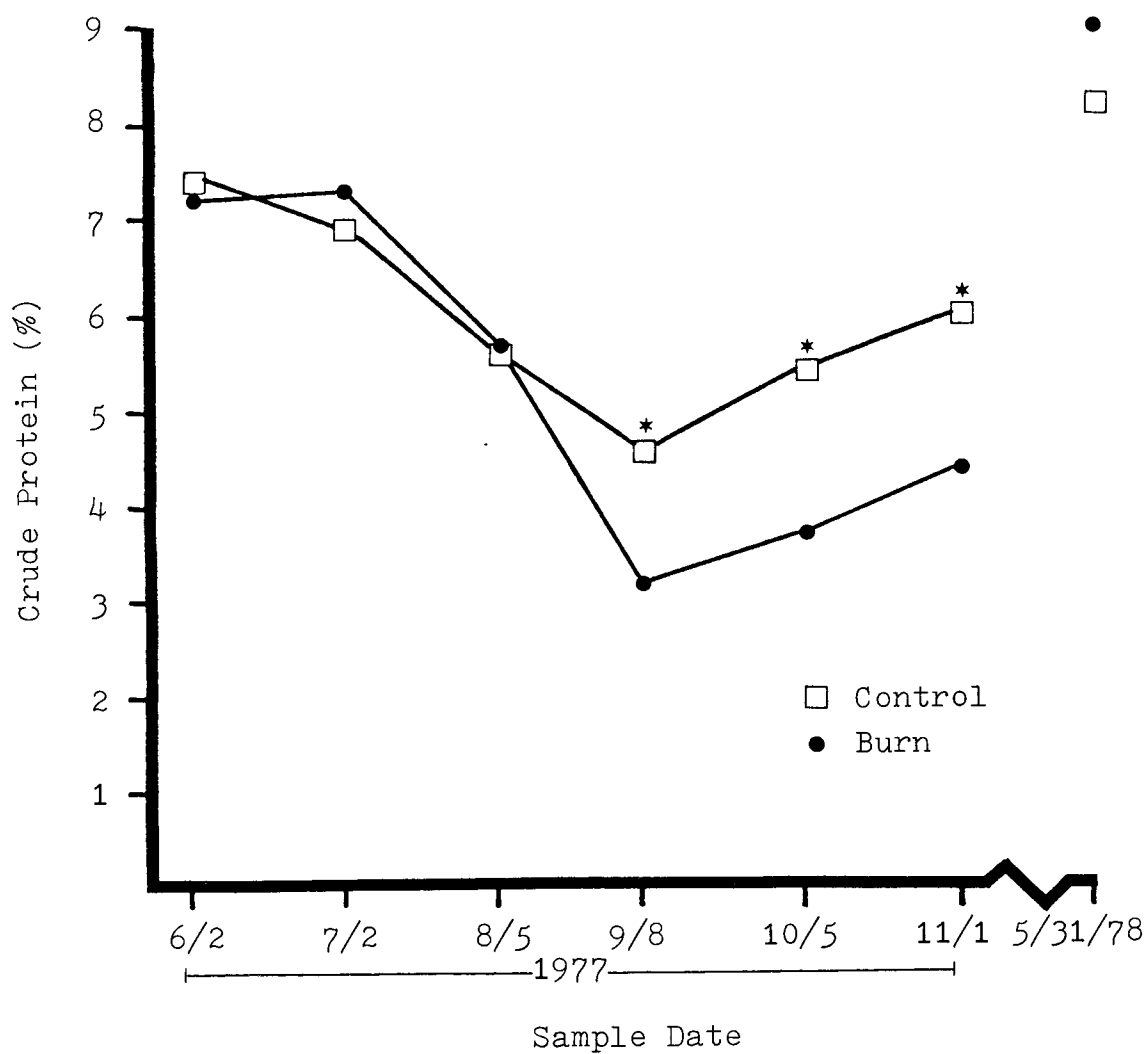


Fig. 6. Comparison of crude protein content on dry matter basis (%) for steer diets in burn and control. Significant differences at 0.05 level of probability between burn and control for a particular date are indicated by an asterisk.

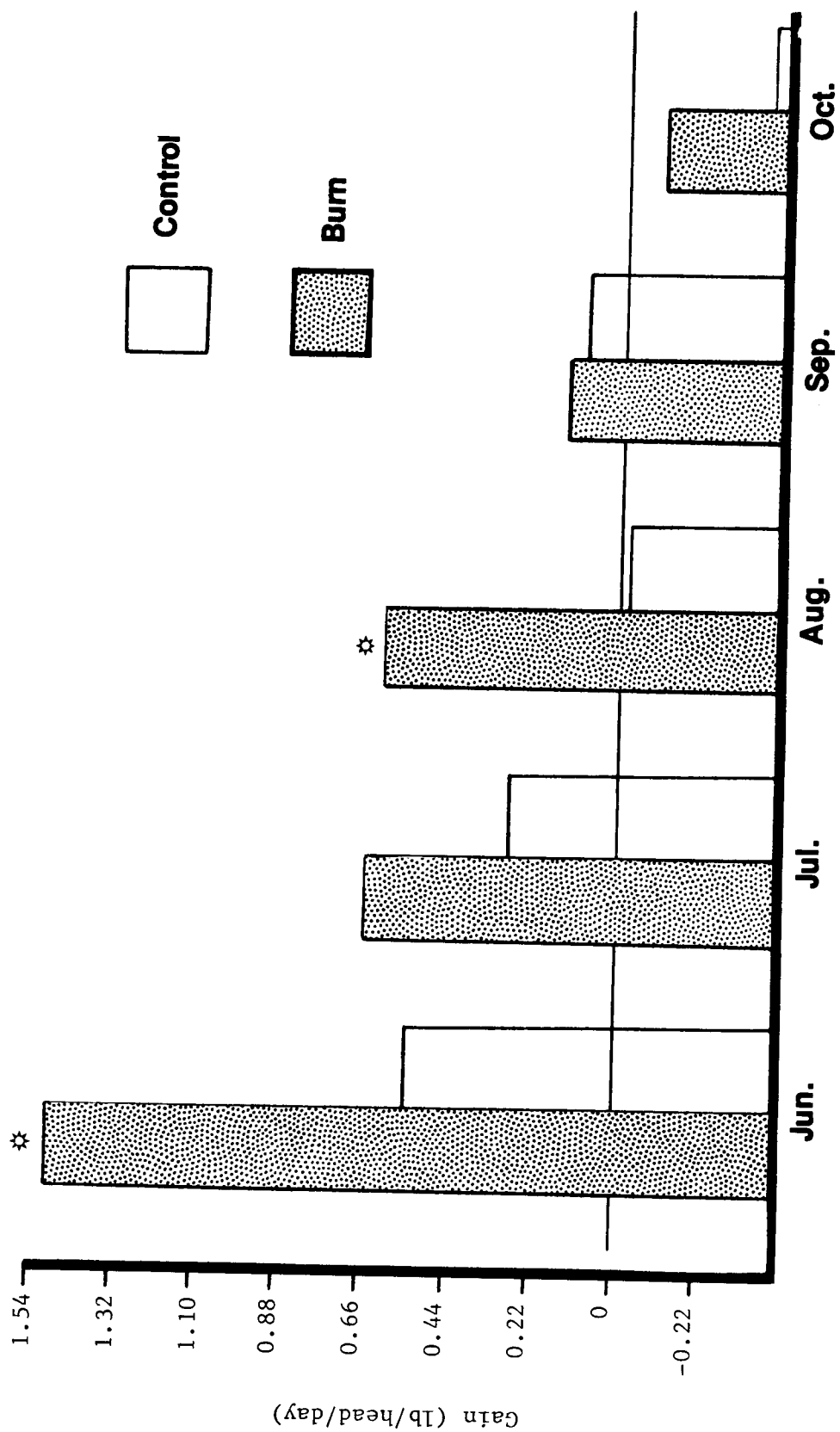


Fig. 7. Comparison of heifer gain (lb/head/day) in the burn and control. Significant differences at the 0.05 level of probability between the burn and control for a particular date are indicated by an asterisk.

Increases of forage quality following the burn were extremely short-lived and a rancher must be prepared to take advantage of these increases when they occur.

This study indicates that increased quality of forage in terms of crude protein content and IVDOM can be generally expected to last three to four months following the burn dependent on precipitation received. Increased livestock performance following burning may be expected to last longer due to possible greater intake by the grazing animals. A rancher should be concerned with initiating grazing on the burned areas as soon as possible to take advantage of this temporary increase in forage quality and should preferably stock these burned areas with those animals that have the highest nutritional requirements, such as his replacement heifers or lactating cows.

It should also be noted that the results of this study pertain only to the specific conditions under which this particular burn was applied and only for this particular location. Much more extensive research needs to be conducted in other areas of the state before any specific recommendations on the use of fire to improve livestock performance can be made.

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WILDLIFE RESPONSE TO PRESCRIBED BURNING IN THE RIO GRANDE PLAINS¹

Allen E. Steuter

Highlight

Wildlife species respond to habitat changes caused by fire. Brush is the dominant habitat component controlling food and cover availability in the Rio Grande Plains. Prescribed burning reduces brush cover, alters brush composition and structure, and increases herbaceous cover. These habitat changes can be beneficial or detrimental to a wildlife species depending on the scale and intensity of the fire.

Bobwhite quail respond favorably to the increased herbaceous growth, provided some woody cover is maintained. Indeed, bobwhite quail are considered a fire dependent species in areas where dense brush eventually chokes out understory herbs. White-tailed deer require brush as the major source of both food and cover in the Rio Grande Plains.

Forage value of brush increases following burning; however, deer use of large areas with less than 60% total brush cover is reduced during the summer months. Javelina habitat will decline following fire due to a loss of suitable bedding areas, and or cacti, an important food source. The effects of fire on scaled quail and dove is unknown for Rio Grande Plains habitats, but general observations and work in other areas indicate that they are favored by fire.

Introduction

Increased costs of converting brushland to grassland and the desire to retain wildlife have generated interest in using fire to thin brush in south Texas. Fire alone, or in combination with other brush treatments, may be used to accomplish several range management objectives (Wright 1974). Vogl (1974) felt that the most important future use of fire will be in the area of wildlife habitat management. The effect of fire on a habitat is determined by environmental conditions and the components of that habitat. Although some information is available, the effects of fire on habitats and wildlife populations in the Rio Grande Plains have not been adequately determined.

In this paper I intend to review some of the relationships between wildlife habitats and fire as they pertain to the Rio Grande Plains and report on some of our recent findings on the Piloncillo Ranch.

¹Data presented in this paper are preliminary only and will be published later in final form. This paper is a contribution of the College of Agricultural Sciences, Texas Tech University, Lubbock.

Review and Results

Historical reports indicated to Inglis (1964) that the distribution and density of brush in the Rio Grande Plains during its period of exploration was much less than at present. Smith and Techenthin (1964) also noted an increase in brush since 1880. At present, brush is the dominant component of most plant communities (Davis and Spicer 1965) and wildlife habitats (Box 1964).

Individual wildlife species prefer habitats at a specific stage of plant succession. Miller (1963) stated that, with a few exceptions, upland game species have a marked affinity for subclimax plant associations. Fire lowers vegetative succession and a patchy burn is considered the most beneficial to wildlife (Wright 1974). A patchy burn creates a mosaic of vegetation types resulting in an increased edge effect which is considered important to many wildlife species (Leopold 1931).

An understanding of the effects of fire on wildlife cover, nesting sites, and food supply and quality is needed. Future research in the Rio Grande Plains should quantify individual species requirements and the role of prescribed burning in these unique, brush dominated habitats.

Game Birds

Bobwhite quail (Colinus virginianus) require herbaceous ground cover in openings of woody cover (Miller 1963). In the Southeast, only marginal bobwhite quail populations exist in brush-choked forests. Due to local variation in fuel load and burning conditions, prescribed burning in the Rio Grande Plains can be used to produce a variety of opening sizes within dense brush stands. This will increase the amount of edge and favor herbaceous plant stages. Broadleaf weedy plants are an important food source for quail (Stoddard 1963). Spring burning may result in a decrease in some early forbs; however, the removal of dense brush canopy, sparse initial grass cover, and adequate moisture can result in abundant forb growth during the second and third year after burning.

Burning in west Texas can cause a critical loss of bobwhite cover if some of the large lotebush (Ziziphus obtusifolia) and honey mesquite (Prosopis glandulosa var. glandulosa) plants are not left unburned (Renwald et al. 1978). These authors recommended leaving 10 mesquite and 4 lotebush plants per 2.47 acres within the primary covey rest areas.

In the Rio Grande Plains, fire will rarely produce a critical shortage of cover for bobwhite quail due to changes in fire intensity and extensive shrub resprouting (Fig. 1). A lack of cover may be a limiting factor following burning of some improved rangelands unless shrubs in key areas are protected.

The combination of spraying with Tordon 225 (1:1, 2,4,5-T and Picloram, 0.50 lb/ac) followed by spring burning reduced total live brush cover of a dense mesquite-blackbrush (Acacia rigidula) stand from 88% to 26%. Grass cover one year after burning was 91%, while on the adjacent untreated area it was 11% (Steuter 1978). Bobwhite quail production, based on systematic call

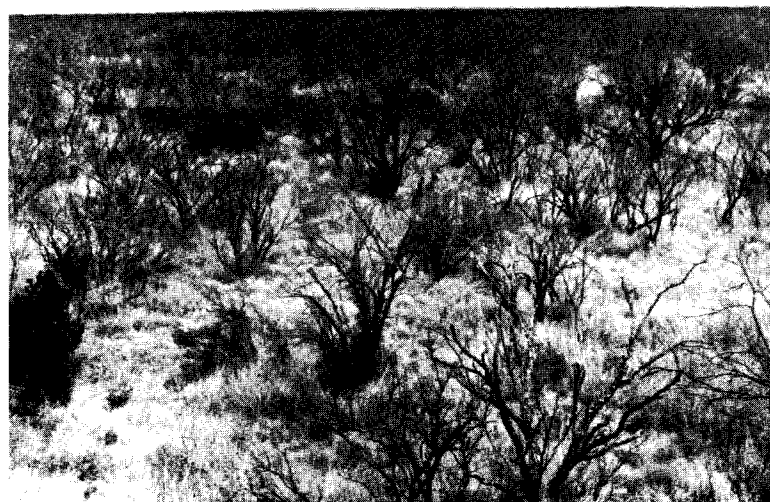


Fig. 1. Comparison of brush cover and structure changes which resulted from spraying and burning on the Piloncillo Ranch: untreated mesquite stand approximately 70% total brush cover (top); mesquite stand (middle); mesquite stand which was sprayed and burned under hot burning conditions (bottom).

counts and direct observation, was significantly higher in the sprayed and burned pastures during the second and third year after burning. This indicates that even under good burning conditions sufficient cover remains to allow bobwhite quail populations to expand in response to the increased herbaceous food supply. Bell (1975) also felt that dense brush stands limited food supplies of bobwhite quail in the Texas Coastal Bend. Open-brush savanna habitats with good grass cover are favored by nesting bobwhite quail in the Rio Grande Plains (Lehmann 1946).

Little is known about scaled quail (Callipepla squamata) ecology in the Rio Grande Plains. We did not collect any quantitative data on this species, but it appeared that scaled quail preferred brush habitats with short grass understories. Scaled quail were less abundant on the burned pastures than bobwhite quail; however, this was not true for the ranch as a whole. Both species are known to fluctuate in response to moisture conditions.

Mourning dove (Zenaidura macroura) nesting ecology is altered by burning dense mesquite in the Rolling Plains (Soutiere and Bolen 1972). Nests established in top-killed mesquite are more successful than those within living canopies. Also, these authors found that doves readily adopted a ground-nesting habit when tree nest sites were unavailable. Older burns which had developed high grass cover had a lower success rate for ground nests.

Mourning doves are primarily seed eating birds. The availability of seeds immediately after a burn and the increase in grass and forb production (e.g. sunflowers) following brush canopy reduction by fire would increase the seed supply for a few years. Although no information is available for the Rio Grande Plains, burning would probably not reduce mourning dove production provided adequate nest sites were available.

Javelina

The effect of prescribed burning on javelina (Pecari tajacu) is probably severe. Javelina bedding sites are usually in the densest brush types available and a herd may require several of these sites within its home range (Ellisor and Harwell 1969). The roots, fruits and pads of prickly pear (Opuntia lindheimeri) and other cacti are an important food source for javelina. Unfortunately, cactus species are easily killed by fire (Bunting and Wright 1976). Javelina were rarely seen in the burned pastures during our study even though several herds were seen regularly in the adjacent untreated pastures. Javelina bedding sites could be protected from fire but areas burned will have little cactus.

White-tailed Deer

The extensive mixed-brush areas of the Rio Grande Plains support some of the highest white-tailed deer (Odocoileus virginianus) densities in the United States. Brush has long been recognized as an important stage in plant succession for deer (Leopold 1950). Browse and cactus supply the major part (53.8%) of deer diets on a year-round basis in the Rio Grande Plains (Arnold and Drawe 1979). Brush is also important to deer as a source of security cover (Davis

and Winkler 1968; McMahan and Inglis 1974). Since brush is a major component of these two habitat requirements, white-tailed deer response to prescribed burning will largely be determined by a fire's effect on brush cover and structure.

Our study of white-tailed deer-brush relationships on the Piloncillo Ranch involved determining the intensity of deer use in habitats ranging from 10 to 97% total brush cover (Steuter and Wright 1980). The response of deer to prescribed burning was then evaluated by comparing deer use and habitat variables between sprayed and burned and untreated sites with similar pre-treatment brush cover.

There was no differential use by deer of habitats ranging from 15 to 75% total brush cover during November and January (Steuter and Wright 1980). However, during the summer, deer use of habitats was positively correlated ($P < 0.01$) with total brush cover in the range of 10 to 97% (Fig. 2 and 3). Quinton et al. (1979) also found a strong relationship between brush cover and deer density in the Rolling Plains.

Total brush cover of 43% and 60% seemed to be critical levels for white-tailed deer summer habitat (Fig. 2) (Steuter and Wright 1980). Below 43% cover deer use was low, with a maximum density of 1.4 deer/10 ac. Total brush cover from 43 to 60% resulted in a maximum density of 3.25 deer/10 ac. Highest summer deer use occurred on sites with 60 to 97% total brush cover (7.5 deer/10 ac). Variability below the maximum line was probably due to site features other than brush cover which made sites less suitable for deer.

The five sites excluded from the regression in Fig. 2 may suggest some negative habitat attributes (Steuter and Wright 1980). Two of these sites had total brush cover of 60 and 63%; however, the brush profile was not uniform. Most cover was above 4.9 feet tall on one site and below 3.3 feet tall on the other site. Two sites were dense whitebrush (*Aloysia lycioides*) bottoms. The fifth site was a dense "running" mesquite type (86% cover) with less than 5% herbaceous cover in the understory. Deer appeared to be selecting against these sites because of the brush structure. A high brush canopy, low brush canopy or dense single species canopy appeared to be avoided by deer. Tanner et al. (1978) also felt that brush structure was an important habitat variable for deer in the Rio Grande Plains.

Good deer habitat had total brush cover above 60%. Mixed brush types with understory shrub growth also characterized these sites (Steuter and Wright 1980).

Deer use of sprayed and burned study sites was reduced by an average of approximately 60% compared to adjacent untreated areas. Live brush cover was reduced 70% by spraying and burning. Dead standing brush added significantly to screening cover and was included in the calculation of total brush cover. The reduction in deer use of sprayed and burned sites could largely be accounted for by the reduction in total brush cover.

Although prescribed burning, especially following herbicide treatments, reduces brush cover, it also increases the forage value of brush (Springer

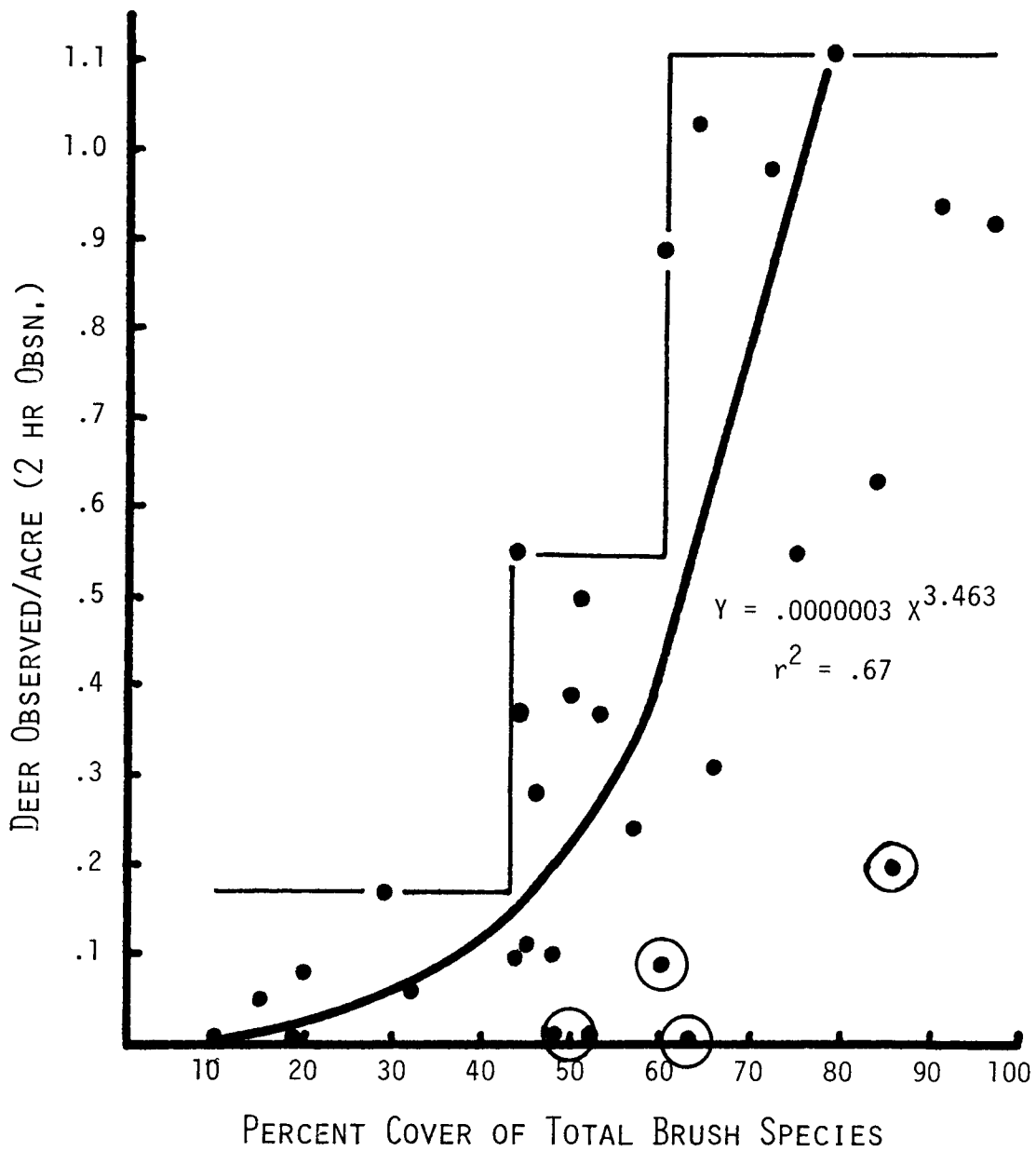


Fig. 2. Relationship between the number of deer observed per acre from towers and percent cover of total brush species for 30 study sites during the summer. Deer data is the average of four, 2-hour observations. Circled sites not included in regression (Steuter and Wright 1980).

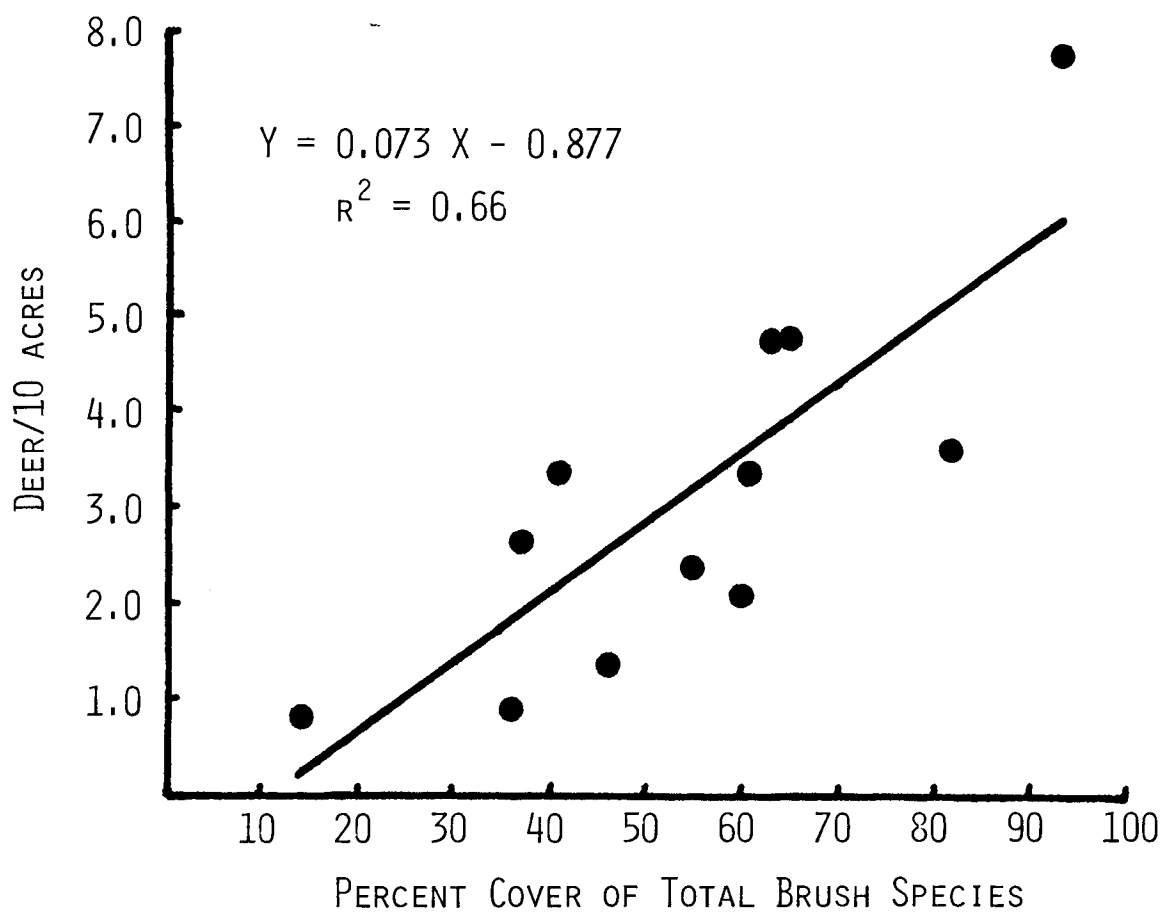


Fig. 3. Relationship between deer density determined from aerial census and percent cover of total brush species for 12 study areas during the summer (Steuter and Wright 1980).

1977). Since most brush species in the Rio Grande Plains resprout, prescribed burning will increase browse availability and quality similar to mechanical treatments (Box and Powell 1965), except for rootplowing. In this respect, burning can benefit white-tailed deer; however, I feel a lack of cover on large areas will discourage deer from using the more accessible browse. A site in the sprayed and burned treatment provided evidence for this.

On a 13 acre site within the sprayed and burned treatment, the area burned very hot because a large amount of fine fuel (> 3560 lb/ac) was present. Almost all standing stems burned down, and although total brush cover was 60%, it was less than 3.3 feet tall. This site had the highest density of saltbush (*Atriplex* sp.) and was on a clay loam range site. The saltbush resprouted vigorously following burning. It is a very palatable browse species. Yet, deer use of this site was only 1/5 that of an adjacent site through which a cool fire left the dead stems standing (75% total brush cover), and only 1/10 that of an adjacent untreated site (91% total brush cover).

When security cover is totally destroyed, as with rootplowing or a very hot fire, the size of the opening is a critical factor (Davis and Winkler 1968). Naderman (1979) suggested that 3.2 acre openings were most effectively used by deer in Coastal Bend brush types.

Management Implications

The use of prescribed fire as a habitat management tool in the Rio Grande Plains will be restricted to areas where fine fuels will carry the fire or where previous control has allowed fine fuel to accumulate under dense brush stands. On these areas burning conditions can be selected to achieve the desired level of brush reduction consistent with wildlife and livestock objectives. Prescribed burning following herbicide treatment is effective in dense mesquite types. If left untreated these sites are of little value to wildlife or livestock.

A mosaic of brush cover patterns will usually result from burning due to changes in fuel loads within a pasture. This would be effective for managing bobwhite quail and livestock. White-tailed deer would benefit most from small hot burns within brush dominated habitats. This would increase forbs and browse forage value while maintaining security cover. Additional research is needed to develop burning prescriptions to efficiently burn these small areas with the desired result. Also, more information is needed on the habitat requirements of many wildlife species and the effect of fire on these habitats.

Lehmann (1960) proposed a strategy for incorporating brush control practices with game management objectives. Fire can be a flexible and inexpensive tool enabling managers to maintain the desired mix of wildlife and domestic animals.

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INTEGRATION OF PRESCRIBED BURNING WITH OTHER
BRUSH CONTROL METHODS: THE SYSTEMS
CONCEPT OF BRUSH MANAGEMENT

C. J. Scifres

Highlight

Recent research is emphasizing the systems concept (brush management) rather than single-treatment approaches (brush control) for improving rangeland supporting excessive woody plant cover. Prescribed burning appears to hold considerable potential as a component of these brush management systems, especially in conjunction with use of herbicides. A potential improvement system based on the pelleted herbicide, tebuthiuron, and prescribed burning for whitebrush-infested Rio Grande Plains rangeland is used as an example. Carrying capacity of rangeland subjected to the system is estimated to be 1 AU/12-15 acres during the fifth year after initiation of the brush management program, compared to carrying capacities of 1 AU/35-40 acres on whitebrush infested rangeland. Prescribed burning following aerial spraying of running mesquite-mixed brush with 2,4,5-T + picloram also appears promising for improving rangeland productivity over spraying alone. In areas where herbicide use is not feasible, roller chopping or shredding has been used successfully to reduce the brush cover and release fine fuel for prescribed burns. Prescribed burning followed by pelleted herbicide applications has allowed as much as 50% reduction in herbicide rates required for high levels of golden-weed control as compared to herbicides alone.

Introduction

Brush and its control have long been the primary concern of most ranchers of Texas and the Southwest. Since the mid 1800's, the woody plant cover has progressively increased causing serious reductions in livestock production, increased costs for livestock handling and care, and reduced profitability of the range livestock industry in various other ways. After many years of attempts with mechanical and chemical practices, the attitude of brush eradication gave way to the more reasonable approach of "control," the process of limiting the influence of brush infestations to release range forage. More recently, the attitude of "brush management" has gained in popularity. Brush management includes the application of brush control techniques as needed to ensure optimizing the products of rangeland including livestock, wildlife, and recreational values with consideration for resource conservation. With the growing understanding of the need for brush management, the interest in prescribed burning has grown steadily during the past 10 years, and especially in the last 5 years. Other reasons for recent increased interest in fire as a range management tool on the Rio Grande Plains include:

- (1) Rapidly increasing costs of mechanical and chemical brush management methods which may decrease their economic feasibility.

- (2) The ineffectiveness of conventional brush management methods, including herbicides, on the broad spectrum of brush species typical of South Texas mixed brush. For example, herbicide 2,4,5-T (2,4,5-trichlorophenoxy acetic acid) effectively controls honey mesquite (Prosopis glandulosa var. glandulosa) but does not effectively control whitebrush (Aloysia lycioides) (Scifres 1973). Conversely, the new herbicide, tebuthiuron (N-(5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl)-N,N'-dimethylurea, trademarked "Graslan"¹) is highly effective at 1 to 2 lb/acre for control of whitebrush but much higher rates are required for control of honey mesquite (Scifres, Mutz and Hamilton 1979).
- (3) The increasing scrutiny of conventional herbicides by the federal government, and the probability of relatively few registered chemical alternatives being available in the future, emphasize the need to seek alternative methods of brush management.
- (4) The need for multiple applications for control of some species seriously reduces the feasibility of herbicide use. For example, two or three successive, annual applications of 2,4,5-T at 0.5 to 0.67 lb/acre are required for control of running mesquite (Prosopis reptans var. cinearascens) in some areas. Such multiple applications not only increase range improvement costs but reduce wildlife habitat quality by seriously reducing the abundance of valuable forbs, especially legumes.
- (5) The increasing value of game animals to the ranch firm, and the need for brush management methods which are highly compatible with needs for quality wildlife habitat, namely retention of adequate cover and food (browse and forbs).

Based on recent research results and observations from studies presently underway, prescribed burning may offer an economical alternative for brush management in many situations. Costs normally assigned to burning projects include grazing deferment prior to burning for fuel development and for post-burn recovery of forages, fire guard construction and maintenance, and installing and patrolling the burns. Although there are few estimates of these costs, most workers feel they usually range from \$0.50 to \$2.50/acre--a fraction of the costs for conventional brush control methods.

Although fire appears to hold considerable promise for range improvement on the Rio Grande Plains, there are some inherent constraints which hinder its most effective application. Paramount for effective burning is the requirement for a continuous cover and adequate amount of fine fuel. Effective fuel loads and fuel distribution are extremely difficult to develop under a heavy brush cover, even with extensive periods of grazing deferment under better

¹Trademark names are mentioned for ease of discussion only and do not imply endorsement of any proprietary product by the author or the Texas Agricultural Experiment Station nor suggest use of any product to the exclusion of others which may also be suitable for the same purpose(s).

than average rainfall conditions. Although deferment under optimum growing conditions may provide an adequate fuel load (generally 3,000 lb/acre air-dry fuel is considered a minimum) the woody plant canopies cause disruptions in fuel continuity which reduce the effectiveness of the burns. Achieving adequate fuel continuity in mixed-brush dominated communities using fire alone may require two or three burns to progressively open the woody plant canopies. For this reason, prescribed burning has been used most effectively when applied in conjunction with other methods, as an integral part of a brush management system. Our research has emphasized herbicide-fire systems, although mechanical methods have been effectively integrated with prescribed burning.

Research results emphasize the weaknesses of total dependence on any single method for effective brush management. The word "effective" does not relate solely to degree of brush removal but to the economic shifting of the vegetation from dominance by brush to grassland. This has been approached successfully with infestations of Macartney rose (Rosa bracteata) on the Coastal Prairie (Scifres 1975) and several similar systems appear promising for the Rio Grande Plains.

The Systems Concept

Use of fire in the systems is more than simply a combination of treatments or the application of fire for maintenance purposes. Brush management systems consist of coordinated treatment sequences using proven techniques applied in an orderly manner to achieve specific management objectives. The management objectives cannot be totally achieved by any one of the system components if applied singly because the systems are designed specifically to take advantage of the unique strengths of each method while minimizing their characteristic weaknesses. Thus, systems are designed to yield synergistic results, that is for a greater production response (or the same production response at a lower cost) to be achieved than should be expected based on responses to the methods when applied individually. Moreover, the systems approach allows a high degree of flexibility in treatment application. If planned well, systems employing fire allow timing of treatments to take maximum advantage of weather conditions.

The general complementary effects of herbicides and fire can be used as an example of the interdependence of treatments with a system. Herbicide applications remove the woody plant canopies which release herbaceous species (contributors to the fine fuel load) and promote continuity of the fuel load. This effectively reduces the deferment time for building the fine fuel load, top kills many of the woody plants too large to be damaged by fires, and reduces the need for repeated burns. Thus, the herbicide applications help prepare the vegetation for effective burns as well as achieving levels of control normally expected from the treatment. The prescribed fire suppresses brush regrowth (basal sprouts) from plants which survive the herbicide application, accelerate secondary succession by favoring climax perennial grasses, reinstate forb populations damaged by the herbicide, improve grazing distribution, improve forage production and quality by removing the "rough" plant top growth, and may suppress populations of certain external parasites. Moreover, the prescribed burning extends the effective life of the investment in the herbicide, improving the economic framework of range improvement compared to herbicide use alone.

Potential System for Improvement of White-brush Infested Rangeland:
Illustration of the Concept

The experimental herbicide tebuthiuron applied at 1 to 2 lb/acre (active ingredient) effectively controls whitebrush (Scifres, Mutz and Hamilton 1979). It also controlled other species such as spiny hackberry (Celtis pallida) and blackbrush acacia (Acacia rigidula) but only partially damaged the mesquite. Thus, tebuthiuron was chosen as the initial treatment component (PHASE I) of the system (Figure 1). Since the herbicide is formulated as a pellet, it can be applied during a rather long time period each year, compared to applications of foliar sprays which are restricted to relatively brief periods in the fall or spring. Native grass release following ground broadcast or aerial applications of tebuthiuron pellets at 1 to 2 lb/acre of active ingredient have been impressive. End-of-season, dry matter grass yield averaged across the first three growing seasons after aerial application of 2 lb/acre of tebuthiuron to mixed brush near LaPryor was 2,660 lb/acre, compared to 1,327 lb/acre from untreated rangeland (Scifres and Mutz 1978). Near Tilden, application of 2 lb/acre of the herbicide increased grass yields from 1,300 lb/acre to 2,560 lb/acre by the second growing season. Moreover, the proportion of grasses of good-to-excellent grazing value on treated plots was much higher (69%) than on untreated areas (27%). The grass release improved the fine fuel load and distribution in preparation for burning. Results were similar whether the herbicide was applied in the spring or in the fall.

Although tebuthiuron application effectively controls whitebrush and promotes herbaceous forage production, the dead standing debris following the application of the herbicide may pose a hindrance to livestock management and can constrain uniform distribution of grazing animals. Moreover, the herbicide also controls forb populations, many species of which are valuable wildlife forages. For example, 2 lb/acre of tebuthiuron applied near LaPryor reduced forb yields by 90%, 74%, and 26% at 1, 2, and 3 years, respectively, after treatment (Scifres and Mutz 1978). Much of the reduced forb production was native legumes. Therefore, it is advisable to apply the herbicide in strips to preserve adequate cover and maintain forb production to meet needs of wildlife such as white-tailed deer (Odocoileus virginiana) (Figure 1). The time lapse from herbicide application to burning has been 18 to 24 months in our studies, although it may be longer if rainfall becomes limited. PHASE II of the system concentrated on building the fine fuel necessary for the burn and preparing for physically conducting the burn (Figure 1). If a winter burn is planned, grazing deferment for 90 to 120 days including the fall herbage growth peak (September - October) has been adequate to accumulate the fine fuel necessary for an effective burn. If rainfall is less than average during this fall period, it is advisable to utilize the proper amount of any accumulated fuel by grazing and defer the burn for another growing season.

The prescribed burn should be installed according to a sound fire plan. Depending on the fire plan used, additional activities must be added to the system. Several generalized fire plans have been published for adapting to specific situations (Wright 1974; Gordon and Scifres 1977). Wind speed and relative humidity are primary considerations for installing an effective burn. When the relative humidity is low, relatively low but constant wind speeds have resulted in satisfactory burns (Figure 1, PHASE III). As relative

Fig. 1. POTENTIAL TEBUTHIURON PRESCRIBED-BURNING SYSTEM FOR IMPROVEMENT OF WHITEBUSH-INFESTED RANGELAND

| ACTIVITY | PHASE I | | PHASE II | | PHASE III | | PHASE IV | |
|---------------|---|--|--|--|--|--|----------|--|
| | HERBICIDE APPLICATION | FINE FUEL DEVELOPMENT/ FURN PREPARATION | PRESCRIBED BURNING | | MAINTENANCE OF RANGE IMPROVEMENT | | | |
| CONSIDERATION | Aerially apply tebuthiuron pellets at 2 lb/acre (a.i.) in fall (Sept. - Oct.) or late winter (Feb.). | Defer grazing during fall for 90 - 120 days; prepare fire plan and install fire guards. | Install prescribed burn according to sound fire plan; defer grazing until late April-May or until reserve soil moisture adequate for rapid growth; defer after 60 - 65% of top growth removal by grazing. | | Schedule prescribed burns as needed (approximately 3-year intervals). | | | |
| | Apply in strips for game management (ex: 600 - 650' treated alternated with 100 - 150' untreated to improve 80 - 85% of area) will control spiny hackberry and several other associated species but not mesquite. | Deferment period must be adjusted to rainfall conditions; under drought conditions utilize proper amount of accumulated fuel and delay burn until next year. | When wind speed 10 - 12 mph, RH <60%, fine fuel moisture content <25%, backfire 100 to 150 ft; if RH <20%, fine fuel moisture <10%, wind speed of steady 5 - 7 mph will effectively burn. | | Grazing deferment to build adequate fuel and post burn to allow grass recovery. | | | |
| | Whitebush defoliation greater than 90% by end of first growing season under average rainfall; ultimate kill usually exceeds 90%; grass release evident by end of first growing season; fall deferment expedites grass release; forb production greatly reduced. | Accumulate 3,000 to 3,500 lb/acre of standing fine fuel of relatively uniform distribution. | Dead brush stems ≤0.625 in. in diam. consumed or dropped, grass released to uniform stand; warm season perennials increased, annuals decreased; forb population restored (wet springs stimulate forb production); fires usually do not carry through heavy brush covers on untreated strips. | | Suppress brush sprouts, remove rough vegetation, improve grazing distribution, improve range condition, etc. | | | |
| RESULTS | | | | | | | | |

humidity increases, progressively greater wind speeds are required to drive the fire. Fire removes the dead standing whitebrush stems 0.625 inches or smaller in diameter, increases the cover of perennial grasses, and promotes the cover of desirable forbs, especially legumes. This system is being researched near Tilden, Texas (Figure 1) and has progressed through PHASE III. Based on our research results, it appears that prescribed burning at approximately 3-year intervals, depending on rainfall conditions, will perpetuate range improvement. However, this schedule may be adjusted as more research information is accrued.

Based on calculations from standing forage (Whitson, Hamilton and Scifres 1979), the whitebrush-infested rangeland was capable of supporting 1 AU year-long per 35 to 40 acres. At the end of PHASE I, 18 months after herbicide application, carrying capacity was estimated to be 1 AU/20-22 acres. It is emphasized, however, that carrying capacity was essentially unchanged the growing season of herbicide application. Range improvement was initiated during the second growing season and under complete protection from grazing. The growing season following completion of PHASE III, estimated carrying capacity was 1 AU/12-15 acres, and untreated ("brushy") areas protected from grazing for the same 18 months were judged to be capable of supporting 1 AU/30 acres.

A similar system is being studied near Cotulla, Texas for improvement of running mesquite-infested rangeland. The potential system involves a single aerial application of 2,4,5-T + picloram at 1 lb/acre in the spring, compared to the two or three successive annual applications of 2,4,5-T at 0.5 to 0.67 lb/acre which are presently recommended for running mesquite control. The herbicide application has reduced the running mesquite canopy by more than 85% for two growing seasons. During the winter following the second growing season, a prescribed burn was applied to suppress the running mesquite regrowth and expedite forage release. Based on research results to date, this system appears to hold promise. One of the basic weaknesses of the system is its dependency on use of the herbicide 2,4,5-T which is being scrutinized by the Environmental Protection Agency for potential cancellation for use on rangeland. Should the 2,4,5-T + picloram combination be cancelled by EPA, alternative herbicides will have to be studied as potential substitutes for PHASE I of the system.

Although our research emphasizes herbicides, other workers have successfully combined fire with relatively low cost mechanical methods. Dodd and Holtz (1972) reported that shredding or roller chopping could be utilized to temporarily remove the brush canopy and release fine fuel. Prescribed burning was then applied to suppress woody plant regrowth and improve range condition.

The chemical/herbicide systems are also showing promise for management of perennial weeds, such as goldenweed (Isocoma coronopifolia) as well as for woody plant management (Mayeux, H.S. and W.T. Hamilton, Pers. Comm.). The application rate of picloram pellets may be reduced by 50% when applied following a prescribed burn, compared to the rate required for control of unburned stands. Although more research is needed, fire-based vegetation management systems appear most promising for improved range management on the Rio Grande Plains.

Acknowledgments

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PRINCIPLES AND REQUIREMENTS FOR SAFE PRESCRIBED BURNING¹

Henry A. Wright

Introduction

Learning to conduct prescribed burns is similar to learning how to ride a bicycle. One cannot learn how to ride a bicycle by just reading instructions. One must get on the bicycle and practice. However, once the basics of riding a bicycle have been learned, the novice rider can read or listen to more experienced riders in order to improve his riding, increase efficiency of effort, safety, speed, ease, comfort, and satisfaction. The same is true for learning how to conduct prescribed burns.

On all prescribed burns there are many judgments to be made and often there are unforeseen circumstances peculiar to each burn. Thus, the fire boss should be experienced, for experience is the best teacher. We learn by doing, and by doing, we learn rapidly.

Wildfires are frightening, but prescribed burns are less dangerous because they are generally conducted under moderate weather conditions with prepared firelines. Prescribed burning is, however, dangerous to the inexperienced. It is very dangerous to personnel who are not fully experienced, for they can easily become over-confident and, inadvertently, let fires get away.

Prescriptions for specific fuel are helpful in the planning of a burn, but they do not protect you against the intangibles--a hill on the side of a pasture that might cause unusual winds, a canyon on the lee side that may aid the formation of an intense firewhirl which will throw firebrands at greater distances than normal, unusual fuel densities that can create intense firewhirls, possibility of a night-time low-level jet of wind, or volatile fuel material. This is why experience in fire behavior is stressed before letting people strike out on their own.

Experienced people "weigh" the intangibles along with weather and fuel moisture when planning a prescribed burn. Generally, they use two to four critical variables (ambient temperature, wind speed, relative humidity, and fuel moisture) before making a decision as to whether to burn a specific fuel type, although a host of other "experience factors" are involved.

The secret to all prescribed burning is to let the weather work for you. When all environmental factors are right, the job is easy. With the proper weather, a crew of 6 to 10 people, 2 pickups, 1 pumper, 1 dozer (or extra pumper), 2 weather kits, 5 drip torches, an adequate quantity of diesel-gas fuel (4 to 1 mixture), and 4 FM radios, burns in most fuel types can be conducted safely.

¹This paper is a contribution of the College of Agricultural Sciences, Texas Tech University, Lubbock.

In an unfamiliar fuel type, an experienced fire manager should supplement his past training by burning a few test plots based on the best prescribed burning data available. Experienced personnel will need 1 or 2 seasons of experience with a new fuel type before they feel comfortable using prescribed fire in a new area. Those beginning with no experience may need 4 or 5 seasons of experience.

For maximum safety, always prepare adequate firelines, especially where headfires are being used to burn volatile brush fuels (e.g. juniper). Burn out firelines that will more than adequately hold the headfire (and spot fires) under the desired burning conditions. The extra expense to prepare wide firelines (500 ft) is minimal and will more than offset the cost of extra pumpers and the risk of a fire getting away with a less than adequate fireline.

For each vegetation type, and really, each locality, specific prescribed burning techniques need to be developed by modifying other known prescriptions. Moreover, prescribed fires should always be conducted on a manageable unit basis, for small fires within large pastures are sure to be overgrazed and they always make fire look like the worst possible management practice. Good soil moisture should also be a prerequisite for most prescribed burns, especially in grasslands.

Fuel Considerations

Volatility

Vegetation for prescribed burning is classed as one of the two basic fuel types--low volatile or high volatile (fuels containing ether extractives such as waxes, oils, terpenes, and fats). Grasses and honey mesquite are low volatile fuels, where chaparral and juniper are high volatile fuels. Sagebrush, oaks, rough beneath southeastern pine, and slash are moderately volatile.

Low volatile fuels such as grass are relatively safe to burn, whereas high volatile fuels are explosive and create serious firebrand problems. High volatile fuels can be burned safely, however, but wide firelines (500 ft) and a thorough knowledge of weather and fire behavior are necessary (Green 1970; Bunting and Wright 1974). A minimum of (600 to 1,000 lb/acre) of fine fuel is necessary for prescribed burns (Wink and Wright 1973; Beardall and Sylvester 1976), although wildfires will carry with as little as 300 lb/acre of fine fuel.

Firebrands

Firebrands can be a problem when burning high volatile fuels (Bunting and Wright 1974). Usually, the brands ignite low density fuels that have low heat capacity such as punky wood or dung. After these materials are ignited, they will ignite surrounding fuels. Occasionally, the brands will fall into tight crevices such as between bark and wood or in a pile of matted leaves and start fires in this manner.

There is no way to totally eliminate the potential of spot fires and still accomplish prescribed burning objectives. The best precaution is to prepare adequate firelines and use wind speed, relative humidity, air temperature, and fuel moisture as guides for spot-fire danger and the amount of patrolling that may be necessary.

In our opinion volatile fuels should not be burned without a pumper and a dozer on standby. One dozer is worth 15 to 20 men in such fuels. We have never had spot fires get away using the precaution, and we have tested this technique under some very hazardous burning conditions (fine fuel moisture 1 percent, relative humidity 11 percent, temperature 80°F, and wind speed 15 mi/h). Where dung and punky wood are scarce, spot fires will be greatly minimized.

Fuel Moisture

In the absence of precipitation, fine fuel moisture is closely related to relative humidity (Countryman 1964; Countryman 1971; Mobley et al. 1973); thus, relative humidity has a direct effect on fine fuel moisture. The most important effect of fuel moisture may be described as a smothering process in which water vapor coming out of the fuels dilutes the oxygen in surrounding fuels (Davis 1959). This effect is especially important in getting fires started. Once a fire is started in woody fuels, large amounts of water in wood or green shrubby material, have a very mild effect on heat yield for optimum or complete combustion (Davis 1959; Lindenmuth and Davis 1973).

The threshold moisture in which fine fuels will or will not burn in sunlight, based on our experience, is about 33 percent. Other authors (Mobley et al. 1973) use a figure of 30 percent. Below 20 percent fine fuel moisture has relatively little effect on fire behavior in comparison to wind speed and relative humidity (Britton and Wright 1971). The preferred range of fine fuel moisture for prescribed burns is from 7 to 20 percent (Mobley et al. 1973).

Surface fuel moisture of woody fuels as indicated by relative humidity seems to be more important than total fuel moisture. On one of our fires, where relative humidity was 66 percent, fine fuel moisture was 10 percent, and there had been no precipitation for 6 months, the fire burned the grass (2,000 lb/acre) and left dead piles of high volatile juniper essentially untouched. Surface fuel moisture of the woody fuels is our only explanation for this unique behavior of fire.

Other threshold fine fuel moisture contents, are 5 percent, 7 to 8 percent, and 11 percent. Below 5 percent fine fuel moisture (relative humidity < 20 percent) spot fires are certain, whereas spot fires are rare when fine fuel moisture is above 11 percent (relative humidity > 65 percent). The 7 to 8 percent fine fuel moisture corresponds to a relative humidity of 40 percent, which is the minimum relative humidity at which firebrands usually cease to be a problem in dry grass (Wright 1974; Green 1977).

Following a rain, fine fuels such as grass reach 80 percent of their equilibrium moisture content with atmospheric weather within 1 hr (Britton

et al. 1973). However, limbwood that is 2 inches in diameter may require up to 4 days at a constant relative humidity and temperature to reach equilibrium, and logs may require weeks or even months (Countryman 1971). Based on our experience, we need to wait at least 1.5 days after a 1.0-inch rain in the spring before we can burn high volatile dead wood in grasslands with reasonable success.

Ten-hour timelag fuel moisture (based on moisture in 0.5-inch diameter pine dowels) is a good indicator of moisture for heavy fuels. Prescribed fires will carry well when the 10-hour timelag fuel moisture is between 6 and 15 percent (Beaufait 1966). If the 10-hour timelag fuel moisture is 15 percent or higher, there is no danger from firebrands (Bunting and Wright 1974), but this is also the threshold at which fires do not carry well.

Weather Considerations

General

Weather for prescribed burning varies widely depending on fuel type and objectives of the burn. For example, where there is a lot of fine fuel to burn (6.0 to 8.0 tons/acre), such as in prairie marshes, thick stand of seeded grass, or roughs in southeastern forests, a temperature range of 20° to 50°F and a relative humidity of 30 to 50 percent is desired for prescribed burning (Mobley et al. 1973). By contrast, where surface fine fuels are light and brush needs to be removed, such as in much of our chained juniper (Juniperus sp.) in the Edwards Plateau or chained mesquite in buffalograss (Buchloe dactyloides) vegetation, the preferred burning prescription for headfires is a temperature range of 70° to 75°F and a relative humidity of 25 to 40 percent (Wright 1974). Firelines would be burned out when the wind speed is less than 8 mi/h and relative humidity is 50 to 60 percent. Thus, there is no such thing as "ideal" weather for prescribed burns. Prescriptions must be developed for each vegetation type, depending on the objectives (Martin and Dell 1978). Even with prescriptions we are usually burning around them, out of necessity, and learn by experience how much a prescription can be varied (Wright 1974).

Relative Humidity

A relative humidity of 40 percent is a threshold value (Britton and Wright 1971; Lindenmuth and Davis 1973). Below this value fine fuels burn easily with about the same intensity until the relative humidity drops below 20 percent. As the relative humidity creeps above 40 percent, the rate of spread slows significantly (Lindenmuth and Davis 1973), standing woody material is difficult to ignite (Britton and Wright 1971), and danger from firebrands is noticeably low (Green 1977).

At a relative humidity of 50 percent, glowing firebrands rarely start fires, and we have never had problems with glowing firebrands when the relative humidity was above 55 percent. Below a relative humidity of 20 percent, fire causes fine fuels to crackle and pop and the danger from firebrands is

always present. Thus, we seldom like to burn when the relative humidity is below 20 percent, unless the winds are less than 6 mi/h, temperatures are below 40°F, or we are burning interior brushlands west of the Rocky Mountains. When the relative humidity exceeds 60 percent, fires burn very spotty unless the fuel bed is at least 4 inches deep with dry leaves or needles in the lower portion of the fuel bed.

Temperature

Ambient temperature plays a more critical role in fire behavior than one might think. As shown by Bunting and Wright (1974), danger from firebrands is low if ambient temperatures are below 67°F, but increases exponentially if ambient temperature is above 67°F (Fig. 1). This threshold temperature of 67°F is supported in the rate of spread model for Arizona chaparral by Lindenmuth and Davis (1973) and by practitioners in the Interior West (Great Basin and adjacent regions) who say that prescribed fires are difficult to start in brush fuels if the air temperature is below 70°F (Stinson 1978).

Except for the dry Interior West, a temperature of 80°F is considered the upper limit for safe burning of volatile fuels unless the relative humidity is greater than 40 percent and the wind speed is less than 10 mi/h. In the Great Basin and surrounding regions where the relative humidity is usually below 30 percent, prescribed burns are often conducted with air temperatures as high as 90° to 95°F.

When temperature is below 40°F, firebrands will not ignite dung, although punky wood will ignite down to 32°F. Below 32°F grass will not stay lit with a flame unless it is very thick. Under these conditions piles of debris can be burned without risk from flaming firebrands, but if the piles are surrounded by grass, one must be on guard for hold-over fires in days to follow. Smoldering roots or partially covered logs are frequently a problem if wind speeds increase or the relative humidity drops on days following the burn.

Wind Speed

Wind speed affects the burning rate of fuel directly by influencing the rate of oxygen supply to burning fuel (Davis 1959). Also, strong wind speeds increase the rate of fire spread by tilting the flames forward so that unburned fuels receive energy by radiation and convection at an increased rate (Countryman 1976, 1978). These two mechanisms are especially important in causing smaller fires to build their intensity. As wind speed increases, however, it has a cooling effect and increases fuel moisture slightly (Britton et al. 1973).

A wide range of wind speeds are used for controlled burns, and to achieve most objectives, some wind is preferred. The threshold value for igniting and burning standing honey mesquite stems (Prosopis glandulosa var. glandulosa) (sprayed some time in the past) is 8 mi/h (Britton and Wright 1971). Thus, to remove dead hardwood material or topkill shrubs, a wind speed in excess of 8 mi/h, but not exceeding 15 mi/h, is preferred to achieve the desired result (Wright 1974). This wind speed is necessary for 1 to 2 hr after ignition to be assured of consumption of low volatile wood. High volatile fuels ignite

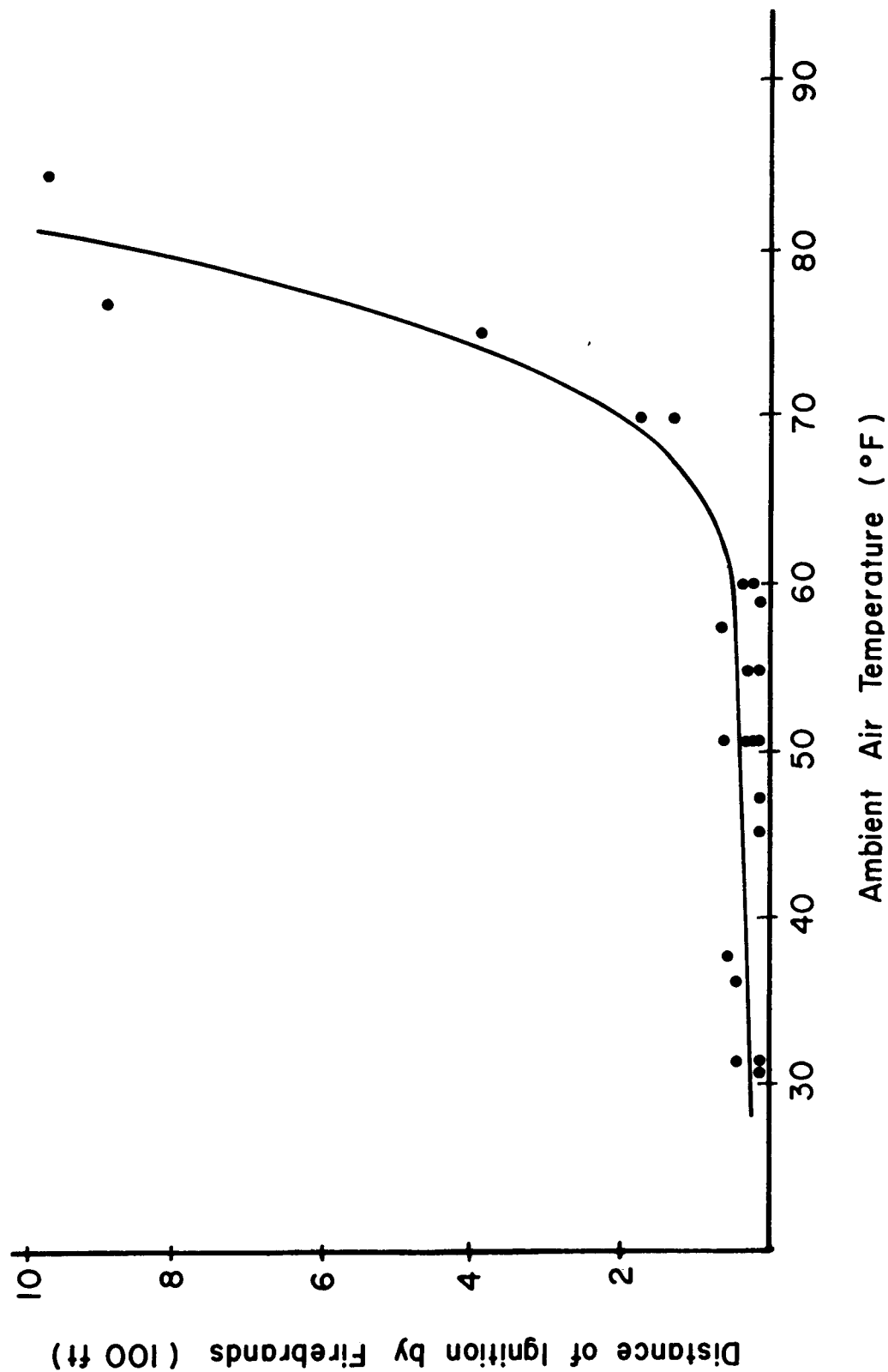


Figure 1. The maximum distance of spot fires from prescribed fires in relation to air temperature. Spot fires that started when temperatures were below 60°F were caused primarily by flaming firebrands (Bunting and Wright 1974).

and burn up easily regardless of wind (Wink and Wright 1973), although the preferred wind speed for burning most volatile fuels is 8 to 15 mi/h (Wright 1974).

Proximity of natural low pressure centers to fire and canyons will affect wind movements. For example, wind will move from bodies of water to land during the day, but then move from the land to water at night (Schroeder and Buck 1970). Similarly, winds move up canyons during the warm part of the day and down canyons at night. Different colors of the landscape cause differential heating patterns which influence the "light and variable" wind patterns that are often forecast on calm days. This is why burning on a calm day can be risky. A steady wind is preferred for prescribed burning.

Nocturnal low-level jets are also of concern when burning at night. Many times at night we have noticed sudden increases in wind speeds that lasted for several hours. These jets usually set in shortly before sunset when cooling sets in and lasts until midnight. They are most common at 1,500 to 2,500 ft in valley bottoms and at 1,000 to 3,500 ft on level terrain (Davis 1959).

Weather Forecasts

A good fire weather forecaster who is used to giving "spot weather forecasts" is very important in the success of a prescribed burning program. He can save many unnecessary trips to the field and help avoid burning just prior to the passing of a front or unusual weather. Many times we have burned large tracts safely and then had firebrand problems the next day after passage of a front with 30 to 50 mi/h winds. A good job of mopping up after a fire will minimize problems the day after a fire.

Fire weather forecasters have saved us about \$1,000 per year in travel expenses to burn 2,000 to 3,000 acres per year. With information from a fire weather forecaster we have been 95 percent certain that we could burn when we got to the field. When dependent on local forecasts, we were only 50 percent certain that we could burn when we got to the field.

Fire weather forecasts for Texas are provided by the U.S. Weather Bureau in Fort Worth, Texas. Their current commercial phone numbers are (817) 334-3451 or 334-3401.

Ignition

Ease of ignition of woody materials depends on diameter and fuel moisture (Fons 1950), density (Countryman 1975), arrangement, bark characteristics, and volatility. Fine fuels as well as low density fuels (dung and punky wood) are very easy to ignite. As fuel diameter and density of wood increases, it takes longer for the material to ignite but bark characteristics and decay or wood borer activity in the wood can aid ignition. For example hardwood with wood borer activity is twice as easy to ignite at a threshold temperature of 900°F than wood with no wood borer activity (Burton et al. 1972) because the wood with wood borer activity has a lower heat capacity (Countryman 1975). This characteristic is unimportant when temperatures are in excess of 1100° because the surface of the wood is being heated faster than the heat can be conducted toward the center of the log.

Logs laying on the soil surface are easier to keep ignited than wood that is perched in the air. The reason for this is that as heat radiates to the soil and re-radiates back to the log, it will stay lit easier than if the heat radiates in all directions with none of it reflected back. Once air-dry volatile wood such as juniper is lit, it will continue to burn regardless of the weather. By contrast, hardwood will go out easily if the wind drops below 8 mi/h or the humidity increases above 40 percent.

Topography

Slope

In addition to weather and fuel characteristics, topography affects fire behavior (Southwest Interagency Fire Council 1968). A fire spreading upslope resembles a fire spreading before a strong wind (Davis 1959). Based on many individual fire reports from California (Southwest Interagency Fire Council 1968), researchers showed the relative rate of spread for different slopes (Table 1). A fire burning up a slope of +20 to +39 percent will spread twice as fast as a fire on level terrain. Nevertheless under the influence of a brisk wind, fire spread is slowed when a fire's intensity in the center of the burn becomes high enough to produce a strong indraft opposite the direction of firespread.

Table 1. Relative rate of forward spread of flame front (no allowance for spotting^{1/} or roll) in relation to percentage slope.^{1/}

| | Slope % | Rate of spread (ft/min) |
|------------|------------|----------------------------|
| Fires | -40 to -70 | 1.0 |
| Burning | -20 to -39 | 1.5 |
| Down Slope | - 5 to -19 | 2.5 |
| | - 4 to + 4 | 5.0 |
| Fires | + 5 to +19 | 7.5 |
| Burning | +20 to +39 | 10.0 |
| Upslope | +40 to +70 | 22.5 |

^{1/} Data from Southwest Interagency Fire Council (1968).

Firewhirls

Topography can also affect the formation of firewhirls. If a fire burns across a ridge, firewhirls will almost always develop on the lee side of the ridge. They will pick up large chunks of material because of internal winds up to 300 mi/h (Countryman 1971) and create a potential for spot fires at distances greater than normal from the leading edge of the fire. Thus, we should always burn with ridges, not across them.

Firewhirls can also be developed on very still days by lighting the entire perimeter of an area. We had a whirl form on level grassland under such conditions which was 40 to 50 ft in diameter at the base and lasted for 10 min.

However, it was in the center of the fire and did not move. Generally, such whirls on still days do not move. Burning headfires into backfires will also cause whirls, as we have experienced with a 50 ft streak of fire across a 20 ft fireline.

Tumbleweeds and possibly rabbits are other potential sources of danger from fire. Common broomweed (Xanthocephalum dracunculoides) will burn off at the base and blow quite a distance with the hot base oriented toward the wind. With our prescription procedures for low volatile fuels, however, we have never experienced a spot fire from one of these weeds. When areas are encircled, we run the risk of having animals run through the fire to get out and light adjacent unburned areas. To prevent all of these problems it is best to burn into prepared firelines with wind so that no whirls form in the fire, and the animals have an area in which to escape from the fire.

Firelines

Fireline widths vary considerably depending on the type of fire and specific objectives within specific vegetation types. For burning in rough in southeastern pine communities, slash, and litter in grasslands, a fireline width of 5 to 20 ft is adequate. In sagebrush-grass communities (moderate fuel type) in Utah, a 250 ft fireline is usually preferred. As we get into high volatile fuels, however, such as those in West Texas where heavy grass is a continuous cover between dead piles of juniper and in California chaparral, a 500 ft fireline is desired.

One point of grave concern is to never mix woody material with soil along firelines for this is a prime source of "hold-over" fires (Beaufait 1966; Schinke and Green 1970). Always plow firelines away from the area to be burned. We have had several fires break out 3 to 4 weeks after pile burning was completed. The fires started from sparks that blew from dozed piles of soil and woody material.

Firelines are usually dozed or plowed because these techniques are versatile in a wide variety of terrain and vegetation. However, more attention should be given to the preparation of safe firelines without the use of dozers where possible (Davis 1976) to minimize the effect on esthetics. In annual grasses in Idaho, the wetline technique has proven to be successful (Martin et al. 1977) and would be equally useful in other light to moderate grass fuels on relatively smooth terrain. Fire retardants and the use of chemicals are possible alternatives for firelines, but have not been adequately tested to be recommended. Building firelines with liquid explosives in slash still needs more testing before it is ready for operational use (Dell and Ward 1970). Shredded lines are used in tallgrass prairies where soils are wet at the time of burning. In general, dozed or plowed lines allow the greatest flexibility in planning and conducting a burn on most terrain over a wide variety of vegetation types. Nevertheless, natural firebreaks and other alternatives should be used when possible.

Air Quality

Air-borne particulates are the primary pollutant of wildfires and prescribed burns (Komarek 1970; Dieterick 1971) and account for 23.7 percent of all particulates emitted into the atmosphere (Martin et al. 1977). Their most objectionable feature is their effect on visibility. However, burning under favorable dispersal conditions minimizes the visibility problem (Perovich 1977). Their effect is short-lived. The large particles settle out rapidly, but small particles may remain suspended for several days (Martin et al. 1977).

Carbon monoxide is given off in substantial quantities (60 lb/ton) in forest fuels (Martin et al. 1977), but it seems to oxidize quite readily (Fritchett et al. 1970) and does not pose an immediate threat to people, plants or animals (Dieterick 1971). Sulfur is almost absent in woody fuels, and nitrogen oxides are not formed, as their formation generally requires a temperature higher than that generated by burning wood (Sandberg and Martin 1975).

Thus, the most objectionable feature about smoke is that it looks bad and can obstruct visibility. To minimize these undesirable effects, burning should be done after the morning inversion has broken and before the evening inversion forms, when mixing depth and wind is most favorable for smoke dispersal (Nikleva 1972). Adhering to such a time frame is not always convenient, but it should be adhered to around populated areas. Moreover, burns should be conducted in as short a time as possible. People are willing to tolerate smoke for a few hours, but not for several days. Once the public starts to react to smoke, more restrictions are placed on prescribed burning which ultimately limits the use of fire. It is to our advantage to adhere to the rules and burn when the conditions for dispersal of smoke are optimum.

Be sure to familiarize yourself with the burning regulations for the state of Texas (see Appendix 1). Burning is permitted between 9:00 a.m. and 5 p.m. However, if you are burning near a town, residence, recreation area, commercial or industrial area, or across a road, special precautions need to be taken. Distance from these areas and wind direction are important. Burning is not permitted when a significant shift in wind direction is predicted which could produce adverse effects to persons, animals, or property during the burning period. If at any time the burning causes or may tend to cause smoke to blow onto or across a road or highway, it is the responsibility of the person initiating the burning to post flag-persons on affected roads in accordance with the requirements of the Department of Public Safety. Burning of salt marsh grass shall not be conducted during periods of actual or predicted persistent low-level atmospheric temperature inversions or in areas covered by a current National Weather Service Air Stagnation Advisory.

Burning shall not be commenced when surface wind speed is predicted to be less than 6 mph or greater than 23 mph during the burn period. Please abide by the rules and ask for a special permit to burn from the Texas Air Control Board, if for some reason you cannot burn within the state guidelines (e.g. burn out firelines at night).

Appendix 1. Excerpts involving prescribed range burning.

TEXAS AIR CONTROL BOARD
REGULATION I
CONTROL OF AIR POLLUTION FROM
VISIBLE EMISSIONS AND PARTICULATE MATTER
131.03.
01.001-08.002(b)

OUTDOOR BURNING
131.03.
01.001-01.004

(131.03.) 01.001. No person may cause, suffer, allow or permit any outdoor burning within the State of Texas, except as provided by Rule 131.03.01.002.

01.002. EXCEPTIONS. Outdoor burning is authorized in each of the following instances:

(a) Pursuant to a written grant of authority from the Texas Air Control Board or Executive Director, who, before granting such authority, must determine that there is no practical alternative to outdoor burning, and the burning will not cause or contribute to a violation of any Federal primary or secondary ambient air standard.

* * * * *

(f) Outdoor burning in a rural area of trees, brush, grass and other dry vegetable matter at the site where it occurs and only when no practical alternative to burning exists for right-of-way maintenance, land-clearing operations, and for those forest, crop, and range management purposes not specifically governed by orders issued pursuant to Rule 131.03.01.002(a) of this Regulation if all the following conditions are met:

(1) Any burning conducted for salt marsh grass management purposes in the following counties may be conducted only after verbal or written notification to the Texas Air Control Board Regional Office having jurisdiction: Orange, Jefferson, Chambers, Galveston, Harris, Brazoria, Matagorda, Jackson, Calhoun, Aransas, Refugio, San Patricio, Nueces and Kleberg. Burning of salt marsh grass in these counties shall not be conducted during periods of actual or predicted persistent (12 hours or more) low-level atmospheric temperature inversions (non-surface based) or in areas covered by a current National Weather Service (NWS) Air Stagnation Advisory. This meteorological data will be available from the Texas Air Control Board Regional Office having jurisdiction.

(2) Prior to prescribed or controlled burning for forest management purposes, the Texas Forest Service shall be notified.

(3) The burning must be outside the corporate limits of a city or town except when it is necessary to eliminate a naturally occurring fire hazard.

(4) Burning shall be commenced only when the wind direction is such as to carry smoke and other pollutants away from any city, town, residential, recreational, commercial or industrial area, navigable water, public road or landing strip which may be affected by the smoke. Burning shall not be conducted when a significant shift in wind direction is predicted which could produce adverse affects to persons, animals, or property during the burning period. If at any time the burning causes or may tend to cause smoke to blow onto or across a road or highway, it is the responsibility of the person initiating the burning to post flag-persons on affected roads in accordance with the requirements of the Department of Public Safety.

(5) The burning must be at least three hundred feet (ninety meters) from any residential, recreational, commercial or industrial area except those located on the property where the burning is to take place, except when it is necessary to eliminate a naturally occurring fire hazard.

(6) Heavy oils, asphaltic materials, items containing natural or synthetic rubber or any material other than dry plant growth which may produce unreasonable amounts of smoke must not be burned.

(7) The hours for burning shall comply with the following:

(a) The initiation of burning for land-clearing and right-of-way maintenance purposes shall commence after 9:00 a.m. Material which will not be completely consumed before 5:00 p.m. shall not be added to the fire.

(b) The initiation of burning for crop and range management purposes shall commence after 9:00 a.m. The acreage to be burned should be adjusted to provide that the burning is completed by 5:00 p.m. on the same day or as soon as is reasonably practical.

(8) Burning shall not be commenced when surface wind speed is predicted to be less than 6 mph (5 knots) or greater than 23 mph (20 knots) during the burn period.

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TECHNIQUES FOR SUCCESSFUL PRESCRIBED BURNING¹

Henry A. Wright

Introduction

We know a lot about the effect of fire on western rangelands and its value as a tool, but information necessary to conduct specific prescribed burns is generally inadequate or non-existent. Thus, the use of fire is frightening, and many desirable prescribed burns just do not get started. Few land managers have the training or courage to conduct a burn. Most have been exposed only to catastrophic fires, which are untimely, have undesirable effects, and scare everyone in their path.

There are other fears which inhibit prescribed burning. One is a fear of the liability consequences if a fire gets away. This fear affects individual landowners and also influences government agencies. Another fear, which has been important in the past but may be less so now, is a concern about one's career if he lets a fire get away.

Fire is not as dangerous as most people think. It is just dangerous to be inexperienced. It is very dangerous to be half-experienced, for this is the person who becomes over-confident and could do the most damage.

When I arrived at Texas Tech 12 years ago, I had very little experience in burning plots or large acreages. My students and I learned as we went. Despite our inexperience, we have not had any serious escapes, although we have had a little "slop-over" from time to time, particularly during the first few years. This should provide each of you with encouragement that you can learn to do prescribed burns without serious consequences, if you try to be reasonably careful and follow some basic guidelines.

During the past 12 years that I have been at Texas Tech, I have conducted or supervised about 130 fires under a wide range of fuels and weather conditions. Firewhirls caused two escapes in 1969. One burned 10 acres and the other burned 500 acres in honey mesquite-tobosagrass (Prosopis glandulosa-Hilaria mutica) communities. Neither of these escapes were serious and they occurred before we knew anything about firewhirls. Firebrands from high volatile fuels (e.g. Ashe juniper (Juniperus ashei)) have caused numerous spot fires, particularly in dozed Ashe juniper and shin oak (Quercus sp.). Again, however, most of these occurred while we were developing prescriptions, and we were prepared for their occurrence (D-7 caterpillar, pumper, and crew of 12 people on standby). Only one of the spot fires burned as much as 0.5 acre.

My point is that although fires need to be planned and we need to be careful, the training period for prescribed burning is not necessarily one of high risk. Keep in mind that we have never had more than 12 to 14 men, a D-7 caterpillar tractor, and a 100 gal slip-on pumper on any fire. Many of the fires were handled with 3 or 4 men and a slip-on pumper.

¹This paper is a contribution of the College of Agricultural Sciences, Texas Tech University, Lubbock.

In this paper, I intend to give you some basic background on firing techniques and how you can apply them to accomplish various management objectives in the Rio Grande Plains.

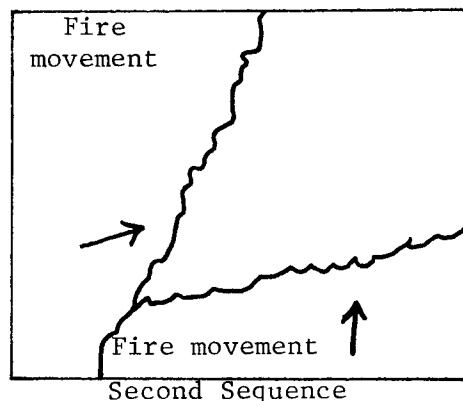
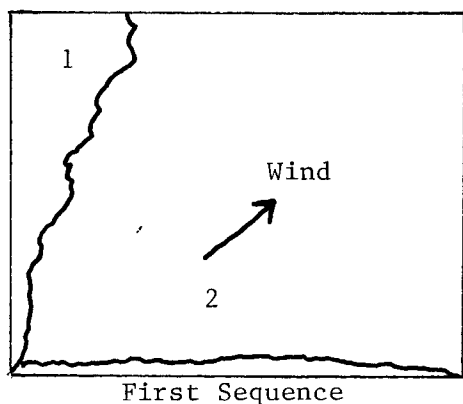
Firing Techniques

Headfires, backfires, strip-headfires, flank fires, center ignition, and area ignition are all procedures used to ignite fires (Fig. 1) (Davis 1959; Dixon 1965; Southwest Interagency Fire Council 1968; Sando and Dobbs 1970; Mobley et al. 1973). Since these procedures have been thoroughly discussed in the above references, they will only be briefly discussed here, although their use will be more fully illustrated for the Rio Grande Plains in sections that follow.

Headfires (fires that move with the wind) are most effective for killing shrubs and trees (Fahnestock and Hare 1964; Gartner and Thompson 1972) and in getting an effective burndown of standing dead trees (Britton and Wright 1971). They are also effective in using low quantities of fine fuel (600 to 1,000 lb/acre) to efficiently clean up debris and brush (Heirman and Wright 1973; Wink and Wright 1973). Backfires (fires that back into the wind) work well (1) when the fuel exceeds several thousand pounds per acre, (2) when you wish to maintain good control in high volatile fuels, (3) when you wish to reduce heat damage to overstory conifers (Biswell et al. 1973; Mobley et al. 1973) and (4) when the weather is more risky than is desirable.

Strip-headfires and flank fires are variations in between the speed with which headfires and backfires move. They are usually used when backfires move too slowly but a headfire would be undesirable or too dangerous. Area ignition (Fenner et al. 1955; Schimke et al. 1969) is used to set the entire area on fire at once and cause a fire to suck into the middle. Center ignition (Beaufait et al. 1966) is similar to area ignition although the center is lit first, and the intensity of the fire increases more slowly over time than area ignition. These latter two fire techniques usually burn very intensely and can cause firewhirls to start. Center ignition and sometimes area ignition are generally used for slash burning when winds are light. They are of little value for prescribed burning in the Rio Grande Plains. Their primary value is to create intense fires that "suck" winds into the center of the fire and minimize danger from firebrands.

The way that a fire is lit can affect fire behavior as much as anything. Fires in one location can be used to draw fire from another even though the prevailing wind may be blowing against the latter. Two diagrams below illustrate this point:



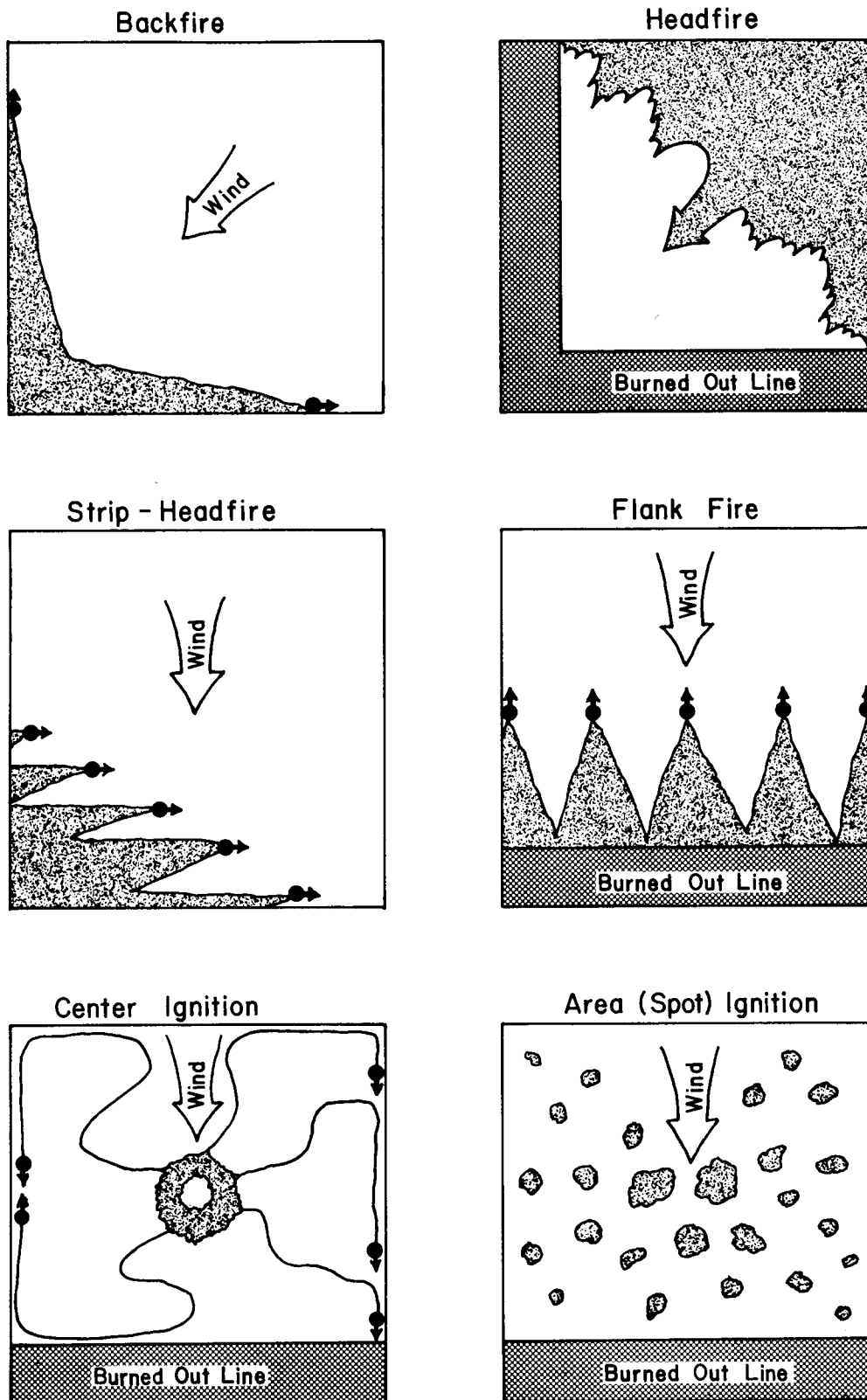


Figure 1. Firing techniques used for prescribed burning.

Prescriptions for Low Volatile Fuels

Detailed prescriptions for conducting burns in low volatile grassland fuels have been given by Wright (1974) and Wright and Bailey (1980). Depending on the objectives and the quantity of fine fuel, a wide variety of prescriptions can be used. Experience is the best teacher. Generally, firebrands (glowing embers) are not a problem in grasslands with low volatile shrubs and trees (e.g. honey mesquite), but chunks of glowing debris will easily roll on the ground when wind gusts above 20 mi/h. Thus, depending on the objective of a prescribed burn, i.e. to remove litter, burn debris, or topkill shrubs and trees, the desired fireline width will vary depending on quantity of fine fuel in adjacent pastures and the wind speed and relative humidity needed to accomplish objectives. Firelines in low volatile fuels may range from the width of a cow trail to 200 ft.

Shortgrass Prairie or Chained Areas

Generally, fire is not used in the shortgrass prairie because it seldom enhances the growth of grasses (Wright 1978). However, it is a beneficial tool to remove chained mesquite and to kill cactus species. Most burning is done during February and March, before the warm season grasses begin to grow.

If you wish to clean up chained debris in buffalograss (Buchloe dactyloides) that has 2,000 lb/acre of fine fuel, a 100 ft fireline should be burned out on the north and east sides (Fig. 2) when the relative humidity is 30 to 60 percent and wind speed is 5 to 10 mi/h. Air temperature is usually 60° to 75°F. Strip-headfire the fireline (Fig. 3). The rest of the pasture should be burned with a headfire when the relative humidity is 20 to 40 percent, wind speed is out of the southwest at 8 to 15 mi/h and air temperature is 70° to 80°F.

Mixed Grass Prairie (Including Mixed Brush)

Fire is desirable in mesquite and mixed brush communities to (1) remove excess litter, (2) increase yields of grasses, (3) increase accessibility and palatability of grasses, (4) reduce brush canopy to acceptable levels, (5) burn down dead honey mesquite stems and other plant material, (6) kill about 25 percent of sprouting honey mesquite trees, (7) kill 40 to 80 percent of most species of cactus, (8) kill undesirable cool-season annual weeds, and (9) ease the handling of livestock. Blackbrush (Acacia rigidula) is especially resistant to fire.

If dead mesquite is standing in a mixed brush community and you wish to burn it down, you need a minimum of 3,000 lb/acre of fine fuel, a relative humidity below 40 percent and wind speed in excess of 8 mi/h. Burn a 200 ft wide fireline on the north and east sides when the relative humidity is 50 to 60 percent and the wind speed is less than 8 mi/h (Fig. 4). Headfire the rest of the pasture when the relative humidity is 25 to 40 percent, wind speed is 8 to 15 mi/h and air temperature is 70° to 80°F (Fig. 4). Burns should be conducted in late February and March with southwest winds (drier than southeast winds).

Fireplan for Shortgrass Prairie

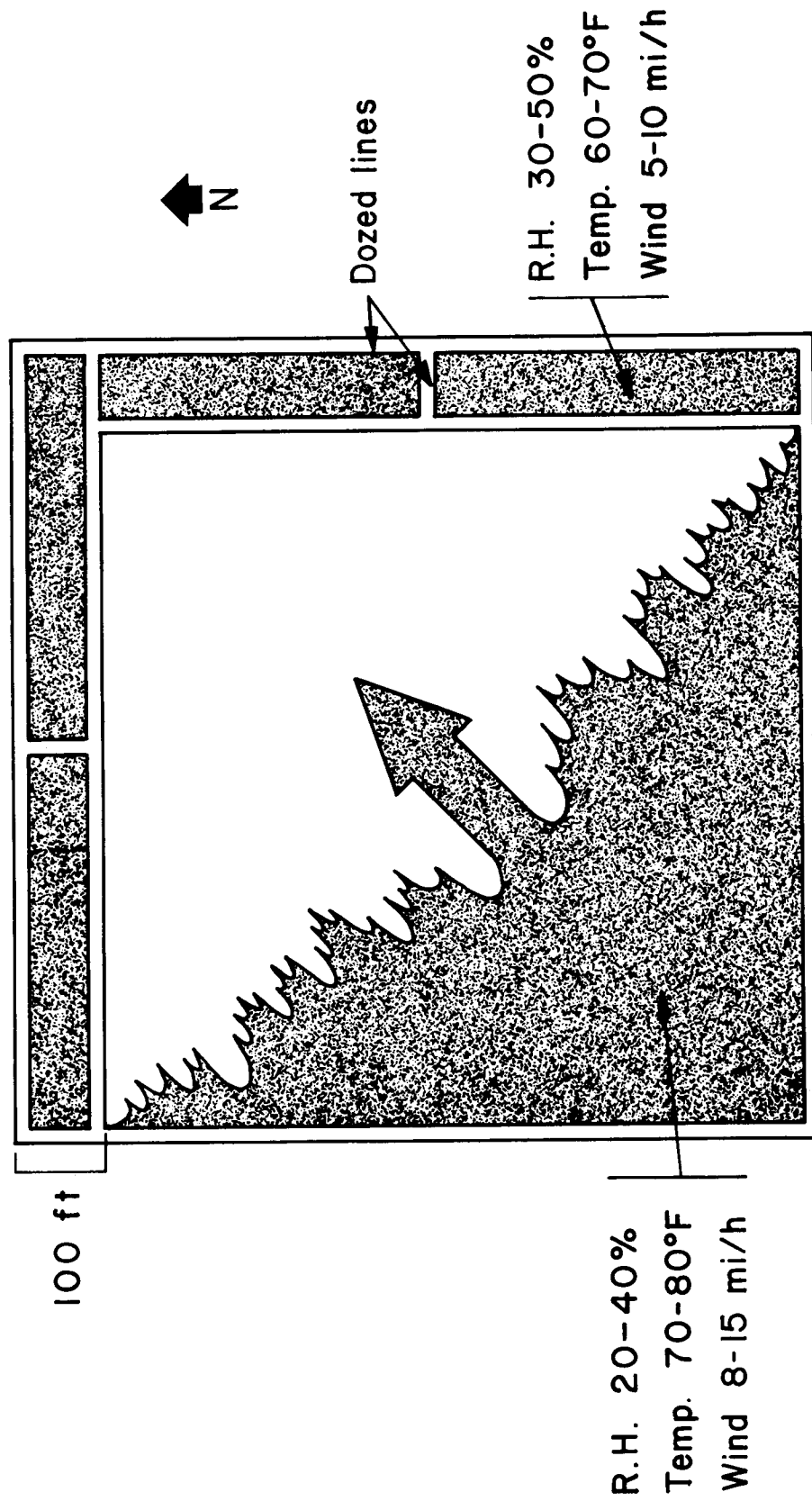


Figure 2. To burn fuels in shortgrass prairie, doze a 10 ft line around the entire area to be burned and around the area that you plan to burnout for a fireline as shown in the figure. Strip-headfire the fireline when relative humidity is 30 to 50 percent and wind speed is less than 10 mi/h. Head-fire the remainder of the pasture when relative humidity is 20 to 40 percent, air temperature is 70° to 80°F and wind speed is 8 to 15 mi/h.

Strip - Headfire Technique to Prepare Firelines

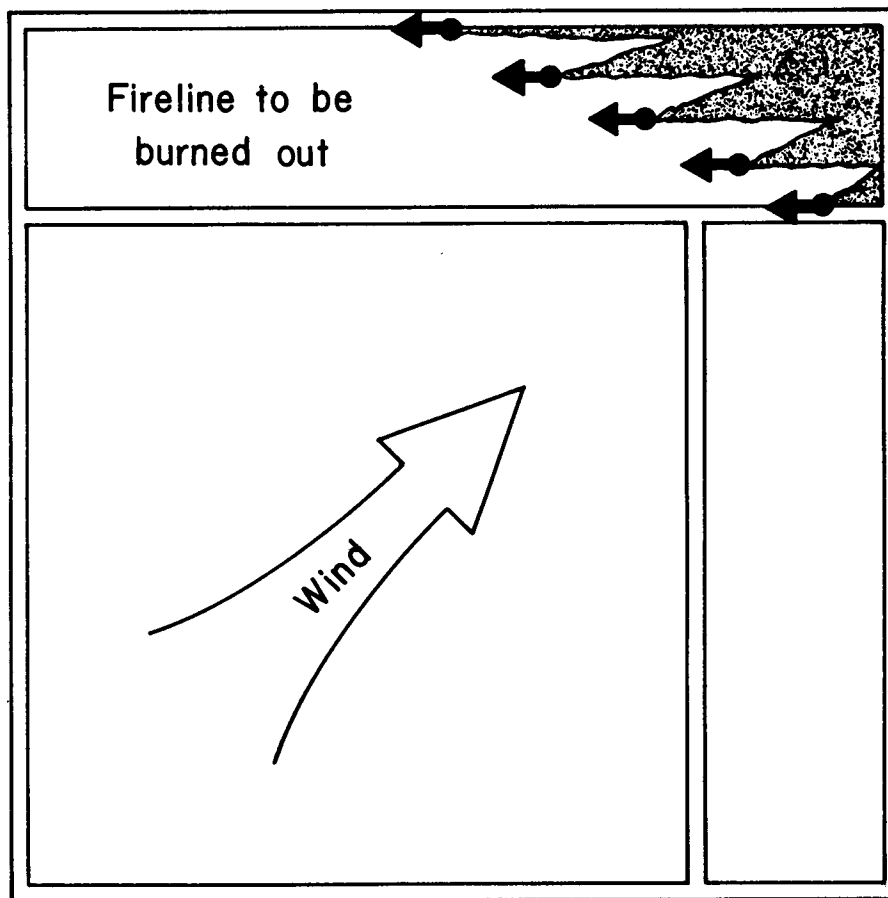


Figure 3. The strip-headfire technique usually involves the combination of a backfire (lead man) and several staggered strip-headfires. The men are staggered so that the fire will not over-run anyone. Also the line of the second man may only be 10 to 20 ft from the dozed line, whereas the men will usually be spaced progressively further apart (e.g. 33, 82, 164 ft). This is a very common technique to burn firelines in most vegetation types.

Fire Plan for South Texas Mixed-Brush

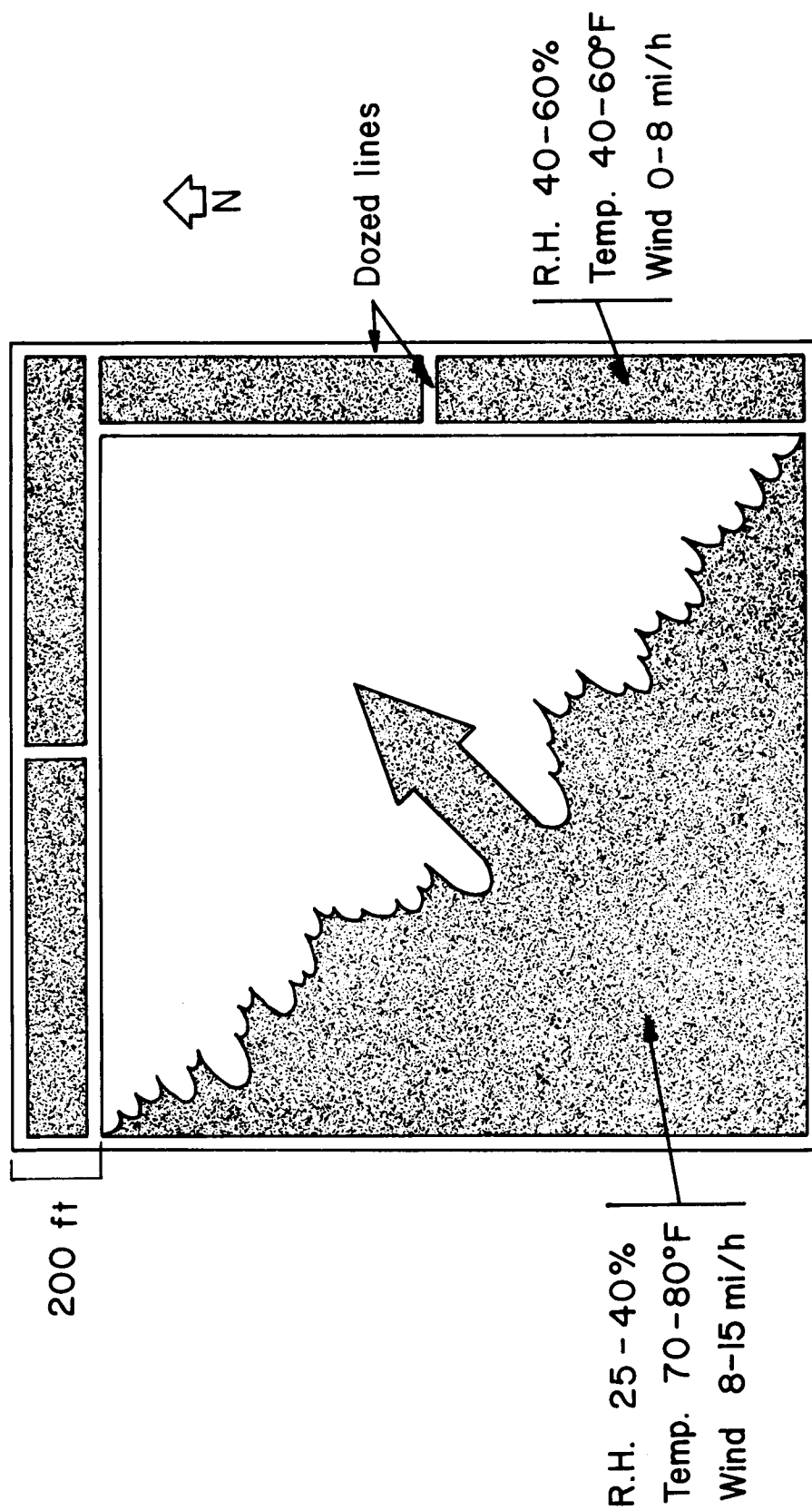


Figure 4. Doze a 10 ft line around the entire area to be burned and in interior areas of burn as shown in the figure. Burn out the firelines in January and February when relative humidity is 40 to 60 percent, air temperature is 40° to 60°F, and wind speed is less than 8 mi/h. In February or March, light the main headfire when relative humidity is 25 to 40 percent, air temperature is 70° to 80°F and wind speed is 8 to 15 mi/h.

Firewhirls develop where wind shears occur such as when a headfire runs into a backfire or a fire goes up slope into a wind. We have seen several firewhirls develop when headfires met backfires while wind speeds were 10 to 15 mi/h. We have also seen two huge firewhirls develop when wind speeds were light and variable. For these reasons, we prefer to burn with a steady wind and never burn into backfires unless we have at least a 300 ft fireline. Fires should be planned to move with the ridges, not across them.

Decadent Tallgrasses or Seeded Species

The primary reason for burning areas such as this are to (1) remove litter, (2) increase forage yields, (3) increase palatability of grasses, and (4) suppress undesirable shrubs. Usually, 3,000 to 4,000 lb/acre of fine fuel (less than 1/8-inch in diameter) is present. Thus, most burns can be conducted when the relative humidity is 50 to 60 percent, wind speed is less than 10 mi/h, and air temperature is 40° to 60°F. Firelines only need to be 10 to 12 ft wide.

A procedure for conducting such fires (Fig. 5) has been outlined by Launchbaugh and Owensby (1978). They start the fire on the downwind side using two people to light and two pumpers to patrol. After the fire has burned back 50 to 100 ft, then the rest of the pasture is headfired. Grasses are relatively safe to burn unless the winds become gusty and blow burning debris across the fireline.

Prescriptions for High Volatile Fuels

High volatile fuels (generally not very prevalent in the Rio Grande Plains) require more preparation before burning than other fuel types. This is particularly true for juniper species (Juniperus sp.). Firelines on the leeward sides should be about 500 ft wide and the trees and shrubs in the firelines need to be crushed, chained or dozed before being burned. These firelines with a 10 ft dozed strip on each side (Fig. 6) need to be burned when relative humidity is within the range of 40 to 60 percent, air temperature is within the range of 40° to 60°F, and wind speed is less than 10 mi/h. When air temperature drops to 40°F and relative humidity rises to 60 percent, it is very hard to ignite anything. However, as long as the relative humidity does not drop below 40 percent and wind speeds are light, there will be little risk from volatile firebrands (Bunting and Wright 1974; Green 1977).

After the firelines have been prepared, crushed strips in brush or grass will be needed to ignite the headfire. For headfires, we recommend air temperatures of 70° to 80°F, relative humidity of 25 to 40 percent, and wind speeds of 8 to 15 mi/h, provided you have a 500 ft fireline to burn into.

Dozed Juniper in Mixed Prairie (Texas)

This is a high volatile fuel that gives off firebrands which ignite cow dung easily. Generally, dozed or chained areas are not burned until 3 to 5 years after treatment. This allows time for native grasses to recover, time

Fire Plan for Tallgrass Prairie

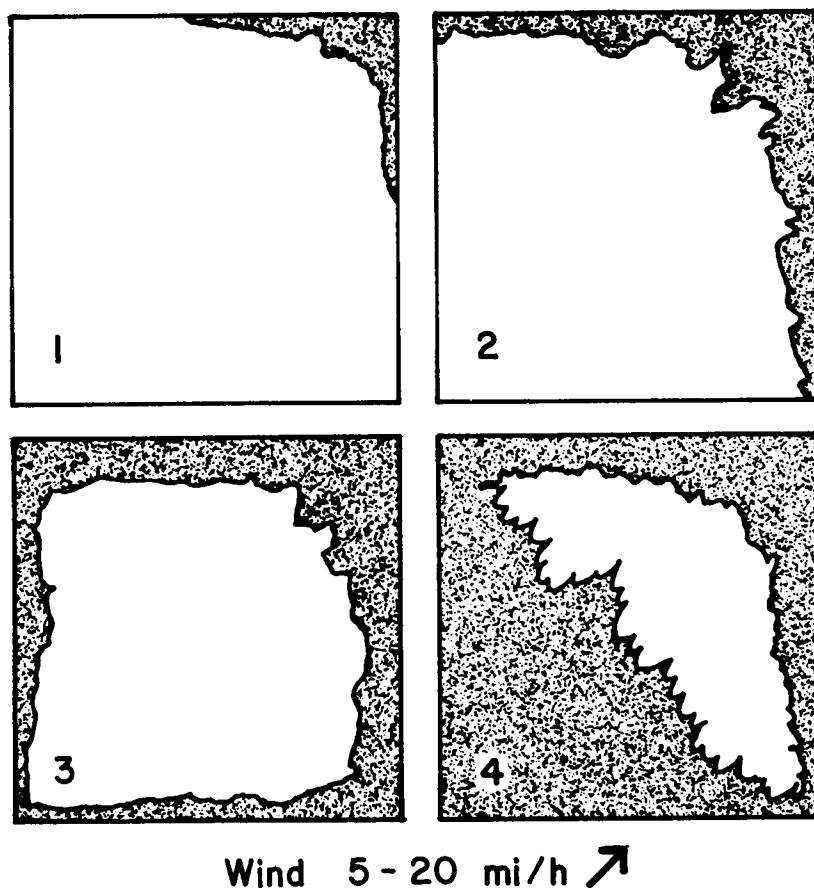


Figure 5. In tallgrasses natural firebreaks, including roads, trails and fenceline cowpaths, are used to the extent possible. In some cases a wetline may be put down with a sprayer where there is no natural break. A backfire is started on the downwind side (1) and lit simultaneously in each direction on the downwind sides (2). After the backfire has burned 50 to 100 ft on the lee sides, then the remainder of the area is lit (3), and burned with a headfire (4). Wind speeds may vary from 5 to 20 mi/h (Launchbaugh and Ownesby 1978). Relative humidity is usually above 40 percent.

Fire Plan for Dozed Juniper (Mixed Prairie)

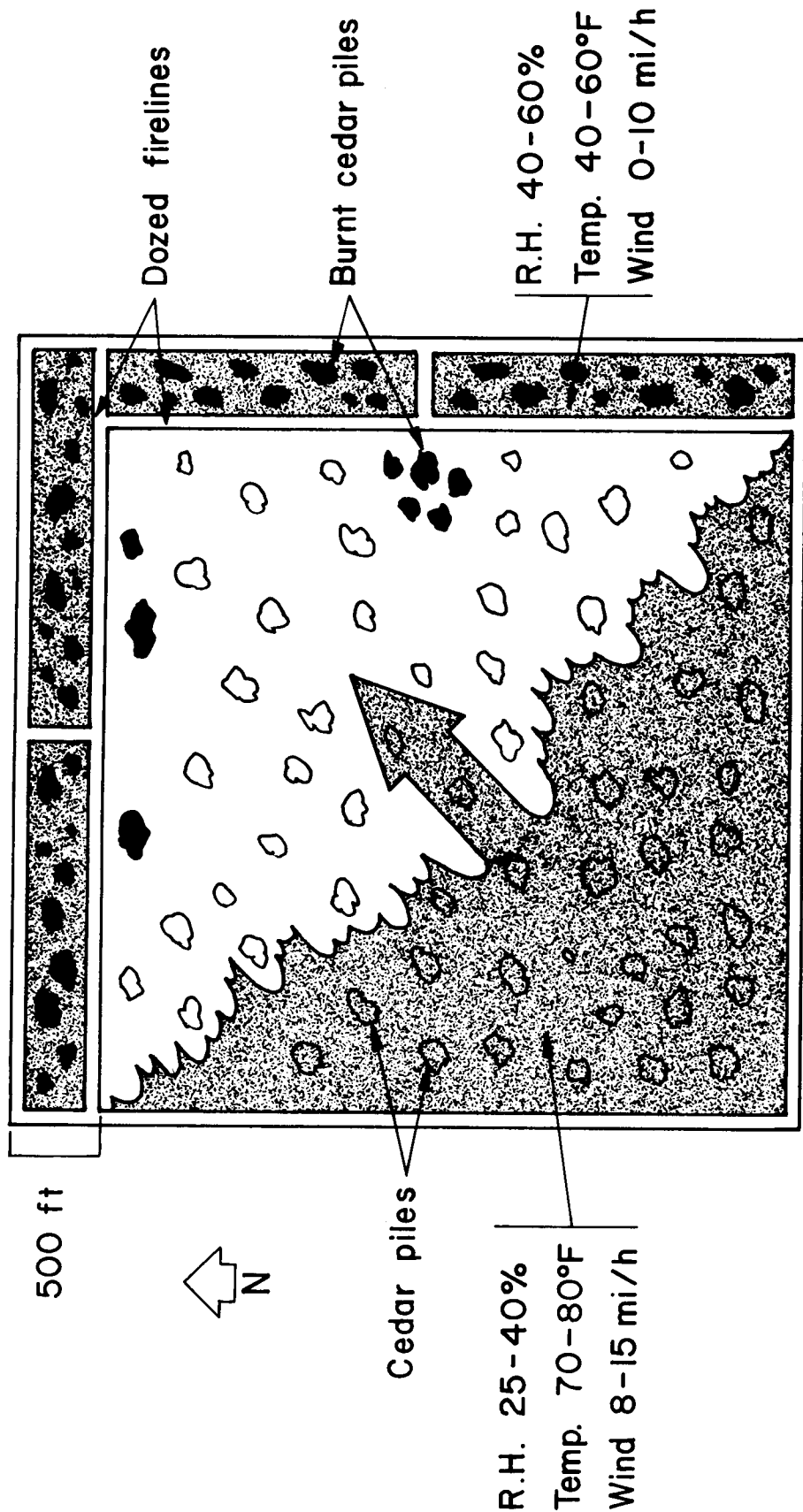


Figure 6. When the grass is green, juniper piles in the 500 ft strip (black splotches) on the downwind sides (north and east) are burned with wind velocities less than 10 mi/h and relative humidity above 45 percent. Eight months later (when grass is dormant), the grass in the 500 ft strip is burned (strip-headfire techniques) when the wind speed is less than 10 mi/h and relative humidity is between 40 and 60 percent. Lower relative humidities may be used if the grass fuel is less than 2,000 lb/acre. All large concentrations of piles are backfired on the downwind sides of main area to be burned, and then the entire area is burned into the prepared firelines with a wind speed of 8 to 15 mi/h and a relative humidity of 25 to 40 percent.

for juniper seeds to germinate, and time for most leaves to fall off the dead trees. The primary objective of burning is to remove dead piles and to kill young juniper trees.

A 500 ft fireline is prepared on the north and east sides of a pasture (Fig. 6). Dead piles of brush (4 to 5 years old) are burned out of this line in May or early June when the grass is green, wind speed is less than 10 mi/h and the relative humidity is above 45 percent. Later (January or February), where little bluestem (Schizachyrium scoparium) is the primary fine fuel, the 500 ft firelines are burned out when the relative humidity is 40 to 60 percent and the wind speed is less than 8 mi/h (Fig. 6). Where buffalograss occurs, a higher wind speed and lower relative humidity are required.

After the fireline has been burned out, the rest of the area is burned with a southwest wind when the relative humidity is 25 to 40 percent, wind speed is 8 to 15 mi/h, and air temperature is 70° to 80°F (Fig. 6). After a rain, wait at least 5 days to burn.

For safety, avoid burning backfires into headfires and avoid burning across ridges. Firewhirls can easily develop under these situations. When possible, burn into heavily grazed pastures to minimize risk. In this fuel type, one should have at least two seasons of burning experience before assuming responsibility for conducting a burn.

Chained Juniper in Mixed Prairie (Texas)

Chained juniper is less hazardous to burn than dozed juniper because the dry juniper fuel is closer to the ground and burning embers are not likely to travel more than 250 ft, although we use the 500 ft fireline in this fuel type for safety. Thus, the dead trees in the fireline can be burned at the same time as the grass. Follow the procedure as outlined in Figure 6.

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RANGE AND RANCH MANAGEMENT CONSIDERATIONS FOR PROPER USE OF PRESCRIBED BURNING

Wayne T. Hamilton

Highlight

The proper use of prescribed burning by ranches for range improvement requires adherence to the logical management principles of any good business enterprise. Burning differs from other improvement practices primarily in the lead time that is necessary to accomplish preburn objectives, such as accumulation of fuel load. Preburn considerations of the planning process include equipment, personnel, notification and preburn patrols. The actual implementation of a prescribed burn requires little time, but is often the product of many months of preburn preparations and activities. Postburn management considerations include postburn patrols and grazing control. After the fire is installed, successful results depend on grazing management to allow adequate replacement of ground cover and recovery of the key forage species. Close observations and timely livestock management decisions can gain the advantage of very quick range condition improvement. Managers who contemplate the continued use of prescribed burning can systematize burns and grazing management to provide "built in" pre and postburn deferments.

Introduction

The first step for a ranch manager considering prescribed burning is to thoroughly answer the questions: Why, where, when and how should I burn? It is advisable at this point to arrange for competent technical assistance for an "on-the-ground" inspection of the areas being considered for prescribed fires.

Fire is an alternative tool which is not necessarily applicable to every situation, or for use as the sole range improvement approach. It may be best used as a follow-up practice to a mechanical or chemical method. Deciding where and when to burn involves not only consideration for fire characteristics to match your objectives, such as the need for reclamation versus maintenance burns, but necessitates a plan for building fuel load and handling the associated forage loss in your livestock operations. Diverting herbaceous vegetation from "feed to fuel" is a critical consideration in the planning process. "How to burn" is a process of technical decisions resulting in a comprehensive fire plan to insure the best results with minimum risks.

Effective application of prescribed burning on ranches requires adequate lead time to accomplish the necessary steps for preparation, installation and postburn management of pastures selected for burning (Fig. 1). For example, considerable time is usually required to build a fuel load adequate to carry the fire. Fuel preparation should begin several months ahead of the target date for burning. An early decision allows plenty of time for preburn preparations, and less chance of costly oversights or poor results from a last-minute effort.



Fig. 1. Installing a burn requires little time, but pre and postburn activities may require several months.

Once you have properly decided on the use of prescribed burning in your range management program, make a strong commitment to successfully complete the practice. Be just as dedicated to the follow-up deferment of grazing, for example, as you were to properly executing the steps necessary for preparation and execution of the burn. Moreover, be committed to the long-range advantages you can gain from proper use of the range. Well managed ranges not only allow maximum benefits from the initial burn you install, but helps you effectively use fire as needed for maintenance of range improvements.

Preburn Considerations

Foremost of preburn functions for ranch management personnel is effective implementation of the planning process. First among the planning considerations is the forage needs for livestock, both pre and postburn. Preburn forage concerns result from the need to defer grazing of pastures scheduled for burning to build or retain the necessary fuel load. This means deciding where to place cattle on your remaining range or pasture resources. It would be counterproductive to overgraze some pastures for significant periods in order to build fuel for a fire in another pasture.

Also, it is not recommended that less than an entire management unit be burned because of overuse of forage by livestock on the burned area during the postburn period. If less than a whole pasture is scheduled for the fire, it should be fenced to allow control of the preburn fuel development and recovery

after the burn. Such fencing may be a low-cost, temporary structure which can be easily removed and reused for other areas. Most ranchers, if they begin planning for burns well ahead of the target date, can find places to go with livestock for the 4 to 9 months necessary to rest the pasture to be burned.

The whole idea of building fuel is to use it for the fire, and if you have a successful burn, it will leave the pasture bare. While we have seen very quick recovery of forage on some burns, there is always the chance, because of dry weather, that such areas will require several months for preburn carrying capacity to be reinstated. Even though the dry forage you burned may have been low in nutritive value, it was forage you can't count on until nature replaces it. In the case of late winter burns, regrowth can be fairly well predicted if soil moisture content is good. On summer burns, however, the dry fuel is a product of dry conditions which forced dormancy. Regrowth is dependent on rainfall, which may come promptly, or may not (Fig. 2). In my opinion, ranchers contemplating summer burns should plan for the contingency that significant regrowth may be delayed until the following spring.

Another part of planning is assessing vulnerability to erosion or undesirable vegetation shifts. We are fortunate on the Rio Grande Plains to have fairly level lands, but even so there is a potential for increased soil loss by erosion when the land is bare. Generally steeper slopes will be more susceptible to erosion, and probable length of open soil exposure will be greater from summer than from late winter or early spring burns. A vigorous weed growth can occur on burned areas, depending on weather conditions. We have observed this following late winter burns, for example, when temperatures stayed low and soil moisture high, promoting weed development over grass. It was easily cured in one instance by "flash" grazing¹ to remove the weed overstory, but it takes management observations and timely actions to make the needed moves.

Planning also involves development of the actual fire plan. You are now familiar with the elements of a plan, and why and how it is developed. The sooner the plan can be developed, the sooner you can arrange for specific preburn preparations.

Finally, the costs associated with your burn must be budgeted. Burning costs include those for personnel, costs of deferment and the building of special facilities, such as fencing. There is a too common misconception that burning for range improvement costs little or nothing. It may be less expensive compared to other practices, but it is surely not free. As a manager, you should identify all costs associated with the burning projects and keep track of them for future budgeting and for benefit information.

The ranch will undoubtedly have access to some of the equipment needed for conducting prescribed burns, but it is unusual when additional personnel or equipment is not needed. You should list out the individual items required

¹"Flash" grazing is the use of a high density of livestock on an area for a short time period in order to remove a competing vegetation without significant damage to the desirable species.



Fig. 2. Successful burns leave the pasture bare and require planning of alternate feed sources for livestock.

and assign responsibility to see that they are obtained. This is a part of the planning process, as is assignment of personnel, notification of authorities, and final preburn patrols. We will examine each of these areas briefly as they concern ranch management.

Equipment

A part of working with competent technical assistance early in the planning process will include aid in decisions concerning fire lane needs. For example, location of fire lanes, their width, and possible methods of construction. If you don't have the equipment to do the job, you will have to arrange for it and remember,--timing is an important concern. Fire lanes built too early may have to be re-run prior to the fire. It has worked well for us on several occasions to cut fire lanes immediately prior to the fire and to have the contracted equipment stand by as fire holding equipment during the burn. This adds a measure of safety and allows flexibility in case a late decision is necessary because of wind shifts or other reasons, to add lanes for further division of blocks, and for extra safety precautions.

There is probably no single better piece of equipment for fire lane construction than a maintainer. Your function as management is to nail down the availability of such equipment and to supervise construction in accordance with the fire plan. Most fire lanes can be run on existing right-of-ways or ranch roads, but occasionally they must be built through brush too heavy for a

maintainer without bulldozer blade work, and you need to arrange for such equipment in the correct time sequence. Thus, a maintainer and occasionally a bulldozer, are two primary tools that are not a part of standard ranch equipment needed for many burning jobs. One possible substitute for the maintainer would be a large wheeled tractor and heavy disk plow, but your technical expert can advise you on the suitability of other available equipment (Fig. 3).

Fire lanes can be sources for accelerated erosion the same as any new right-of-way or road cut. In fact, because of the possibility of added runoff from the pasture following burning, erosion can be intensified for a short period. Be sure and make adequate provisions for erosion control structures as you see the need.

Other equipment that you may want to have available includes a pumper truck from one of the local fire departments. In some cases, these trucks can be made available with a crew if adequate lead time for arrangements is allowed. Resupply water source was provided on one job by a large water truck belonging to a drilling company working on the ranch.

An essential part of any prescribed burn is communications equipment. CB radios are excellent. Designated vehicles of the fire crew should be equipped with radios, and hand sets for the fire starters are advisable, particularly for large burns. Most ranches don't have this amount of communications equipment, but can arrange for it with proper lead time.

Ranch owned equipment, such as pickups, cattle sprayers, water barrels and sacks, and hand tools such as shovels, are usually readily available for burn jobs. But, if you wait until an hour before ignition time to congregate this equipment and check it out, you may be delayed. Don't have more equipment than you need on a burn job, but be sure that what you need is on the job and that it works.

Personnel

As ranch managers, you have the job of seeing that the people on your payroll are in the right place at the right time, and that their roles are well identified and fully understood. If you are doing a burning job on your own, it is probable you will be both the boss and the fire boss. However, a crew is quite often made up of people from at least two sources. Your job is to be a part of planning when roles are identified, and to plug ranch people into these required slots with the proper authority to function in their roles. You can't very well exact responsibility without granting authority, and this most often involves providing the necessary time away from other ranch responsibilities. In other words, don't schedule a cattle working on top of a burn. Ranch people must know who the fire boss is and that they are working for him on that day--your job lies in making sure they know from you, first hand, that this is your decision.

You will likely have other people on the scene for large scale burns, such as equipment operators and fire department personnel. As ranch manager



Fig. 3. Maintainers are excellent for most fire lane construction. Equipment needs for ranch burning are part of the planning process.

you have the job of seeing that these folks fit into the overall plan. They know you and are on the ranch at your request. It is your place to coordinate their activities through directions of the fire boss. Just as important as having the required people to properly execute a prescribed burn, is not having unneeded people. Burns have a way of attracting people, and while they may be well-meaning, they can get in the way and cause confusion.

Notification

The function of ranch management in notification is fairly well-defined. You understand the legal requirements involved with permits from the Texas Air Control Board, and such clearance is a ranch responsibility. I would like to address other notifications of burning that are necessary.

First and foremost of folks to notify are your neighbors--especially on the downwind side! We are a fire conscious, in fact, fire fearing people, and excite very easily when smoke is spotted on the horizon. You can cause considerable distress and inconveniences to your neighbors with unannounced fires. You can bet they will come to the scene, and this adds confusion when you need it least. I believe your neighbors also have a right to standby for protection of their own resources in the event of wildfire. I have had a backup crew of neighbors on the other side of a common fenceline for several burns, and I believe we both appreciated this opportunity. What neighbors don't

appreciate is to drive hell-bent to a fire with a crew and equipment that should be doing something else only to find out it is a prescribed burn. The relief to know that the fire is under complete control doesn't totally offset the resentment at being unnecessarily inconvenienced, or not having had a chance to decide on protective measures for their side of the fence.

Another notification I strongly recommend is the sheriff's office. Calls from concerned observers of the fire most frequently come to the sheriff's office. A knowledge of your burning activities can not only dissell undue concern, but also place the county facilities in a better position to assist in control if they are needed. You may want to visit with your county commissioner as to location of this equipment on the day of the burn.

Obviously, your local fire department should be notified if they are not involved directly in the burning activities. Burns near highways should be planned for wind directions which will carry the smoke away from the highway. However, because of the unforeseen possibility of a wind shift, the Department of Public Safety should be notified if the burn is less than a mile from the highway.

There are people on your ranch who may have structures in pastures scheduled for prescribed burns. They should receive notification and perhaps be included in preburn inspections. One such group would be oil and gas leasees where wells or storage facilities are involved. Certainly these people can't prevent you from burning, but they may make needed preparations or even relieve you of certain responsibilities involving their structures with proper notification.

In southwest Texas there are other facilities common to most pastures associated with hunting including stands and sometimes cabins or other buildings. Many stands are on metal legs which would not be damaged by most fires. Some cabins, however, might be vulnerable to damage if vegetation has grown up adjacent to the structure, which is often the case. You might provide fire lane protection for such facilities, particularly if they belong to you, and notify hunters to take their own precautions. Regardless of your attitude concerning hunters' facilities, recognize that they are there and that they constitute part of an asset to your income producing potential.

Preburn Patrols

Preburn preparations may be accomplished over a period of time leading up to the fire. You won't be concentrating entirely on the burn during this time as you go about the multitude of other duties required to run the ranch. This is why a final preburn patrol or inspection is needed. Livestock will probably have been moved out of the area for some time before the burn date arrives, and you should have been able in routine operations to pick up signs of remnants in the pasture or determine if other livestock have slipped in. Satisfy yourself that the pasture is clean.

Preburn patrols should check out protection of such items as feeders which may be in the pasture. These can often be dragged onto tank dams or

other locations safe from the fire. Be sure wooden portions of pens and chutes are adequately protected. Give attention to highline poles in the pasture. These might require fire lane protection and can provide a division in the pasture if desirable. Remember to give poles 360° protection, and not just a fire lane on one side if you are burning on both sides of the line.

Check fence protection along the outside perimeter of the pasture. Ranches often have traps, water lots and wing fences off of pens or traps which may not be noticed in the process of cutting fire lanes on the perimeter and when establishing major inside divisions. Check these out and make a final survey of oil and gas structures and hunters' facilities.

If fire lanes have been completed prior to the final inspection, make sure on the preburn patrol that these lanes are carefully covered for fuel "bridges" the fire might use to escape. Such bridges are simply vegetation which has not been completely removed. Creek bottoms or other low, rough areas and corners where the blade could not cut effectively are the first places to look. Keep in mind that like a chain, a fire lane is no better than its weakest spot. A relatively insignificant looking area of uncut material can carry the fire if conditions are right. You may want to re-run such spots with equipment, or put a crew on them to take them out by hand.

Postburn Considerations

Postburn Patrols

Ranch management responsibilities immediately following the burn begin with postburn patrols. Once the main body of the fire has burned out, your attention can be diverted from concern about direct control to assurance that the pasture can be left without further concern for danger. It may be a relief to know that the initial burn has been successfully contained, but this should not lead to complacency about the remaining threat as long as live coals are adjacent to unburned pastures. In fact, the danger can be greater if crews and equipment are dispersed too early.

Burning is usually done with winds in the range of 6-15 mph. However, we have seen on several occasions where winds were kicked up from nearby thunderstorms after a burn, or by frontal passage. These wind speeds may gust to 30-40 mph, creating a whole new situation as concerns the movement of firebrands out of the burned area. Burning logs and smoldering piles well within the burned pasture present very little threat except in the most severe conditions. Attention can be focused on the outside pasture perimeter where long-burning materials are separated from fresh fuel by only a few feet of fire lane. Postburn patrols can effectively put out such fires by wetting them down, covering them with soil, or opening them up so that they will burn out quickly while under surveillance. Some ranchers post a night-long patrol on burned areas where threat to homestead and headquarters facilities is great.

Another function of postburn patrols is to check protected facilities in the pasture, such as fence posts and highline poles (Fig. 4). This crew should finally make a complete check of all water gaps and fences where livestock from adjacent pastures could get in.



Fig. 4. Failure to adequately protect facilities in burned pastures can be costly and embarrassing.

Postburn Control

The biggest element of postburn control is grazing deferment and close control of grazing for the growing season following the fire. Burned areas are particularly vulnerable to heavy overuse by livestock. All vegetation is fresh, succulent and highly preferred by livestock over the same species on unburned areas. Deferment should provide time for the key species on the area to establish adequate leaf area and reinstate vigorous growth. It is difficult to predict a specific time for this requirement, since a lot depends on rainfall following the burn. There is no substitute for close observations by ranch management to decide when the burned area can be reopened for use. If less than an entire pasture is burned, and stock are placed in the pasture, the burned portion is invariably grazed heavier than unburned areas. Management must decide essentially on whether to give up the whole pasture, fence off the burned portion or key grazing use only to the burned portion.

You should watch the vegetative composition shifts very carefully following burning. We have seen desirable grazing plants increase in abundance following burning. This usually dictates a reassessment of the key species to use for determination of range proper use. If the burn is not separately fenced, you may use the burned area as the key grazing area and pick a key species on this area to use for deciding when to move livestock. It should be repeated that burning of entire pastures, or the use of temporary fencing, is the most practical management solution.

Grazing Systems and Burning

Much burning will probably depend on decision deferments to build fuel and provide postburn rests, rather than systematic grazing management schemes. This type of deferment usually means that a decision must be made each time as to where to move stock, unless you provide a reserve pasture for such use. Reserve areas of forage are always good insurance, and many ranches have pastures or even cropland that can accommodate the stock from an entire pasture for extended time periods.

There is one systematic grazing approach that is particularly well suited to "building in" prescribed burning or other range improvement practices which require deferments. The system is short duration grazing (SDG), a one herd system featuring short grazing periods and building adequate rest periods through the use of several pastures. The more pastures available for the herd, the longer the rest before grazing again occurs on the same pasture. Pastures can be selected for burning simply on the basis of time required to building adequate fuel load since the last grazing use. The deferment is automatic, since only one pasture in the system is being used at one time. If necessary, the burned pasture can be skipped in its regular grazing rotation to allow adequate postburn deferment. This reduces the rest period on the other pastures by the length of grazing time allotted to the burned pasture, but would likely be insignificant where 120-150 day rest periods are involved. For example, in an 8-pasture system with 140 days of rest and 20 days of grazing, the rest period would be reduced to 120 days for one cycle by skipping any one pasture in the rotation (Fig. 5).

A Merrill 4-pasture, 3-herd system is perhaps less likely to conveniently accommodate needed preburn and postburn deferments. Assuming, however, that fuel load was sufficient at the end of a grazing period, the regular deferment could be used to rebuild forage. Another alternative would be to hold cattle out of the deferred pasture for longer than the normal four month rest period. With the exception of SDG systems, it is probably better to reserve extra forage requirements in a supplemental pasture. Each ranch is different and management must work out the specific details to best fit the situation.

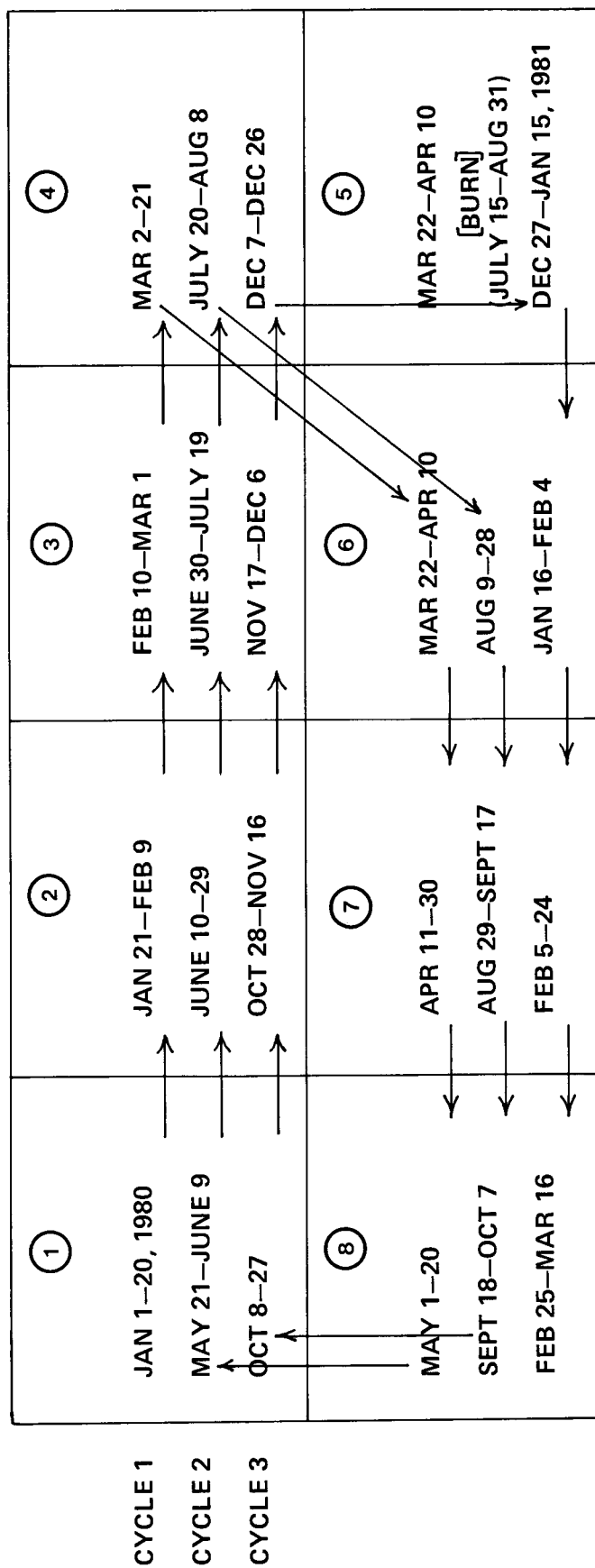
Summary

Burning is really no different in the demands on ranch management than any other range improvement practice or other elements of general ranch operations. It requires planning, organizing, staffing, direction and control. These are the basic functions of all managers.

If burning has a current uniqueness, it is because it is "new" as a range improvement technique because of renewed interest and is assumed to be a greater risk than other accepted practices. We have all become largely dependent on contractors for mechanical and chemical brush control methods. Burning, on the other hand, can be done by ranch personnel and will involve us more directly until contractors become available.

There is a real opportunity to get in on the "ground floor" of burning technology and add the benefits from prescribed fires to your alternative methods for long term range improvements. The key to success for you will be your management skills as they are applied to the practice in your own ranch environment.

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