# Fire as a Tool to Manage Tobosa Grasslands

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Tobosa grass (*Hilaria mutica*) is a dominant of the Southern Desert Plains of North America (Clements and Shelford 1939) and is the climax on adobe soils (Campbell 1931). Moreover, it is a productive grass type (Paulsen and Ares 1962) that is regarded by southwestern ranchers as a "reserve" feed during dry years. Tobosa is otherwise a coarse grass, generally unpalatable (Heirman 1971), and builds up huge amounts of litter (Wright 1969).

Mesquite (*Prosopis glandulosa* var. *glandulosa*) associated with tobosa communities is a real problem to grazing management (Fig. 1). Soils are cold and very few trees can be root-killed by spraying with 2,4,5-T (Dahl 1971). After trees are sprayed, standing dead stems still reduce the ease of handling livestock. Five to 6 years later, new resprouts thicken mesquite brush to the point that it is almost impossible to penetrate. Lotebush (*Condalia obtusifolia*), which cannot be killed with 2,4,5-T, is a crown and a root sprouter. It continually remains as an explosive occupant in tobosa communities where mesquite is being controlled, especially in dozed or rootplowed areas.

Frequently cactus (*Opuntia engelmannii*), cholla (*Opuntia imbricata*), and tasajillo (*Opuntia leptocaulis*) become very thick in these communities and the spines cause some livestock losses. Other undesirable range plants include annual weeds, particularly annual broomweed (*Gutierrezia dracunculoides*).

The objective of this study was to determine the feasibility of using

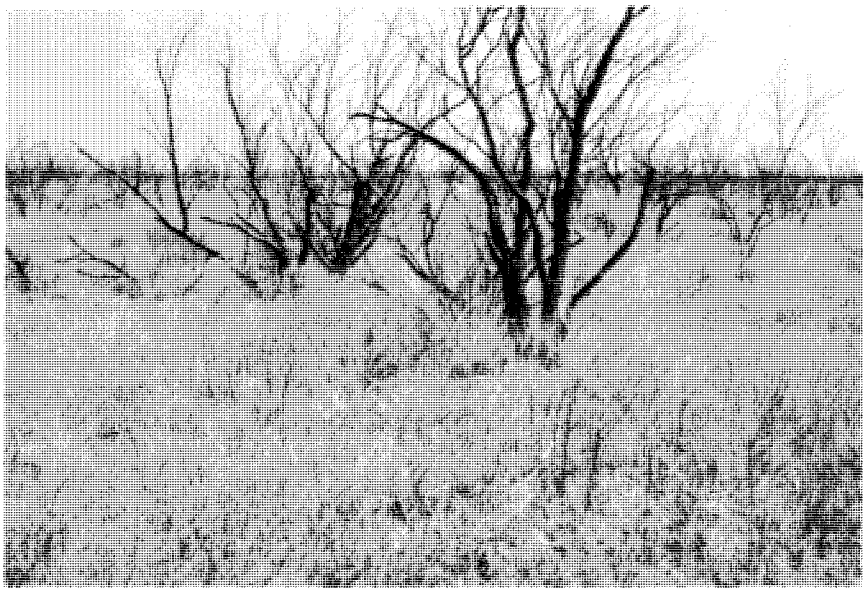
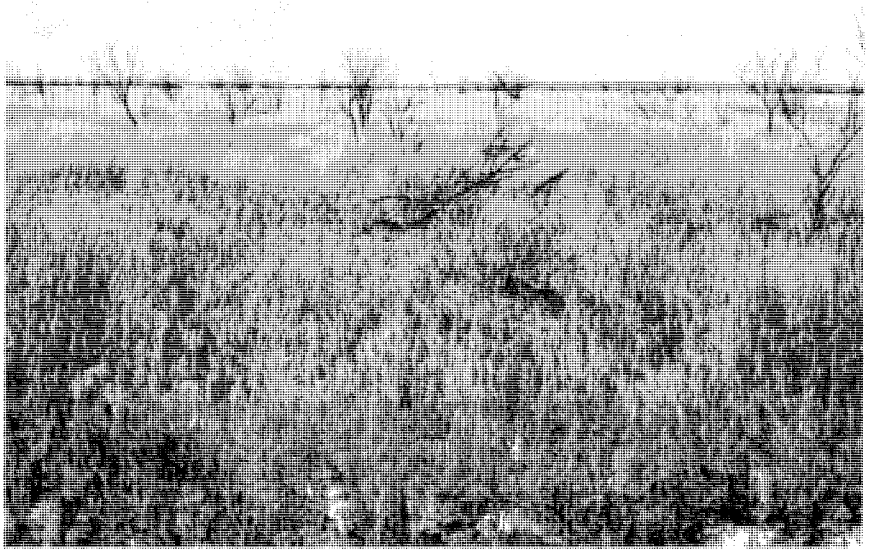


FIG. 1A. View of a mesquite-tobosa grass community at Colorado City, Texas before burning. Tobosa fuel is 4,668 lbs/acre.

FIG. 1B. The same area on 15 July 1969, 3½ months after burning. Burndown was 69 percent and yield of tobosa grass was 2,813 lbs/acre compared with 1,128 lbs/acre on the control. The plot was burned with a 9 mph wind, 23 percent relative humidity, and 84 F air temperature.



fire as a management tool in mesquite-tobosa communities. Specific objectives were: 1) to determine the short-term and long-term effects of fire on tobosa yields in relation to winter and spring precipitation; 2) to determine the long-term effect of fire on mesquite mortality, and 3) to develop prescription burning techniques for all types of mesquite-tobosa communities. In this paper, utilization of tobosa, the effects of fire on annual grasses and forbs, and mortality of cactus species will be reviewed.

## METHODS AND PROCEDURES

Yields on pure stands of tobosa were measured on burned and unburned plots at seven locations in west Texas: two near Post, one about 15 miles east of Guthrie, one about 7 miles north of Quanah, two 15 miles south of Colorado City, and one 5 miles south of Garden City. The most intensive research has been concentrated at Colorado City. Only one site at Post is on the High Plains, the rest are on the Rolling Plains.

All plots were burned in late winter or early spring from 28 February to 7 April 1968–1972. Burning is concentrated in the spring for three reasons: 1) ranchers can decide whether they need tobosa as a reserve feed and are willing to burn at this time if they do not need it; 2) an evaluation of adequate soil moisture for plant regrowth can be made, and 3) top removal of the dormant tobosa should be least harmful.

Size of the burned plots varied from 1 to 2,000 acres; a total of 45 plots and 7,250 acres were burned over a 5-year period. Elevation varies from 1,620 to 2,880 ft, and precipitation averages about 19 inches per year. The vegetation at each location was nearly a pure stand of tobosa grass with a few annual forbs.

Mesquite also existed on all plots. On most plots the mesquite had been sprayed in 1965 or 1966 with very little root-kill. On three plots, Garden City and the two areas at Post, mesquite had no prior treatment. To measure mortality and the long-term effect of fire on mesquite, 1,200 trees that had been sprayed with 2,4,5-T in 1966 were permanently marked at Colorado City in 1969.

Ten quadrats ($1 \times 2.4$ ft) were clipped to sample current growth

and litter on burned and unburned plots at each location. Vegetation at all sample locations was clipped in late July. Samples were oven dried and weighed.

## RESULTS AND DISCUSSION

### Tobosa Yields

Based on data from 11 burns that encompassed seven locations over 4 years, the first year's production of tobosa following burning averaged 2,195 lbs/acre compared with 1,165 lbs/acre on the unburned controls (Fig. 2). These yields were harvested in July and do not include fall growth. Normally, an additional 20 percent growth takes place in the fall.

Following the initial burn, increased yields of tobosa last for several years (Fig. 3). An extrapolation of the percentage increase in Figure 2 indicates that equilibrium is reached at about 5 years

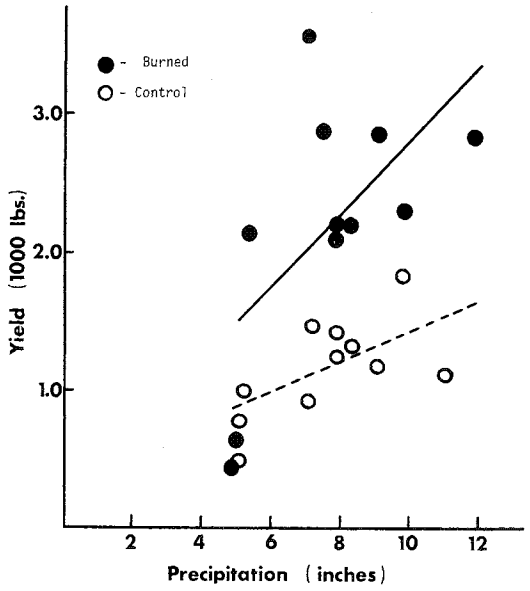



Fig. 2. Yields (lbs/acre) on 3 to 4 month-old burns in relation to the amount of spring precipitation (1 March to date of clipping).

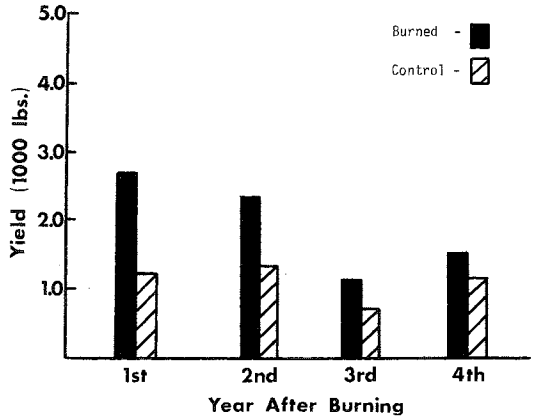



FIG. 3. Long-term effects of fire on tobosa yields (lbs/acre) compared with unburned areas. These data are an average from four locations—Post I, Post II, Guthrie, and Colorado City.

(Fig. 4). However, this is an average and is not necessarily typical of what will happen during a particular year. For example, if drouth sets in, there will very likely be less growth on the burned than on the unburned site for that growing season (Table 1). But when rain comes, the burned areas recover very rapidy and generally outproduce the control (see footnote below Table 1).

During "wet" springs, tobosa yields increase dramatically on burned sites (Fig. 2). On bottomland sites, where flooding occurs, we have measured yields as high as 3,572 lbs/acre 3 months after burning. Even during drouths, bottomland sites seem to get enough runoff moisture to produce close to 3,000 lbs of forage per acre. On

TABLE 1. YIELD (LBS/ACRE) OF TOBOSA BEFORE (1969 AND 1970) AND DURING A DROUTH YEAR (1971) ON TWO UPLAND TOBOSA SITES.

| | Site 1 | | Site 2 | | Site 3[a] | |
|---|---|---|---|---|---|---|
| Year | Burn (1969) | Control | Burn (1970) | Control | Burn (1971) | Control |
| 1969 | 2813 | 1128 | — | — | — | — |
| 1970 | 1400 | 998 | 2139 | 998 | — | — |
| 1971 | 844 | 954 | 801 | 954 | 625 | 768 |

[a] Following 17.55 inches of rain during late summer and fall, on 11 November 1972 the burn was producing 3,731 lbs/acre and the control was producing 3,152 lbs/acre.

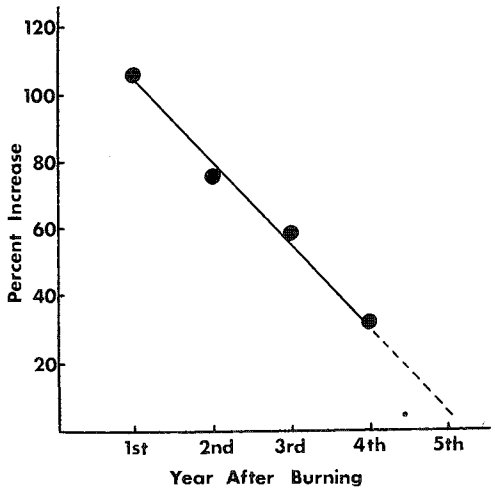



FIG. 4. Percent increase of tobosa (current growth) on burned vs. unburned areas in relation to year after burning.

upland sites, however, this is not true. Production is severely reduced during drouths and burned sites do not appear to retain much of the precipitation from intense rain storms.

Most of the increase in tobosa yields following burning has been attributed to the removal of litter (Wright 1969). Increased fertility following burning also seems to be a factor, but we are not sure how much. In one of our earlier studies we attributed 13 percent of the increased production following burning to fertility (Wright 1969). But a current study indicates that in some years fertility may be a much greater factor. For example, last fall we had a lot of rain and tobosa produced as much as 2,500 lbs/acre. This spring the control tobosa plots are producing very little while the burned plots are growing very well. My reasoning at this time is that a lot of nitrogen was tied up in last fall's growth, whereas our spring burns released a lot of this nitrogen.

The continued increases in forage yields for the third and fourth year after burning (Fig. 3) are difficult to explain. Possibly, this is a reflection of reduced competition from mesquite. However, I have never really felt that our species of mesquite with its lacey canopy

was a severe competitor with grass. It may be, and only longer term studies will enable us to find out.

Litter build-up is very fast during the first three growing seasons after burning (Fig. 5), then the rate of recovery levels out. It may take 5 years for full recovery, the same length of time that we project yields of tobosa on burns will approach that of yields on unburned controls. This suggests that reburns should be conducted every 5 years. Based on a litter recovery of 4,000 lbs/acre, we are tentatively recommending reburns on an interval of 4 to 7 years (tempered with prevailing precipitation patterns).

## SEASON OF HERBAGE REMOVAL

From 1 May 1968 to 1 April 1969 we conducted a 12-month clipping study to see if season of top removal would have a significant effect on the following seasons production of tobosa (Wright 1969 b). In general, season of top removal had very little effect on the following season's production. Only the current year's production was reduced due to clipping.

Clipping, however, does not have the same effect as burning on tobosa. The rosette forbs beneath tobosa litter during February—and

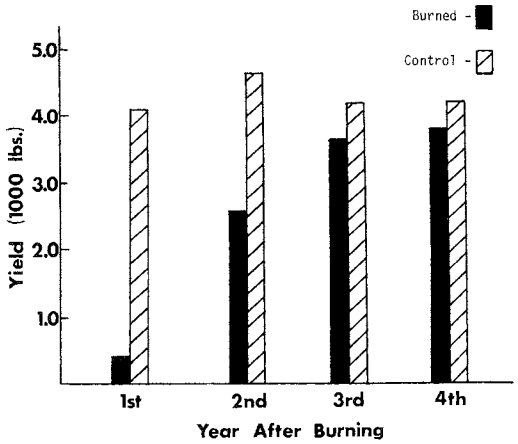



FIG. 5. Rate of litter build-up on tobosa burns compared with unburned areas. These data are an average from four locations—Post I, Post II, Guthrie, and Colorado City.

to some extent during March—are not removed by clipping, but they would be killed by burning. Thus, the forbs are given a competitive advantage by clipping during these months and slightly reduce tobosa yields.

Data from this study together with data from spring burns suggest that tobosa can be burned throughout the year without reducing the following year's yield. All clipping treatments, except the February treatment, produced more than the control. Since burning during February increased the yield of tobosa when compared with the control, herbage removal by burning during anytime of the year should not harm the folowing year's production of tobosa. Only the current season's production will be reduced, if burned between 10 April and 15 November.

## ANNUAL FORBS AND GRASSES

We have not taken intensive data on forbs following burning in the tobosa communities. However, there is no question that our spring burns harm cool season plants (predominantly annual forbs and grasses) and favor the warm season plants (perennial grasses). Annual broomweed (*Gutierrezia dracunculoides*) is our major winter annual in tobosa communities and is essentially eliminated for the first 2 years by spring burning (Wright, 1969 a). Similarly, little barley (*Hordeum pusillum*) and Carolina canary grass (*Phalaris carolinaiana*) are drastically reduced by burning.

Eliminating our winter annuals is not entirely desirable because they are preferred by livestock during winter months. Thus, livestock will avoid burned tobosa sites after frost in the fall until greenup in spring. Also, many species of wildlife are dependent on some forb species. For these reasons, we do not recommend burning an entire pasture of tobosa; probably no more than half of a pasture should be burned at any one time, as the annual forbs and grasses should be well on their way to recovery before the other half is burned.

## MESQUITE MORTALITY

Mesquite, the most prevalent shrub or tree species in the southern mixed prairie is moderately affected by fire, depending upon its age,

its origin, its history, and the amount of fine fuel available for burning (Wright 1971). Green mesquite trees that have not been top-killed are very difficult to kill with one fire unless they are very young (Fisher 1947; Cable 1967; Wright 1971). However, if the trees have been top-killed by a previous fire, drouth, or herbicide, they become more susceptible to fire damage. Following an initial top-kill by spraying, mortalities from 6 to 44 percent on mesquite trees have been obtained with one burning, the larger trees being more easily killed (Britton and Wright 1971).

Trees which have been top-killed by drouth, fire, or a basal diesel treatment are heavily infested with insect borer activity which greatly reduces ignition temperature and ignition time (Burton, Portnoy, and Wright 1972). This seems to be one of the reasons why we can kill mesquite by burning at Colorado City, but not at Post, Texas. Insect borers are present at Post, but relatively little bored wood can be found. At Colorado City many trees with multiple trunks of bored wood are prevalent. Another reason why I think that we can kill mesquite more easily at Colorado City than at Post, Texas is that there may also be a genetic difference between mesquite on the High Plains and the Rolling Plains. For example, the High Plains ecotype, when grown from a seed, produces multiple stems whereas ecotypes near Austin produce only single stems (McMillan 1971). This may mean that the High Plains ecotype has adapted to frequent fires and is a much better resprouter than the Rolling Plains ecotype.

On a long-term burning study in the Rolling Plains near Colorado City, we have shown that the mortality of mesquite trees from one fire, previously top-killed by spraying, was 10.8 percent the first year, 17.7 percent the second year, and 22.4 percent the third year. Obviously, fire alone does not kill these trees. Fire, drouth, insects, and competition from grass all work together to kill mesquite. In my opinion, competition from a good grass sod is the most essential requirement for fire to effectively harm mesquite. During periods of drouth, the effect of fire on mesquite mortality may be magnified by its interaction with drouth, although Albertson and Weaver (1945) have shown that drouth alone can kill trees.

## CACTUS SPECIES

Cactus (*Opuntia* spp.) is not as well adapted to fire as most of the woody plants (Wright 1971). Tasajillo (*O. leptocaulis*) is easily killed by fire; 85 to 90 percent mortality often results following fire. Pricklypear (*O. engelmannii*) and cholla (*O. imbricata*) are moderately harmed the first year after burning, but continue to die in years following the burn primarily because of increased insect activity. Heirman (1971) found that 32 percent of the pricklypear plants were dead by the end of the first growing season after burning in tobosa communities; by the end of the second growing season 82 percent had died. Similarly, 19 percent of the cholla had died by the end of the first growing season and 62 percent had died by the end of the second growing season.

Heirman's study on cactus species was conducted during a mild drouth, which probably had an effect on mortality. We felt that the high mortality on pricklypear and cholla was an interaction of fire, drouth, insect activity, and rodent activity, but we need more information during wet years.

## UTILIZATION OF TOBOSA

Cattle will intensively eat tobosa grass on burned plots from 15 April to 15 June in preference to buffalograss (Heirman 1971). During the spring of 1971 at Post, Texas on the High Plains, cattle ate 1,852 lb/acre of toboca on the spring burn whereas they ate only 122 lb/acre on the control. Then during the summer the animals seem to avoid tobosa and came back to it in the fall when new growth appeared. During the winter they again avoided tobosa.

Since cattle do not normally eat much tobosa (caged and uncaged plots at Colorado City in 1970 indicated that cattle did not eat any tobosa on control plots during spring months), the increased use following burning is a good way to make use of a very productive grass species and relieve grazing pressure on the more preferred species, such as buffalograss. Such a management practice could improve range condition substantially, provided stocking rates are not increased. However, the primary benefit from burning is derived the

first growing season after burning. Cattle eat very little tobosa the second spring after burning unless it was grazed heavily the first year.

We recommend grazing tobosa immediately after spring burning. The reason for this is that it is a very coarse grass, and we cannot otherwise get cattle to eat it if we rest it for 3 to 4 months after the burn; they must be able to eat it while it is young and tender. This is an unusual recommendation in the management of a grass species following burning. For most species, we recommend no grazing until at least 4 months after the burn.

## BURNING TECHNIQUES FOR TOBOSA COMMUNITIES

We have been developing burning techniques for tobosa communities for 5 years. They have now been tested a) during wet winters followed by wet springs, b) during wet winters followed by dry springs, and c) during dry winters followed by dry springs. To effectively burn down dead mesquite stems, relative humidity must be below 40 percent, wind velocities must be 8 mph or higher, and fine fuel (grass) should be above 3,000 lbs/acre (Britton and Wright, 1971).

The following general formula by Britton and Wright (1971) has proved accurate and reliable in predicting burndown:

$$Y = -3.95 + 3.13X_1 - 0.83X_2 + 0.01X_3 \; s_{y.x} = 7.6\%$$

where,

$Y$ = Percent burndown,
$X_1$ = wind speed in mph,
$X_2$ = Percent relative humidity,
$X_3$ = Total fine fuel in lb/acre

If the mesquite has been chained before burning, we can get effective burns with 2,000 lbs/acre of fine fuel, provided wind velocities are above 8 mph and relative humidities are 20 to 40 percent (Heirman 1971). With 5,000 lbs/acre, we can easily burn chained logs with almost no wind and 50 to 60 percent relative humidity.

By using sheets of 4 ml plastic to measure firebrands, we have es-

tablished that mesquite and tobosa grass are relatively safe fuels to burn. We have not been able to measure any firebrands farther than 10 feet from the leading edge of the fire. Mesquite is a hardwood and burns slowly while tobosa grass burns very quickly.

The primary dangers in burning tobosa communities come from broomweeds and firewhirls. Broomweeds burn off at the base and then tumble across pastures with the base generally oriented toward the wind, thus remaining hot. However, we have never had a spot fire start from tumble weeds. We have had two fires start from firewhirls. Generally, firewhirls develop where wind shears occur such as a headfire running into a backfire, or a fire burning up slope into a wind. Our two fires that started by firewhirls, were caused by headfires running into backfires while winds were 10 to 15 mph.

Firewhirls can develop very easily under unstable conditions when winds are less than 5 mph. We had a huge firewhirl develop under these conditions in the middle of a 1,000 acre burn, but it did not give us any problems because it was in the middle of the fire. Firewhirls will rarely develop in grass fuels when winds are above 8 mph unless there is a windshear. When burning a large pasture, I feel much safer with a wind than without a wind.

Using our basic data, we have developed the fire plan for tobosa as shown in Figure 6. After the firelines are cut, a 100 foot strip on the north and east sides are backfired with winds less than 8 mph and with relative humidities between 50 and 60 percent. The fire is very docile under these conditions and if a spot fire occurs, it is easy to put out.

After the north and east firelines have been burned the main portion of the pasture is burned with a headfire and with a southwest wind averaging from 8 to 15 mph (gusts to 20 mph). Relative humidities should average from 25 to 40 percent. Firebrands that can be observed from such a fire carry no further than 30 to 40 feet and are no problem in tobosa; thus we have had no problems with firebrands. However, personnel patrolling fires should watch carefully for rolling broomweeds.

Using this technique of prescription burning, we have had no problems of any kind with firebrands, broomweeds, or firewhirls during the past three burning seasons. This included several burns during

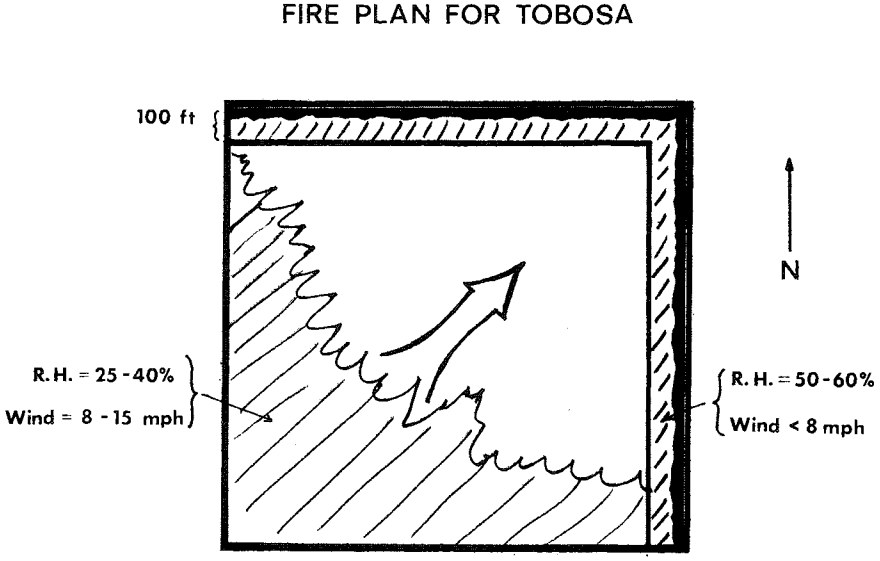



FIG. 6. After fire lines are cut, a 100 foot strip on the north and east sides of a pasture are backfired with winds less than 8 mph and with relative humidities between 50 and 60 percent. Then the pasture is headfired with a southwest wind averaging from 8 to 15 mph (gusts to 20 mph) and relative humidities from 25 to 40 percent.

the drouth of 1971. We use from four to six men to conduct burns in tobosa communities.

Fires should not be conducted when soils are dry or when we are in an extended drouth. Burning under extremely dry conditions increases drouth stress on plants and increases the possibility of serious erosion by intense late spring and early summer rains.

When soil is wet at the time of burning, new growth begins immediately and adequate vegetation plus unburned plant material is available to protect soil from intense late spring rains. Also, after burning, tobosa produces two to three times its normal production during wet years, but during dry years yields are reduced slightly (Table 1).

## COSTS TO BURN

Burning mesquite-tobosa communities can be done at a cost of $0.25 to $1.00/acre, less than one-third the cost of chemical treat-

ments or chaining. Cost figures are based on a minimum of 640 acres and they include $0.12/acre to cut firelines. If the rancher does the burning himself, he can do it for $0.25/acre. If a contractor is hired to do the burning, he would likely charge about $1.00/acre.

## CONCLUSIONS

Decadent stands of unpalatable tobosa can easily be made productive and palatable by burning during a wet spring. Moreover, spring burning will control broomweeds, reduce numbers of cactus plants, and kill some mesquite trees. If done properly, dead mesquite stems can be burned down to make the gathering of livestock easier. Green stems which do not burn down deteriorate very rapidly after burning, which is not true for green stems that have been sprayed with 2,4,5-T.

During wet springs, tobosa will produce up to three times more herbage after burning than the control. By contrast, during dry springs it will produce slightly less than the control. Long-term yield studies show that tobosa burns continue to produce more than the controls, even the fourth year after the burn. However, the trend indicates that equilibrium will be reached about 5 years after burning. We tentatively suggest reburning tobosa 4 to 7 years after the original burn, depending on how soon 4,000 lbs/acre of litter builds up.

The ideal conditions for burning down mesquite stems are wind velocities of 8 to 15 mph, relative humidity of 25–40 percent, and fine fuel (grass) in excess of 3,000 lbs/acre. With less than 3,000 lbs/acre of fine fuel, the area should be chained before burning. About 70 percent of the chained logs can be consumed with 2,000 lbs/acre of fine fuel.

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