Effects of Burning and Clipping at Various Times During the Wet Season on Tropical Tall Grass Range in Northern Australia

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The beef cattle industry in the northern part of the Northern Territory is based on grazing of native vegetation under open-range conditions. Frequent burning of the range is a common practice in the region. In 1958-59, an experiment was carried out on the Katherine Research Station to examine some effects of burning at different times on the native range.

The climate of Katherine can be described as tropical savannah. The year is divided into two distinct seasons—a warm, dry winter season from about May to September and a hot summer period from October to April. Virtually all of the rainfall is received in the summer months, mostly from December through March. The average annual rainfall is 36.45 inches. Maximum temperatures range from 85-90°F in June and July to 100-105°F in October and November.

The experiment was located on Tippera clay loam soil, a lateritic red earth developed on hard Cambrian limestone (Stewart, 1956). Other soil types in the area support a similar type of vegetation.

The range type in this area is "tropical tall grass" (Christian & Donald, 1950). The tree cover is a low, open forest mainly of *Eucalyptus* spp. (Figure 1.). The herbaceous vegetation is composed of 90 per cent tall, perennial bunch-grasses, and 10 per cent broadleaved species and annual grasses.

Almost all growth takes place during the wet season. The perennial grasses are in a state of dormancy at the end of the dry season, but with the onset of

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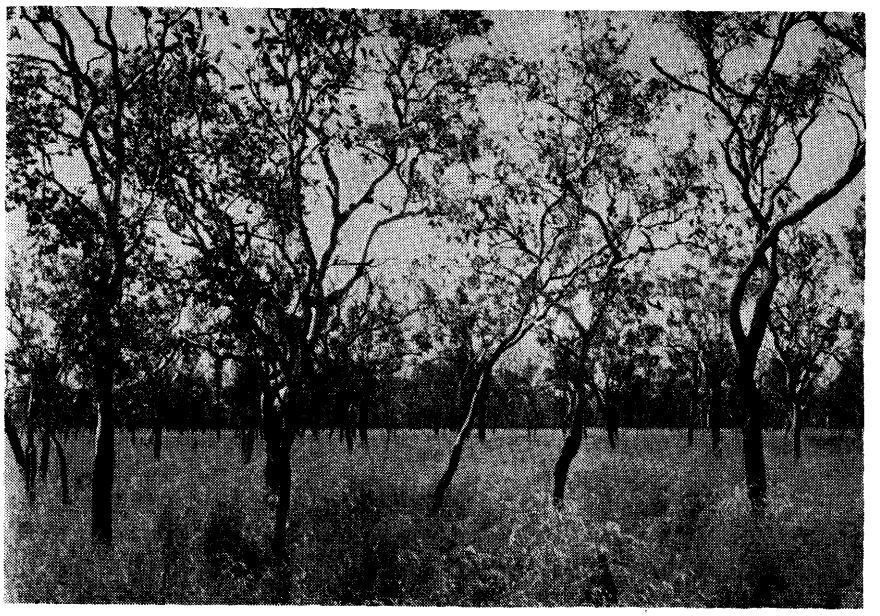

FIGURE 1. Native pasture in the Katherine region.

effective rain in November or December they make rapid growth. This continues until the setting of seed in January and February and then the rate of growth slowly declines until the end of the wet season (Arndt & Norman, 1959). The principal grass species are *Chrysopogon fallax, Themeda australis,* and *Sorghum plumosum.*

Most of this tropical tall grass range is burned annually or biennially. Burning occurs throughout the dry season, much of it being done deliberately by stockmen at the end of the wet season in order to provide a "green shoot" for the cattle. This succulent, green regrowth is usually only of the order of 100-200 pounds per acre (Arndt & Norman, 1959). If the range is burned later the regrowth may be negligible and the ground remains bare until the onset of the following wet season (Figure 2). There are, however, several arguments in favour of burning under the present extensive system of management. (1) Experiments at Katherine have shown that cattle gain more during the wet season on range that was burned during the previous dry season than on unburned range (Norman, personal communication). The better rate of gain could very well be due to the increase in crude protein percentage brought about by burning as shown in Table 2. At the present time, the palatability and nutritive content of the forage are more important than the total amount of forage produced because the stocking rates are so low that only a small fraction of the forage is ever consumed by livestock anyway. (2) When range is grazed for several years without burning, an extremely uneven grazing pattern is produced because cattle tend to return to previously grazed areas for the more palatable regrowth. Burning tends to eliminate this pattern. (3) Protection from fire causes a build-up of dead grass and litter which increases the danger of accidental fires. These fires could be very hot and possibly more destructive in the long run than more frequent but much less intense and more easily controlled planned fires. (4) Under the present extensive system of livestock management, burning at the end of the wet season makes the job of rounding up cattle much easier since they tend to congregate on the burned areas. (5) Frequent fires possibly control ticks to some extent.

Arndt and Norman state that "It is possible to burn in the middle of the wet season during dry spells if the pasture is carrying the previous year's growth, and the yield of fresh grass in this instance may be appreciable."

With this in mind it was decided to burn plots at intervals throughout the wet season to see what time of burning produced

FIGURE 2. Native pasture in the Katherine region after burning.

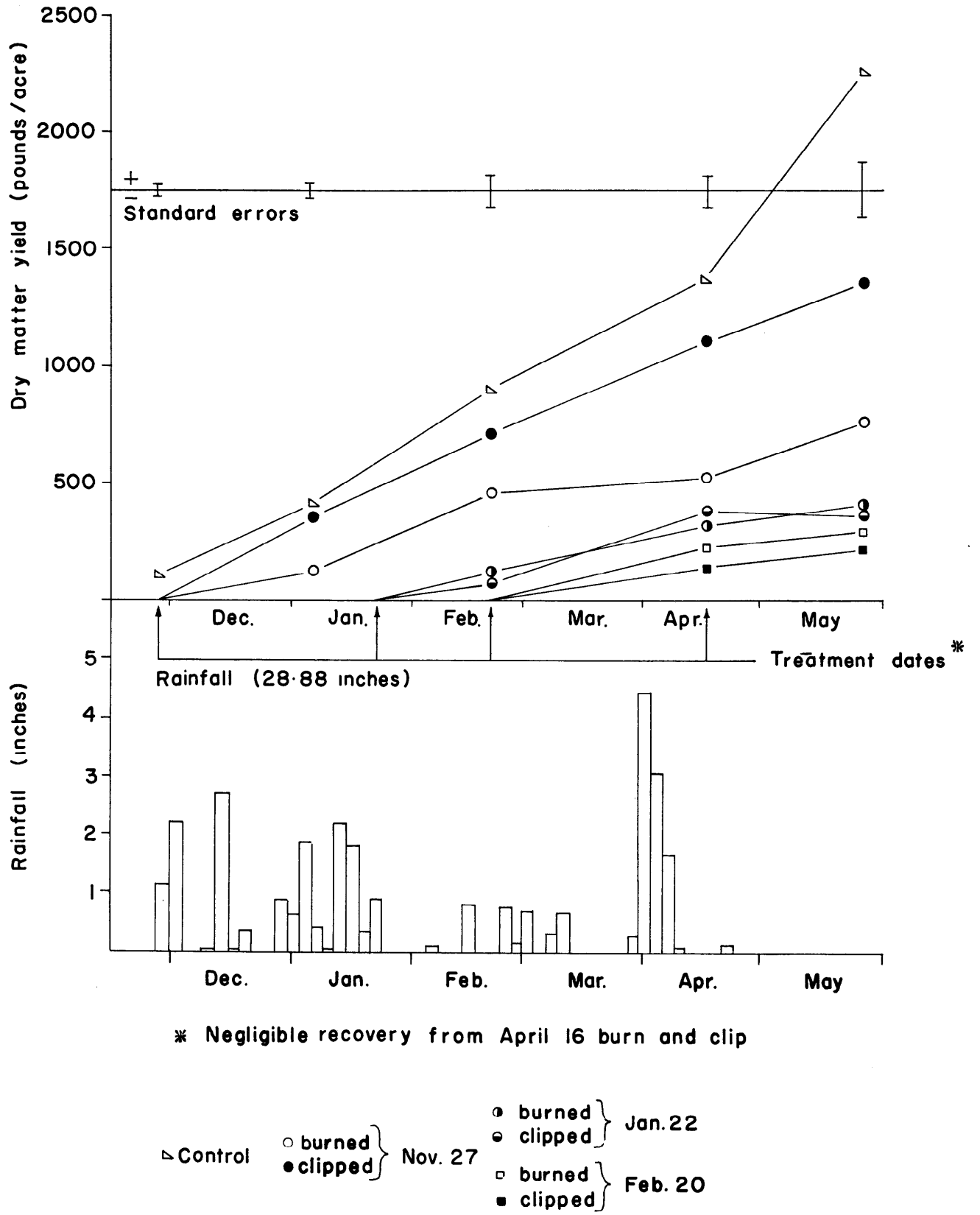

Figure 3. Forage production at different dates after burning and clipping, and rainfall by 3-day periods.

the most favorable combination of quantity and quality of forage available for use during the dry season. It was also planned to clip and rake duplicate plots in order to see if defoliation by burning had a different effect from defoliation by clipping with respect to total herbage yields and botanical composition.

Method

The plots were located in a paddock which had been unburned for at least two years and had had only occasional light grazing in the previous two years.

The burning was done at approximately six-weeks intervals through the wet season depending on the weather. Rain delayed burning on two occasions with the result that only four burns were made rather than the five that were planned. The clipping was done with a power driven, sickle-blade mower. The cut was made about 1½ inches above the ground and all cut material was raked off the plots.

The experiment was a split-plot, randomized block arrangement with three replications. Dates of treatment applied to the main plots which were split for burning and cutting. Each plot measured 10 by 20 yards. One pair of plots in each replicate remained untreated as a control.

The weight of the current year's forage on the plots was determined by clipping and weighing the vegetation on three randomly located yard-square quadrats on each plot ranked in sets of three (McIntyre, 1952). The clippings were separated into the three main grass species, *Chrysopogon fallax, Sorghum plumosum, Themeda australis,* and other species. All weights are on an oven dry basis. The sampling was done just prior to each treatment and once at the end of the season. At each date the plots sampled were: (1) the control plots, (2) all plots which had been treated, and (3) those plots to be treated on the date of sampling.

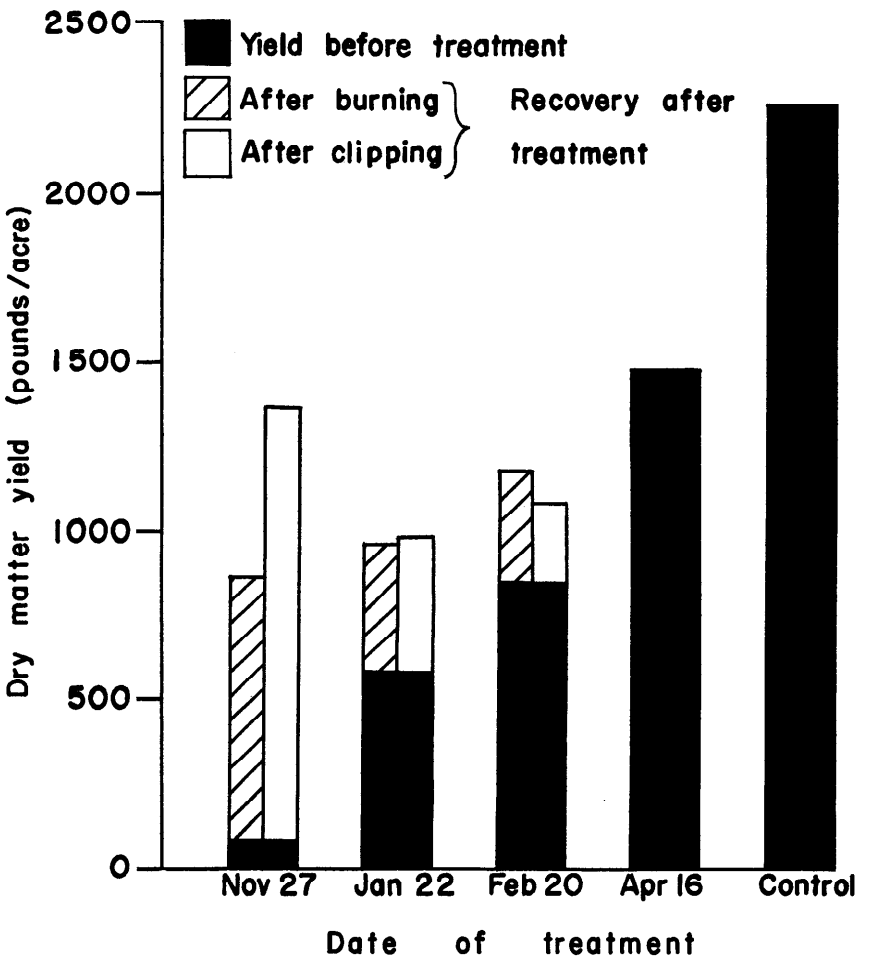

FIGURE 4. Effect of date of burning and clipping on total forage yield.

A sample was retained for nitrogen analysis from the plots sampled at each date. This was not separated into species.

In January it was noticed that wallabies were attracted to the treated plots, particularly the burned ones. In January a netting fence was erected around the plots which had been burned. A close watch was kept on the clipped plots and on the plots which burned later, but no further excessive grazing by wallabies occurred. The fences were removed immediately after the April treatment.

Results

The course of dry-matter increase from the date of burning and clipping on treated plots in comparison with that of the control is shown in Figure 3. The average rate of forage production appeared more or less constant throughout the sampling period with the exception of the control at the end of the season, but dry matter increase had in fact virtually ended by early May.

The treatments greatly reduced the response of vegetation to late rains. The control plots showed considerable increase in forage production just after the wet spell in April, but none of the treated plots showed much response. The plots treated in

Table 1. Effect of burning and clipping on botanical composition.

Species	Untreated	Burned	Clipped
	(percentage of total dry weight)		
Chrysopogon fallax	29±3.0	54±3.6	52±4.5
Sorghum plumosum	34±2.9	21±2.6	13±2.4
Themeda australis	31±3.6	14±2.8	27±3.7
Other species	6±1.2	11±2.1	8±2.2

April failed to produce any measurable regrowth, even though treatments were applied only a week after the rain stopped.

Total yields (pretreatment yield plus regrowth) on the burned plots increased with later dates of burning (Figure 4.) The total yield of plots clipped in November was greater than that of plots clipped in January, but thereafter total yield increased with later dates of clipping. The yield of the plots cut in April was about the same as that of plots cut in November. However, the increases in total yield on both the clipped and burned plots were due almost entirely to increasing pretreatment growth, rather than increasing regrowth. The control plots produced far more than any burned or clipped plots.

The effect of burning and clipping on percentage composition by weight of the major species is shown in Table 1. The figures for treated plots were arrived at by averaging the percent composition of all plots after treatment. The figures for the untreated range are the average of the control plots and the pretreatment composition of the treated plots.

The percent composition by weight of *Chrysopogon fallax* was greatly increased by both clipping and burning. The percentage of *Sorghum plumosum* was reduced by more than one-half on the clipped plots and by about one-third on the burned plots. Clipping did not significantly affect the percentage of *Themeda australis* but burning reduced it by about one-half. Other species increased their percentage of the total yield on both the clipped and burned plots. The percentage of *Sorghum plumosum* on the control plots increased considerably from the April 16 sampling (29 percent) to the May 26 sampling (42 percent), showing that the increase in forage production on the control during that period (Figure 3) was composed largely of *Sorghum*.

The regrowth from clipped and burned plots showed a higher crude protein content than the forage on the control plots at all sampling dates. The total yield of crude protein per acre was approximately the same from all treated plots, regardless of date or method of treatment (Figure 5). The control plots had a lower crude protein percentage but, due to a much greater forage production, still yielded more crude protein per acre than any treated plots. (Samples for crude protein analysis were not kept on the first sampling, November 27, so no pretreatment production of crude protein could be shown for the November treatment in Figure 5. This figure would have been of the order of 2-3 pounds per acre.)

The earlier the plots were treated, the higher the yield of crude protein that remained on the plots at the beginning of the dry season. The amount remaining on the control plots was greatly in excess of that on the treated plots (Table 2).

Discussion

The only date of treatment which showed an appreciable difference in yield between burned and clipped plots was the pre-season treatment (Figure 4). At this time there was very little green material (87 lb/acre) but considerable dead grass and litter from previous years (approximately 3,500 lb/acre). This dead grass combined with the very dry conditions produced an extremely hot fire and all of the grass, both green and dry, and the litter was completely destroyed. Clipping at this time, however, removed mainly the dead grass from previous years; the green material was so scanty and short that it was not seriously affected. Although the plots burned in November later grew at almost the same rate as the clipped ones, they were far behind during the first six weeks after burning and also during the dry period in February and March (Figure 3). Thus it seems that the effects of burning on forage production are similar to simple defoliation by clipping except for very intense burns, which can cause a more serious reduction in growth.

Regrowth on the January treatments was not much greater

Table 2. Effect of burning and clipping on dry matter and crude protein yield of forage remaining at the end of the wet season (May 26)

	Control (Untreated)	Date of treatment							
		Nov. 27		Jan. 22		Feb. 20		Apr. 16	
		Burn	Clip	Burn	Clip	Burn	Clip	Burn	Clip
Dry matter yield (pounds/acre)	2264	771	1369	387	406	328	224	0	0
Crude protein content (percent)	2.68	3.44	3.00	3.93	3.81	4.43	4.50	....	....
Crude protein yield (pounds/acre)	61	26	41	15	15	14	10	0	0

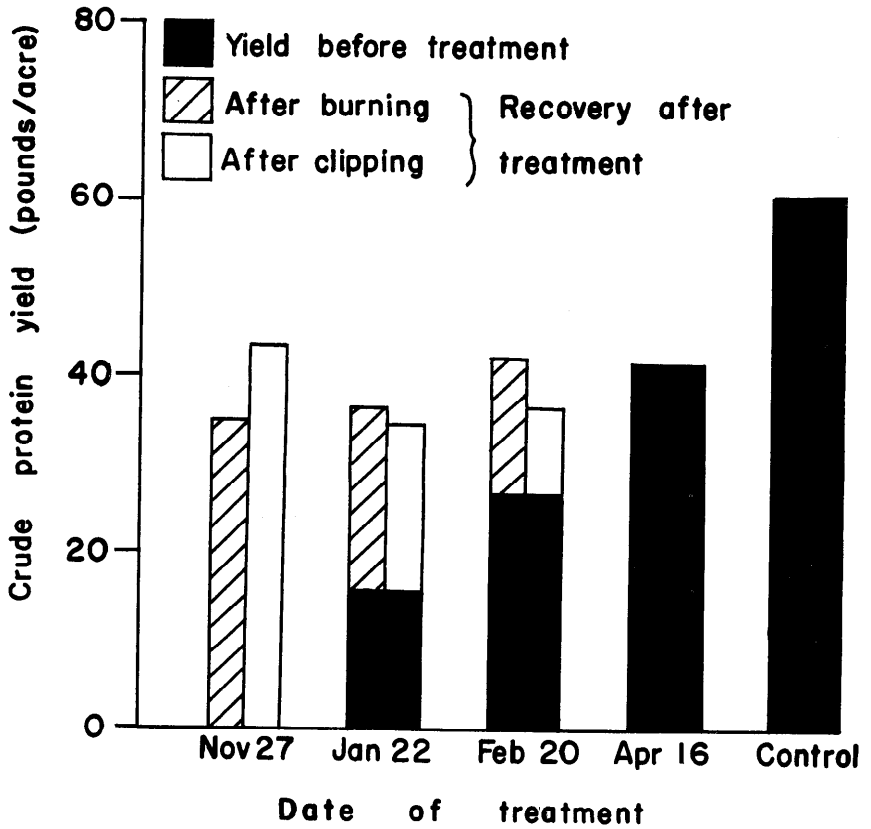

Figure 5. Effect of date of burning and clipping on total crude protein yield.

than that on the February treatments, probably due to the lack of effective rainfall between the two dates. The plots treated on April 16 showed no appreciable regrowth in spite of heavy rain in the previous week.

The untreated plots produced much greater yields than the treated, as might be expected following an interruption in growth cycle. It is also probable that the heavy litter cover on the control plots served to reduce soil temperature and evaporation and to reduce, or at least retard, run-off, causing more water to be available over a longer period of time and at a more favourable temperature for plant growth.

Chrysopogon fallax did not seem to be severely affected by burning, possibly because it was not subjected to as much heat as the other species. The root crown and stem base are well below the ground surface, and the species grows in relatively small clumps on the more open areas and thus does not accumulate the quantity of dead grass and litter which builds up around the other species.

Themeda australis, a species with an exposed crown, was little influenced by clipping, which was at 1½ inches and generally above the crown of the plant, but was markedly reduced by burning. *Sorghum plumosum,* on the other hand, though substantially reduced by burning, was reduced still further by clipping. The species does not root very securely, and clipping tended to damage a proportion of the plants.

The sharp increase in yield on the control plots after the April rains (Figure 3) was largely *Sorghum.* Unlike *Themeda, Sorghum* produces fresh vegetative tillers in mid-wet season, which are able to take advantage of late rains and which form the bulk of the cattle diet during the dry season. Since this late-season increase did not occur on the treated plots, it would seem that wet season burning reduces the growth of vegetative tillers of *Sorghum plumosum,* and so reduces both the quantity and palatability of forage available to cattle during the dry season.

It should be kept in mind that the composition figures are based on weight of forage produced in this one year and do not necessarily indicate a change in basal area or number of plants per unit area of each species. It seems probable that, since this plant community has been subjected to fire for many years, it represents a fire sub-climax, and its actual composition would not be greatly affected by fire (Arndt & Norman, 1959).

Conclusions

Burned range produces less total forage per acre and a lower yield of crude protein per acre over the whole season than unburned range, regardless of the date of burning. However, both burning and clipping increase crude protein percentage over that of untreated range.

Although, in general, the total yield of forage and crude protein increases with progressively later dates of wet season burning, the amount of forage and crude protein remaining for use during the dry season decreases. Thus early burns produce the most favourable forage situation for the critical dry season.

The decrease in forage production caused by burning is due mainly to a decrease in percent composition by weight of *Sorghum plumosum* and *Themeda australis,* the more palatable of the principal forage species. *Themeda australis* is more severely affected than is *Sorghum plumosum.*

There seems to be no major consistent difference between clipping and burning with respect to total forage yields, percentage of crude protein, or composition of the forage, except when the burn is very intense, in which case recovery is less vigorous after burning.

It is not possible to draw many practical conclusions from these data because there are other factors which complicate the picture. Since the results of this experiment indicate that burning is definitely detrimental to the production of forage and crude protein, it would seem that burning is undesirable.

Summary

An experiment was carried out at Katherine, N.T., Australia, to compare the effects of burning and clipping of native tropical tall grass range at various dates during the wet season with respect to total forage yields, composition of forage, and crude protein percentage.

Total forage yield on the untreated plots was greater than on any treated plots. The burned plots increased in total yield with later date of burning. The clipped plots first decreased and then increased in total yield as the date of clipping advanced. A significant difference in total yield between clipped and burned plots was recorded only from plots treated just prior to the wet season, when burned plots gave a lower yield than clipped plots.

The percent composition by weight of *Chrysopogon fallax* increased on the clipped and burned plots, but *Sorghum plumosum* declined considerably on both treatments. *Themeda australis* was reduced on the burned plots but not significantly changed on the clipped.

Clipping and burning increased crude protein percentage but there was little difference in total crude protein yields between the clipped and burned plots or between various treatment dates. The untreated plots greatly exceeded both clipped and burned in total crude protein yields. Seven weeks after the last rains the amount of crude protein remaining on the plots for use during the dry season was highest on the untreated plots and decreased with later dates of treatment on the clipped and burned plots. The plots treated one week after the last rains had no measurable regrowth six weeks later.

It would seem that wet season burns are detrimental to quantity and quality of forage produced. The earlier the burn, the more favourable is the forage situation for dry season use. Only very hot burns have a more serious effect on forage regrowth.

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