EFFECT OF THINNING AND SLASHING ON FORAGE PHYTOMASS FROM A CAATINGA OF PETROLINA, PERNAMBUCO, BRAZIL[1]

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ABSTRACT - The effect of woodland manipulation on forage phytomass was studied in a Caatinga of Petrolina, PE, Brazil. There were five treatments: 1)Control of native vegetation; 2)Thinning 1/3 of shrub canopy cover; 3)Thinning 2/3 of shrub cover; 4)Caatinga slashing; and 5)Treatment 4 + burning. Slashing and burning were carried out in September/84, and thinning done in January/85. Herbaceous mass in the control was 528 kg/ha, half grasses and half forbs, in the only evaluation made (May/85). The slashed area had a higher grass mass than the control (675 vs 251 kg/ha). Forb mass increased from treatment 1 to 5, but only these two were significantly different (1,609 vs 277 kg/ha). *Neoglaziovia variegata* showed the opposite trend, decreasing from treatment 1 to 5 (1,413 vs 25 kg/ha). Slashing was superior to the other treatments in shrub mass, including slashing and burning (706 vs 317 kg/ha), and caused an increase in the tree stratum forage mass over the other treatments (236 vs 50-78 kg/ha), due to coppicing.

Index terms: native pastures, tropical woodlands, vegetation manipulation, slash and burn, sprouting.

EFEITO DO RALEAMENTO E REBAIXAMENTO NA FITOMASSA DE FORRAGEM NUMA CAATINGA DA REGIÃO DE PETROLINA, PERNAMBUCO, BRASIL

RESUMO - Estudou-se o efeito da manipulação da caatinga na produção de forragem. Foram testados cinco tratamentos: 1)Testemunha - Caatinga; 2)Raleamento de 1/3 da cobertura do estrato arbustivo; 3)Raleamento de 2/3 do mesmo estrato; 4)Rebaixamento do estrato lenhoso; 5)Tratamento 4 + queima. Em setembro/84, fez-se o rebaixamento e queima, e em janeiro/85, o raleamento. A única avaliação (maio/85) mostrou, no estrato herbáceo, na testemunha, massa de 528 kg/ha, sendo metade gramíneas e metade dicotiledôneas. Na Caatinga rebaixada, a massa de gramíneas foi significativamente maior que a da testemunha (675 vs 251 kg/ha). Houve maior resposta da manipulação nas dicotiledôneas, que aumentaram linearmente de massa do tratamento 1 ao 5, embora só tenha havido diferença significativa entre estes (277 vs 1.609 kg/ha). O inverso ocorreu com a massa de *Neoglaziovia variegata*, decrescendo do tratamento 1 ao 5 (1,413 vs 25 kg/ha). O rebaixamento aumentou significativamente a massa do estrato arbustivo (706 kg/ha) em relação aos outros tratamentos, inclusive em relação ao rebaixamento com queima (317 kg/ha). No estrato arbóreo, o rebaixamento foi superior ao dos outros tratamentos (236 vs 50-78 kg/ha), devido às rebrotações dos tocos.

Termos para indexação: pastagens nativas, manipulação da vegetação, matas tropicais, desmatamento, rebrotação.

INTRODUCTION

Caatinga is a thorny deciduous dry woodland covering most of the semi-arid Brazilian Northeast. One of the characteristics of this biome in relation to Cerrado and Pantanal is the absence of grasses (Cole, 1960). A low herbaceous phytomass of 500 kg/ha, most of it consisting of forbs, was found in

[1] Accepted for publication on May 29, 1995.

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grazing-free areas, in Petrolina, Pernambuco State, Brazil. In the same area a density of 7,780 and 811 plants/ha of shrubs and trees, respectively (Albuquerque et al., 1982), was found. In a Caatinga of Ceará State, Pfister & Malechek(1986) observed a maximum herbaceous and tree foliage phytomass of 587 and 650 kg/ha, respectively.

Most of Caatinga ligneous foliage is out of reach of livestock and falls off in the dry season. Lima (1984) found in three floristic unities of another Caatinga area in Pernambuco that while the phytomass available to browsing dropped from 461 kg/ha in the wet season to negletible levels near the end of dry season, the mass of dried leaves increased from nil to 600 kg/ha in the same period.

Thinning and slashing have been tested in various bushland-type ranges less dense than Caatinga (Clary & Jameson, 1981; Walker et al., 1986; Harrington & Johns, 1990; Martin & Morton, 1993), and in most of them, there has been more increase in grass yield than in forbs.

Some studies have been conducted on Caatinga, aiming to increase herbaceous production and to make overstory foliage available to livestock. Schacht et al. (1989) cleared the woodland and increased the herbaceous production from 564 to 3,412 kg/ha in the first year, although after three years the clearing effect had disappeared. In other research of the same authors, there was no difference in herb production between clearing and thinning up to 55% of tree cover. These treatments were superior to the control.

Contrary to other rangelands, Caatinga manipulation promotes higher increases in forb than in grass yield (Kirmse et al., 1986; Schacht et al., 1989), although this is sufficient to promote liveweight gains. Araújo Filho (1985) compared natural Caatinga to slashing and to thinning, and concluded that the best combinations were goats and sheep in natural Caatinga, goats and cattle in slashing, and the three species together in thinning. The liveweight gains of these treatments were 12.1, 39.0, and 51.8 kg/ha/year, respectively.

The Petrolina area is right in the middle of region that has the highest concentration of goat herds in Brazil, and in which all small ranches raise cattle and goats.

This research was undertaken in a dense-type Caatinga to give information on the manipulation effect on the phytomass availability in both strata, particularly as they could affect livestock combination.

MATERIAL AND METHODS

The reseach was conducted at the Caatinga Experimental Station (9º 21' S - 370 m) of EMBRAPA-CPATSA (Brazilian Corporation for Agricultural Research-Agricultural Research Center for Semi-arid Tropics), located in Petrolina, PE, Brazil. The area has flat topography, and the soil is plintic podzol, with the following characteristics: pH = 5.8; Ca^{2+} + Mg^{2+} = 3.3 m.e.; Al^{3+} = 0.07 m.e.; P = 3.5 ppm. The annual potential evaporation, the average annual rainfall for the last 32 years, and for the year of trial are 2.630, 572, and 906 mm, respectively.

The vegetation is a dense Caatinga, dominated by *Mimosa tenuifolia* (Willd.) Poir. in the tree stratum, and by a medley of the following species in the shrub stratum: *Bauhinia cheilantha* (Bong.) Steud., *Cordia leucocephala* Moric., *Calliandra depauperata* Benth., *Lippia microphylla* Cham., and *Croton rhamnifolius* H.B.K.

The area was submitted to five treatments: (1) control, natural Caatinga; (2) thinning one third of shrub canopy cover; (3) thinning two thirds of shrub canopy cover; (4) slashing all shrubs and trees at 30 cm height, removing wood, and leaving stumps; and (5) slashing as in previous treatment, allowing the remaining cut phytomass to dry and burn it. A ramdomized block design was used with four replications, with a 0.25 ha plot size, totalling 5 ha.

The study started in September/84 with the determination of density and canopy cover for both shrubs and trees. In each plot, three 4 x 4 m and 10 x 10 m quadrat sizes for shrub and tree, respectively, arranged in a nested system, were evaluated. In each 4 x 4 m quadrat, all shrubs and trees in shrub stage above 0.5 m were counted, and their canopy diameters taken in two perpendicular positions, to determine cover. The same was done with the trees in the 10 x 10 m quadrats. Although the tree stratum was left intact in the treatments submited to thinning, tree canopy cover was determined to show the proportion to shrub cover. After this step, the ligneous vegetation of treatments 4 and 5 was slashed, and plots of treatment 5 were burned. The thinning in treatments 2 and 3 was done in January/85 by hand grubbing, when the soil was wet. As the initial evaluation showed a shrub cover of 14,430.20 m^2/ha (Table 1), plots in treatments 2 and 3 were thinned to remain with two thirds (9,619.2 m^2/ha)

TABLE 1. Density, individual (ind.) canopy cover, and total area cover of the main shrub and tree species in a Caatinga in Petrolina area, PE.

Species	Density (ind./ha)	Ind. canopy conver(m^2)	Area cover (m^2/ha)
SHRUBS			
Bauhinia cheilantha	1,041.6	1.95	2,031.1
Cordia leucocephala	2,173.3	1.13	2,455.8
Calliandra depauperata	454.5	1.07	486.3
Lippia microphylla	3,196.0	0.95	3,036.2
Croton rhamnifolius	2,111.7	2.80	5,912.8
Latana camara L.	28.4	0.46	13.1
Jatropha molhissima (Pohl.) Baill.	203.6	0.66	137.7
Caesalpinia microphylla Mart.[1]	94.7	3.14	297.3
Mimosa tenuifolia[1]	18.9	1.45	27.4
Cnidoscolus bahianus (Ule.) Pax. et Hoffm.[1]	75.7	0.22	16.6
Other 6 species[2]	246.1	-	15,9
Total	9,644.5	-	14,430.2
TREES			
Mimosa tenuifolia	200.0	22.23	4,446.0
Cnidoscolus bahianus	59.1	21.67	1,280.7
Bursera leptophloeos (Mart.) Engl.	15.1	70.51	1,064.7
Caesalpinia microphylla	60.6	9.46	573.3
Tabebuia spongiosa Rizzini	45.4	12.34	560.2
Spondias tuberosa Arr. Cam.	3.0	102.48	307.4
Schinopsis brasiliensis Engl.	6.1	39.23	239.3
Other 5 species[3]	46.9	-	341.7
Total	436.2	-	8,813.5

[1] Trees in shrub stage

[2] It includes two shrubs (*Argythamnia gardneri* Muell. Arg.; *Jatropha ribifolia* (Pohl.) Baill.), a Cactaceae (*Tacinga funalis* Br. et R.), a liana (*Cissus coccinea* Mart. et Planch.), and two trees in shrub stage (*T. spongiosa*; *B. leptophloeos*).

[3] It includes *Manihot pseudoglaziovii* Pax. et Hoffm.; *Sapium* sp.; *Mimosa arenosa Willd.*; *Pseudobombax simplicifolium* A. Robyns.; and *Cnidoscolus phyllacanthus* (Muell. Arg.) Pax et Hoffm.

and one third (4,809.6 m^2/ha) of that cover, respectively.

The shrubs were eliminated in the ascending order of Table 1, starting by trees in shrub stage, followed by *J. molissima*, *L. camara*, and so on. In treat 2, to reach 9,619,2 m^2/ha of shrub cover, all *B. cheilantha*, *C. leucocephala*, *C. depauperata*, *L. microphylla*, and scattered plants of *C. rhamnifolius* were left, while in treatment 3, to reach 4,809,6 m^2/ha of shrub cover, all *B. cheilantha*, *C. leucocephala*, and scattered plants of *C. depauperata* were left.

Forage phytomass evaluation was done only once in May/85. All tree and shrub leaves and twigs below 1.8 m were hand-plucked, in six quadrats/plot, the quadrats being of the sizes described before. For understory evaluation, three 1 m^2 quadrats were placed inside each set of shrub and tree quadrat, totalling 18 quadrats/plot. Inside each 1 m^2, all herbaceous species present were recorded to determine frequency, *Neoglaziovia variegata* (Arr. Cam) Mez. (Bromeliaceae) plants were counted to determine density, and all green herbaceous material and *N. variegata* were harvested. Samples were taken for dry matter determination. Data were submitted to analysis of variance, and means were compared by the Duncan's Test, at the 5% significance level.

RESULTS AND DISCUSSION

Understory stratum

Grass phytomass in the control (251 kg/ha) (Table 1) made up half of the herbaceous stratum, that is, a very low datum compared to other native pastures. Increases in grass production would be the main objective in thinning and woodland clearing. Thinning 2/3 of original cover resulted in a 77% increase in grass mass but the difference was not significant due to the high experimental variability. Slashing produced the highest grass phytomass (675 kg/ha), which was significantly different from the control (168% higher), but not from the other treatments. Higher grass than forb yields have been obtained in many places (Clary & Jameson, 1981; Walker et al., 1986; Passera et al., 1992). Even being a low datum, the additional grass mass of 424 kg/ha obtained by slashing was much higher than those got by Silva (1985) and Schacht & Malechek (1990).

The main influence of manipulation was in forb phytomass (Table 2), with an increase of 480% in the slashing and burning treatment over the control. It has been shown that this dominance of forbs might change to grass dominance in years of drought (Crispim, 1987).

The total herbaceous phytomass in the control (528 kg/ha) was similar to the data of 587 and 564 kg/ha, obtained respectively by Pfister & Malechek (1986), and Schacht et al. (1989), in a Caatinga of the neighboring Ceará State. It must be considered that the present measurement was made in a rainy year, and water availability is usually the limiting factor in Caatinga production. As a result of high forb phytomass, thinning 2/3 of shrub cover, slashing, and slashing plus burning treatments were significantly superior ($P<0.05$) to control in the total herbaceous phytomass. Maximum herbaceous phytomass of 1.94 ton/ha attained in the slashing and burning treatment was lower than the data of 3.41 and 3.80 ton/ha, most of them being forbs, obtained respectively by Kirmse et al. (1986) and Schacht et al. (1989), after slashing.

The linear decrease in *N. variegata* phytomass from treatment 1 to 5 (Table 2) might have contributed to the linear increase of the herbaceous mass in the same treatment order because both masses were significantly and inversely correlated ($r = - 0,60$), taking into account all plots, independently. However, for Caatinga standards, a phytomass of 1.4 ton/ha and a density of 2.6 ind./m^2 for *N. variegata* obtained in the present study, are not high. Lima (1984) found 3 ton/ha of phytomass and 7.3 ind./m^2, while Nascimento (1936) obtained 5 ind./m^2. *N. variegata* phytomass decreased because shrub grubbing affected its highly rhizomatous roots, and the fall of heavy overstory phytomass damaged its aerial parts.

Most forb species had a higher frequency in treatment 4 than in treatment 5 (Table 3), although production followed the opposite trend. There was no determination of forb density, but most of the species in burned plots were sturdier. This is in accordance with Walker et al. (1986), who stated that, for grasses, the pulse of nutrients resulting from

TABLE 2. Grass, forbs, total herbaceous stratum, and *N. variegata* phytomass (kg/ha), in a Caaatinga submitted to five treatments.

Treatments	Herbaceous stratum phytomass: Grasses	Forbs	Total	*N. variegata* phytomass
Control	251.5 a[1]	277.4 a	529 a	1,413.3 a
Thinning 1/3	309.7 ab	562.3 ab	872 ab	850.3 ab
Thinning 2/3	446.5 ab	936.9 ab	1,383 bc	547.5 ab
Slashing	675.4 b	1,069.3 ab	1,745 c	318.3 b
Slashing plus burning	329.3 ab	1,609.4 b	1,939 c	24.6 b
C.V.(%)	40.6	56.1	40.7	90.0

[1] Within each column, values followed by the same letter are not significantly different by the Test of Duncan (5% level).

burning are trapped in the soil surface layers, and are readily available to roots. The same might be applied to forbs.

Overstory stratum

The data of density and canopy cover of shrub and tree strata (Table 1) determined before Caatinga manipulation, show the total shrub cover/ha being much higher than total tree cover. This does mean that this proportion in terms of foliage mass is maintained.

The shrub and tree forage phytomass in the control (479.1 kg/ha) (Table 4) was similar to the mean of 461 kg/ha got by Lima (1984) in three floristic unities. Pfister & Malechek (1986) obtained 650 kg/ha from overstory stractum (below 1.60 m), probably due to the better rainfall conditions in that Ceará area, although Schacht & Malechek (1990) got only 198 kg/ha in the same area, in a year in which rainfall doubled the mean, but the area was under grazing by goats.

As expected, there was a trend in shrub forage mass to decrease from treatment 1 to 3, due to thinning (Table 4). It was decided to exclude only shrubs, because of their higher density and canopy cover in relation to trees, which determine a higher competition with the understory stratum. Walker et al. (1986) stated that the presence of high quantities of shrubs in *Eucalyptus populnea* plots is known to reduce grass phytomass significantly.

Slashing significantly increased shrub and tree forage mass over the other treatments, due to stump

TABLE 3. Frequency (%) of main species in the herbaceous stratum of a Caatinga area submitted to five treatments: 1) control; 2) thinning 1/3 of shrub cover; 3) thinning 2/3 of shrub cover; 4) slashing; 5) slashing + burning.

Species	Treatments				
	1	2	3	4	5
Grasses					
Panicum trichoides Swartz	88.9	93.1	90.3	97.3	62.8
Gymnopogon rupestris Ridley	16.7	36.4	34.7	57.0	12.5
Tragus bertheronianus Schult.	1.4	1.4	-	-	6.9
Eragrostis ciliaris (L.) Link.	-	1.4	4.2	1.4	47.3
Brachiaris mollis (Sw.) L. Parodi	-	-	-	2.8	8.3
Rynchelitrum repens (Willd.) C.E.Hubb.	-	1.4	-	2.8	6.9
Main dicotyledonous					
Centratherum punctatum Cass.	97.3	91.7	88.9	76.4	52.8
Cuphea sp.	36.1	37.6	50.6	29.2	1.4
Schwenkia americana L.	22.2	12.5	33.4	22.2	9.7
Herissantia crispa (L.) Briz.	18.1	13.9	37.5	19.5	20.8
Borreria ocymoides (Burm. F.) DC.	16.7	11.1	41.7	48.6	22.2
Triumfetta sp.	15.3	9.7	26.4	34.7	18.1
Alternanthera brasiliana (L.) Kuntz.	15.3	12.5	11.1	11.1	27.8
Hyptis suaveolens (L.) Poir.	9.7	12.5	7.0	8.3	1.4
Pavonia cancellata Cav.	9.7	1.4	2.8	4.2	12.5
Corchorus argutus H.B.K.	9.7	23.6	27.8	33.4	48.0
Mitracarpus frigidus Schum.	8.3	25.0	37.5	50.0	33.4
Hybanthus calceolaria (L.) G.K.Schulze	4.2	16.7	19.5	25.0	27.8
Macroptilium martii Benth.	-	1.4	-	4.2	22.2
Pteridophyte					
Selaginella convoluta Spring.	62.5	57.0	70.9	30.6	8.3

TABLE 4. Forage phytomass (kg/ha) from shrub and tree strata (below 1.8 m), and from herbaceous stratum, under five Caatinga manipulation treatments.

Treatments	Shrub	Stratum	Tree	stratum	Herbaceous stratum (table 2)	Total
	Main[1] species	Total -	*Mimosa* tenuifolia	Total -	-	-
Control	388.5	428.6 a[2]	14.3	50.2 a	529	1,007 a
1/3 Thinning	313.1	348.1 a	26.3	49.7 a	872	1,270 a
2/3 Thinning	145.5	176.6 a	56.5	74.8 a	1,383	1,634 ab
Slashing	618.6	706.1 b	214.5	235.3 b	1,745	2,686 c
Slashing plus burning	182.6	316.7 a	73.0	78.5 a	1,939	2,334 bc
C.V.(%)	-	42.3	-	29.7	-	30.1

[1] It includes *B. cheilantha, C. leucocephala, L. microphylla and C. rhamnifolius.*
[2] Within column, values followed by the same letter are not significantly different by the Test of Duncan (5%).

sprouting. In the burning treatment, the fire destroyed most of the stumps.

Tree forage mass was not affected in the thinning treatments. Slashing increased tree forage phytomass, but most of it was derived from *M. tenuifolia* sproutings, a species which foliage presents a very low *in vitro* digestibility (Carvalho Filho & Salviano, 1982), possibly due to a high tannin content. As in Lima (1984), also in the present work it was shown that the tree stratum does not contribute to the whole Caatinga forage phytomass, except when the leaves fall off in the dry season. Other studies (Pfister & Malechek, 1986; Kirmse et al., 1987; Schacht & Malechek, 1990) have found ligneous species leaf litter an important source of dry season forage for livestock in other Caatinga areas.

Caatinga slashing would have two aims, to make all phytomass available to livestock, and to extend the green period, avoiding the overstory leaves to fall off early. The first aim was fulfilled, because of the significant increase in forage availability. However, Caatinga slashing has to be done by hand instead of mechanically, and there are some doubts whether the additional yield would pay the costs or not. The extension of the green period was not analyzed.

Adding all forage mass derived from slashing in the two strata resulted in an increase of 167% over control (Table 4). Slashing is recommended. Besides increasing available phytomass, it might be the ideal manipulation to favor the cattle and goat combination, already present in the region, as the work of Araújo Filho (1985) indicated. This manipulation work has the limitation of being evaluated only in part of the first year. As shown by Schacht et al. (1989), the Caatinga recovers very fast. This implies annual costs for maintaining the slashing effects.

CONCLUSIONS

1. Thinning did not increase grass production. Slashing increased grass production over control in 168%, but this represents an increase of just 424 kg/ha.

2. Slashing is recommended for that dense-type Caatinga, although additional research is needed to see the understory-overstory relationship over the years, and to determine the costs of cutting down the woodland and keeping the original vegetation from retrieving.

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