Management of Mopane in Southern Africa

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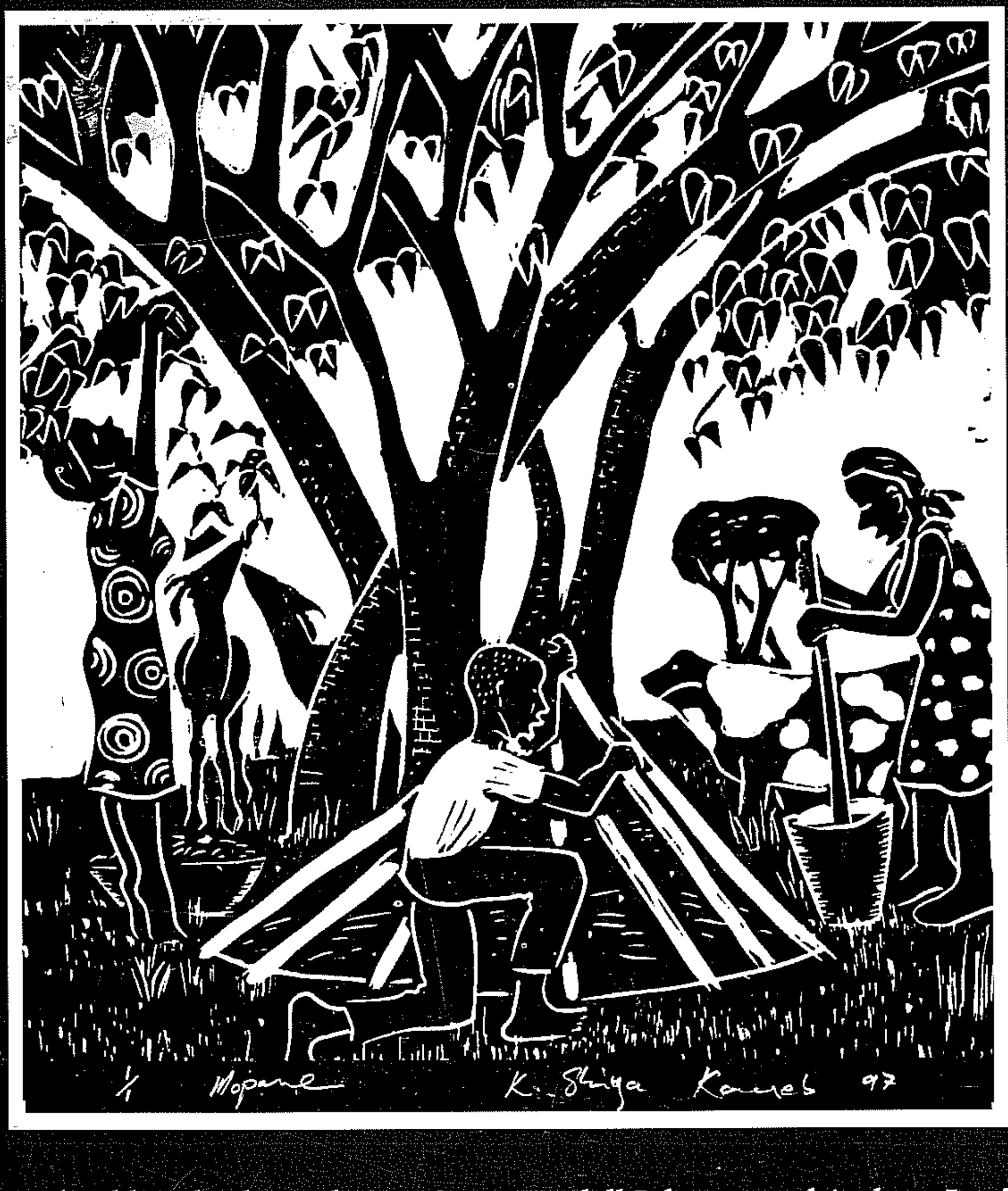

Edited by Charlotte Flower, Grant Wardell-Johnson and Andrew Jamieson

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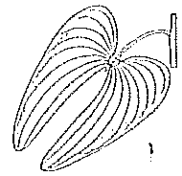
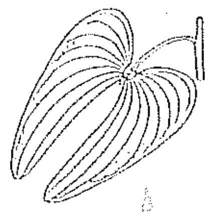
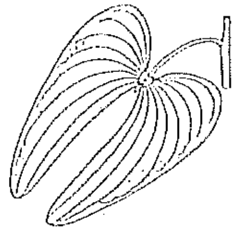




CHAPTER FOUR

INFLUENCE OF INTENSITY OF TREE THINNING ON THE VEGETATIVE GROWTH, BROWSE PRODUCTION AND REPRODUCTION OF *COLOPHOSPERMUM MOPANE*..



Nico Smit [a]

ABSTRACT

The vegetative growth, browse production and reproductive dynamics of *Colophospermum mopane* (mopane) were studied over a period of three years in six plots. The trees in five plots were thinned to the approximate equivalents of 75 %, 50 %, 35 %, 20 % and 10 % of the tree density of the control plot (2,711 trees/ha). Thinning reduced inter-tree competition which resulted in significant increases in the vegetative growth and reproduction of the remaining trees. Though the vegetative growth per tree and the percentage of reproductive trees was higher in the low tree density plots, the larger number of trees in the high tree density plots ensured that the total seasonal leaf dry mass increase exceeded that of the low tree density plots. The total number of trees in the high density plots that flowered and produced seeds were of the same order as those in the low tree density plots. Tree thinning reduced the available browse at peak biomass, but trees from the low tree density plots displayed a wider distribution of browse over the season. Marked differences in the nutritional composition and water content of mopane leaves existed in different phenological states. The seeds from trees within the low tree density plots were larger and heavier than those from the plots with a high tree density, but this did not have a marked effect on their potential to germinate. Seedling numbers were low in all plots and a specific pattern of seedling establishment was lacking.

Keywords; *Colophospermum mopane*, BECVOL-model, flowering, germination potential, seed bearing, seed mass, seedling establishment.

INTRODUCTION

Mopane woodland, dominated by the tree, *Colophospermum mopane* (Kirk ex Benth.) Kirk ex J. Léonard, known commonly as mopane, is an extensive and important vegetation type of southern Africa. It covers large areas of the northern and north-eastern parts of South Africa, Botswana, Zimbabwe, Mozambique and northern Namibia. The total area in southern Africa under mopane vegetation types is estimated at 555,000 km^2 (Mapaure 1994, Fig. A).

The major direct economic uses of mopane trees include their use as firewood and as rough construction timber (Timberlake 1996). In other areas extensive cattle and game farming is practised exclusively. In these areas it is perceived that in recent history an increase in tree density occurred, mainly as a result of overgrazing by domestic stock, but also due to the elimination of mega-herbivores, notably elephant, and the exclusion of sporadic hot fires. The increase in tree density resulted in the suppression of herbaceous plants, mainly due to severe competition for available soil water. This is considered a major factor contributing towards the low grazing capacity of large parts of the mopane woodlands (Donaldson 1980, Gammon 1984).

While measures like tree thinning are often considered as an option to restore the herbaceous production potential of affected areas of the mopane woodlands, very little scientific information exists on the ecological impact of tree thinning on this vegetation type. This study was subsequently undertaken as a preliminary investigation into the effect of intensity of tree thinning on the vegetative growth and reproduction dynamics of the remaining mopane trees and forms part of a comprehensive investigation into the effect of tree thinning on the mopane woodlands.

METHODS

The study was conducted in the Northern Province of South Africa on a site located at 22° 19' S, 29° 12' E and 560 MAMSL. The vegetation consisted of a virtually pure stand of mopane. The rainy season usually extends from October to March inclusive. Mean long-term seasonal rainfall (July - June) for the period 1966/67 to 1989/90 was

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376 mm (SE ± 27.6, range 140 - 620 mm). The study area is well known for its high summer temperatures and moderate to warm winter temperatures. The underlying geology consists mainly of sandstone and the top soil is comprised of 80 % sand, 8 % silt and 12 % clay.

The study area consisted of six, 1.17 ha plots (180 m x 65 m), thinned to the approximate equivalents of 75 %, 50 %, 35 %, 20 % and 10 % of the tree density of the control plot (Table 4.1). The plots were located adjacent to each other on a homogeneous area of 8.2 ha. Treatments were allocated randomly to the plots and not in a numerical order. The control plot yielded a dense stand of mopane with herbaceous plants almost completely absent.

Trees were randomly removed during the thinning process and the thinned plots resembled the structure of a naturally occurring open stand of mopane. Thinning was completed during the winter of 1989 and the tree densities (trees/ha) were as follows; 100 % (control) plot - 2,711, 75 % plot - 1,978, 50 % plot - 1,233, 35 % plot - 744, 20 % plot - 589 and 10 % plot - 300.

The vegetative growth, browse production and reproductive dynamics of mopane trees were studied over a period of three seasons (1989/90, 1990/91, 1991/92) following thinning. Fixed transects (5 m x 180 m) were located in the middle of each of the experimental plots. The spatial canopy of all rooted live mopane trees encountered in these fixed plots was measured at the end of each growing season (usually April or May). Leaf dry mass estimates were calculated from these measurements, using a modified version of the quantitative description technique of Smit (1989a, 1989b) as described by Smit (1994). This technique was compiled into the BECVOL-model (Biomass Estimates from Canopy Volume) (Smit 1994). It incorporates a regression equation, developed from harvested trees, which relates spatial canopy volume (independent variable) to leaf dry mass (dependant variable);
$\ln y = -4.165 + 0.711x$, $r = 0.975$, $p < 0.001$.
Spatial tree canopy volume (x) was transformed to its normal logarithmic value, while y represents the estimated leaf dry mass.

The reproduction dynamics of mopane included flowering, fruit bearing, the germination potential of the seed and seedling establishment. Trees in each plot were regularly observed and the following recorded; dates of flowering, percentage of trees that flowered at the peak of the flowering period and the percentage of trees that bore fruit after flowering. The dry mass of the fruit and germination potential of the seeds produced by trees from the different experimental plots during the 1991/92 season was assessed. The term fruit, as used here, refers to the pod with the enclosed seed.

The dry mass of the fruit was determined by randomly harvesting 100 fruits from trees in each experimental plot during April 1992. These seeds were dried to a constant mass (at 70 °C). The germination potential assessment was conducted at three different times of the season; at the end of the growing season when ripe seeds become generally available (autumn), during the middle of the dormant season (winter) and at the onset of the following growing season (spring). The dates of actual harvests were 21 May 1992, 5 August 1992 and 10 November 1992, respectively. The assessment of their germination potential were conducted at the facilities of the Directorate of Plant and Quality Control, Department of Agriculture, Pretoria, South Africa.

All rooted seedlings of woody plants, not just those of mopane, were counted in the fixed transects of each experimental plot. Surveys were done at the end of each growing season, normally April or May (1990/91 and 1991/92 seasons). Relations which involved parametric data were established using simple regression analysis (Draper and Smith 1981, Statgraphics 1991).

RESULTS

Thinning reduced inter-tree competition which resulted in significant increases in the vegetative growth and reproduction of the remaining trees. As the intensity of thinning increased the magnitude of these increases also increased. The mean seasonal leaf Dry Matter (DM) increases per tree ranged from 12.6 % to 27.8 % in the 10 % plot and were substantially higher than the mean increases of 8.9 % to 17.9 % of trees in the 100 % plot. The total leaf DM yield of the mopane trees in the 10 % plot increased with 64.9 % over the trial period, in comparison to an increase of 22.2 % for trees in the control plot. Though the mean seasonal leaf DM increases per tree were lower at high tree densities, the sum totals of the larger number of trees ensured that increases in total leaf biomass were of a higher order than the total increase on the other end of the gradient (315 kg DM/ha in the 100 % plot *versus* 101 kg DM/ha in the 10 % plot).

On a structural basis, vegetative growth within the trees was not uniform and the trees showed increases in canopy cover rather than increases in tree height. The months September to December were established as the critical months as far as vegetative growth was concerned. Tree thinning reduced the available browse at peak biomass, but trees from the low tree density plots displayed a wider distribution of browse, having leaves in comparatively younger phenological states over an extended period.

Marked differences in the nutritional composition and water content of mopane leaves existed in different phenological states. The percentage crude protein ranged from 19.2 % in the case of immature green leaves to 6.6 % of dry leaves retained on the trees. The *in vitro* digestibility ranged from 48.7 % in the case of mature green leaves to 34.5 % of young green leaves, 7 % lower than that of dry leaves (41.5 %).

Flowering mainly occurred during January and February.

Table 4.1: Summary statistics of six thinning treatments in mopane woodland, northern South Africa

Treament	Season	Tree density (tree/ha)	Flowering at peak biomass (% of trees)	Tree that bore fruit (% of trees)
Control	1989/90	2,711	0.42	Not recorded
75 %	1989/90	1,978	8.57	Not recorded
50 %	1989/90	1,233	9.43	Not recorded
35 %	1989/90	744	12.12	Not recorded
20 %	1989/90	589	17.39	Not recorded
10 %	1989/90	300	17.86	Not recorded
Control	1990/91	2,711	5.93	2.54
75 %	1990/91	1,978	3.14	0.00
50 %	1990/91	1,233	19.19	15.15
35 %	1990/91	744	12.90	12.90
20 %	1990/91	589	31.82	22.73
10 %	1990/91	300	32.14	28.57
Control	1991/92	2,711	11.50	7.96
75 %	1991/92	1,978	21.34	17.07
50 %	1991/92	1,233	31.31	26.26
35 %	1991/92	744	40.63	37.50
20 %	1991/92	589	70.45	59.09
10 %	1991/92	300	62.96	59.26

The percentage of the trees that flowered and developed seeds was substantially higher in the plots with a low tree density, declining linearly over the tree density gradient. Both the percentage flowering and percentage seed bearing were significantly negatively correlated with the tree density (flowering; $r = -0.63$, $n = 6$, $p < 0.05$ and seed bearing; $r = -0.65$, $n = 6$, $p < 0.05$). However, in actual numbers, the number of trees that flowered in the plots with a high tree density (50 %, 75 % and 100 % plots) was generally of the same order as in plots with a low tree density.

Seeds collected from trees in the low tree density plots were heavier than those from the densely wooded plots. In the 10 % plot the largest percentage of seeds, with and without their pod covers, fell within the > 0.4 - 0.5 g and > 0.2 - 0.3 g classes respectively. This contrasted with seeds from the 100 % plot where the largest percentage of seeds, with and without their pod covers, fell within the > 0.3 - 0.4 g and > 0.1 - 0.2 g classes respectively.

The best seed germination (82 % plus) was obtained from seeds harvested at the end of the growing season (21 May 1992). The lowest germination (34 - 60 %) was from the seeds harvested during the middle of winter (5 August 1992), while seeds harvested at the onset of the next growing season (10 November 1992) displayed improved germination (54 - 65 %). Most of the seeds that germinated did so within 12 days. Seeds harvested during the middle of winter took the longest to germinate (peak: 12 days), while those harvested at the onset of the new growing season germinated the fastest (peak: 8 days). There were no marked differences in the germination of seeds from the different experimental plots. Of the seeds harvested at the end of the growing season, those from the 10 %, 20 %, 35 % and 50 % plots, achieved peak germination after 12 days, while the smaller seeds from the 75 % and 100 % plots achieved peak germination after only eight days. Seed size did not have a marked effect on their potential to germinate, but might have an effect on the number that will survive.

The few seedlings other than those of mopane were all *Dichrostachys cinerea*. Seedling numbers were generally low and no specific pattern of establishment that can be ascribed to the thinning of mopane could be established. Seedling numbers were not correlated with tree density, nor with any other parameter related to tree density (e.g. tree canopy cover). At high tree densities severe competition from the established mopane trees could account for the low rate of seedling establishment, while in the low tree density plots competition from newly established herbaceous plants, mainly grasses, could account for the tree seedling absence in these plots.

DISCUSSION

Reduced inter-tree competition by thinning has a significant effect on the growth and reproduction of the remaining mopane trees. The increased growth of trees remaining after thinning can have a significant effect on the management of mopane, where the objectives are the increase of wood and browse production. Further study should examine the effect of tree thinning on production per tree, as opposed to production per unit area. A high intensity of thinning may ensure a high production per tree from the remaining trees, but the highest production per hectare may well be at a lower intensity of tree thinning.

In terms of increased grass production following tree thinning the establishment of new tree seedlings is not desirable. While this study showed that tree thinning does influence the reproductive dynamics of mopane, it will have to be expanded over several seasons with specific observations on the survival of newly established tree seedlings.

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ISSUES RAISED DURING PARTICIPANTS' DISCUSSION

Is the total production greater in the thinned plots than in the control plots?
Not necessarily; biomass production is in the same order in both, but the type of fodder is different - more grass in the thinned plots and more mopane leaf in the unthinned plots.

Are these the trials in which you killed the stumps?
Yes, they are. The plots were randomly thinned rather than selectively and those trees that were removed were killed using a herbicide (Tordon Super mixed in diesel). In a plot where the stumps were not treated with the herbicide there was vigorous coppice regrowth and no increase in grass growth. The cost of treatment varied from 100 - 150 R/hectare.

According to the model, the root system is very widespread; from where is it getting its water?
Grasses are very effective at taking up water, more so than woody plants. However, when there is mopane and some grass, there seems to be a point at which the mopane is more efficient at taking up water than the grass. The wilting points of the grasses differ to those of mopane.

Between 100 % removal and 0 % removal, which is the best treatment to deal with bush thickening?
There is no straightforward answer, it depends on what land-use system is required.

Reflecting on what we saw in the field yesterday [the very low groundwater level], what would be the best system to replenish groundwater, bush or grass?
Trees do much better in mixed stands. If the woodland is dense, then grass doesn't establish easily. If people want to use mopane veld for increased grass production, then mopane should be reduced by 100 %. A good grass cover will reduce rainwater runoff losses.