SMIT, GERT NICOLAAS

THE INFLUENCE OF INTENSITY OF TREE THINNING ON MOPANI VELD (Volume II)

DPhil UP 1994

THE INFLUENCE OF INTENSITY OF TREE THINNING ON MOPANI VELD

(Volume II)

by

GERT NICOLAAS SMIT

Submitted in partial fulfilment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in the Faculty of Biological and Agricultural Sciences
Department of Plant Production and Soil Science
(Grassland Science)
University of Pretoria
PRETORIA

Promoter: Prof. N.F.G. Rethman
Co-promoter: Dr A. Moore

August 1994

TABLE OF CONTENTS: VOLUME II

CHAPTER 2: STUDY AREA AND TRIAL LAYOUT

Tables

Figures

CHAPTER 3: DEVELOPMENT OF A LEAF QUANTIFICATION TECHNIQUE FOR *COLOPHOSPERMUM MOPANE*

Figures

CHAPTER 4: RELATIONS BETWEEN THE EVAPOTRANSPIRATION TREE EQUIVALENT AND OTHER UNITS OF TREE DESCRIPTION AS APPLIED TO *COLOPHOSPERMUM MOPANE*

Tables

Figures

CHAPTER 5: ROOT BIOMASS, SPATIAL DISTRIBUTION AND RELATIONS WITH ABOVE-GROUND LEAF BIOMASS OF *COLOPHOSPERMUM MOPANE*

Tables

Figures

CHAPTER 6: GROWTH AND REPRODUCTION OF THE REMAINING *COLOPHOSPERMUM MOPANE* TREES

Tables

Figures

CHAPTER 7: SUCCESSIONAL TRENDS IN THE ESTABLISHMENT OF HERBACEOUS PLANTS

Tables

Figures

CHAPTER 8: INFLUENCE OF TREE THINNING ON QUANTITATIVE AND QUALITATIVE DYNAMICS OF THE HERBACEOUS LAYER

Tables

Figures

CHAPTER 9: INFLUENCE OF SUBHABITAT DIFFERENTIATION AND TREE THINNING ON SOIL NUTRIENTS

Tables

Figures

CHAPTER 10: THE INFLUENCE OF TREE THINNING ON THE SOIL WATER

Tables

Figures

CHAPTER 11

Figures

APPENDICES

Table 2.1 Description of the soil of the study area from two representative sites (see Figure 2.4).

Soil variable	Profile 1	Profile 2
Soil depth (mm):		
A horizon	0 - 230	0 - 200
B1 horizon	230 - 520	200 - 400
B2 horizon	520 - 1 200 +	400 - 1 200 +
Sand : silt : clay (%):		
A horizon	81 : 7 : 12	80 : 8 : 12
B1 horizon	75 : 7 : 18	75 : 7 : 18
B2 horizon	59 : 9 : 32	65 : 8 : 27
Colour	Red (2.5YR3/4)	Red (5YR4/6)
Soil form (MacVicar *et al.* 1977)	Hutton	Hutton
Soil series (MacVicar *et al.* 1977)	Shigalo	Shigalo

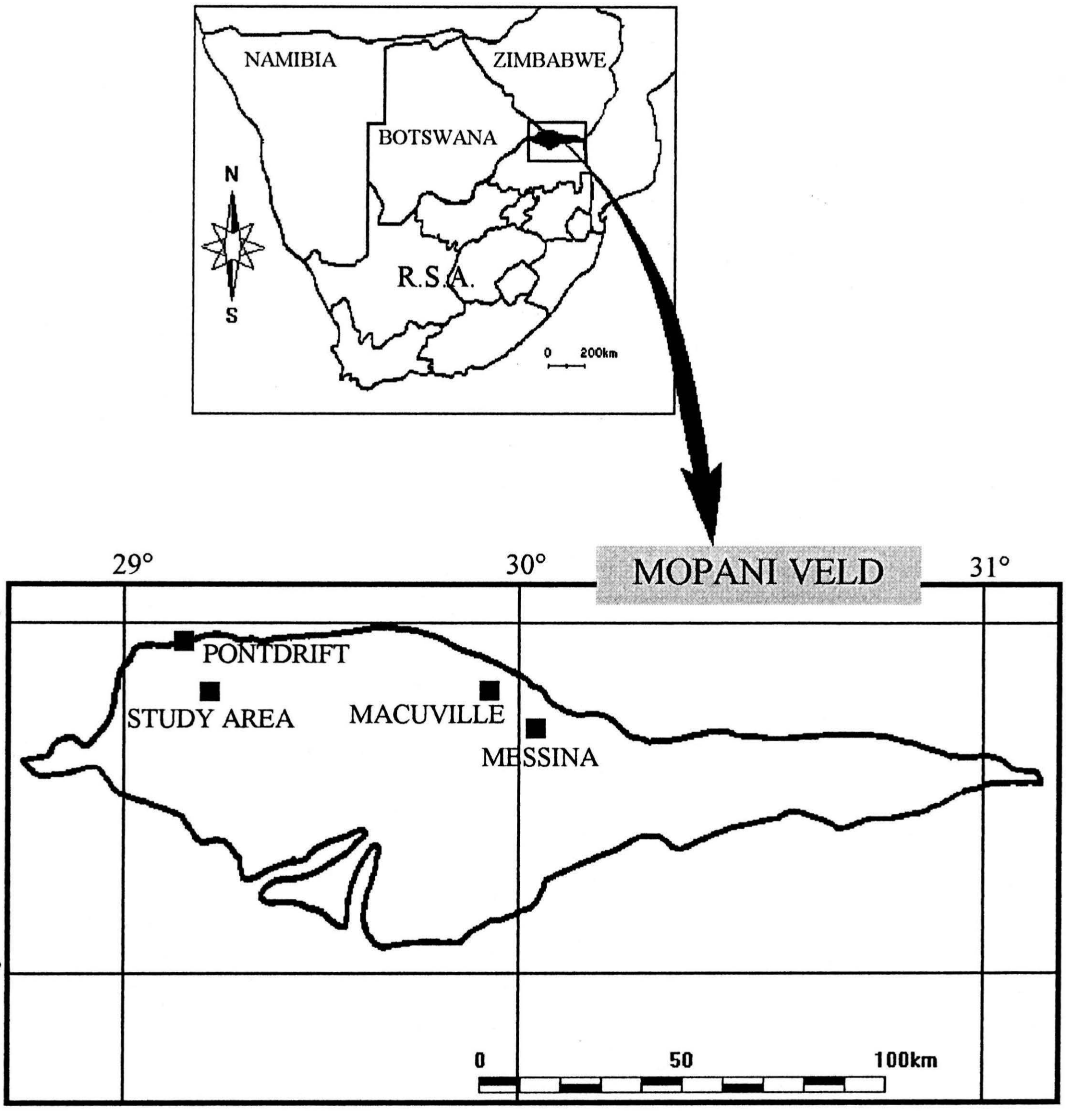


Figure 2.1 Map of southern Africa, illustrating the location of the study area within the Mopani veld north of the Soutpansberg and south of the Limpopo river.

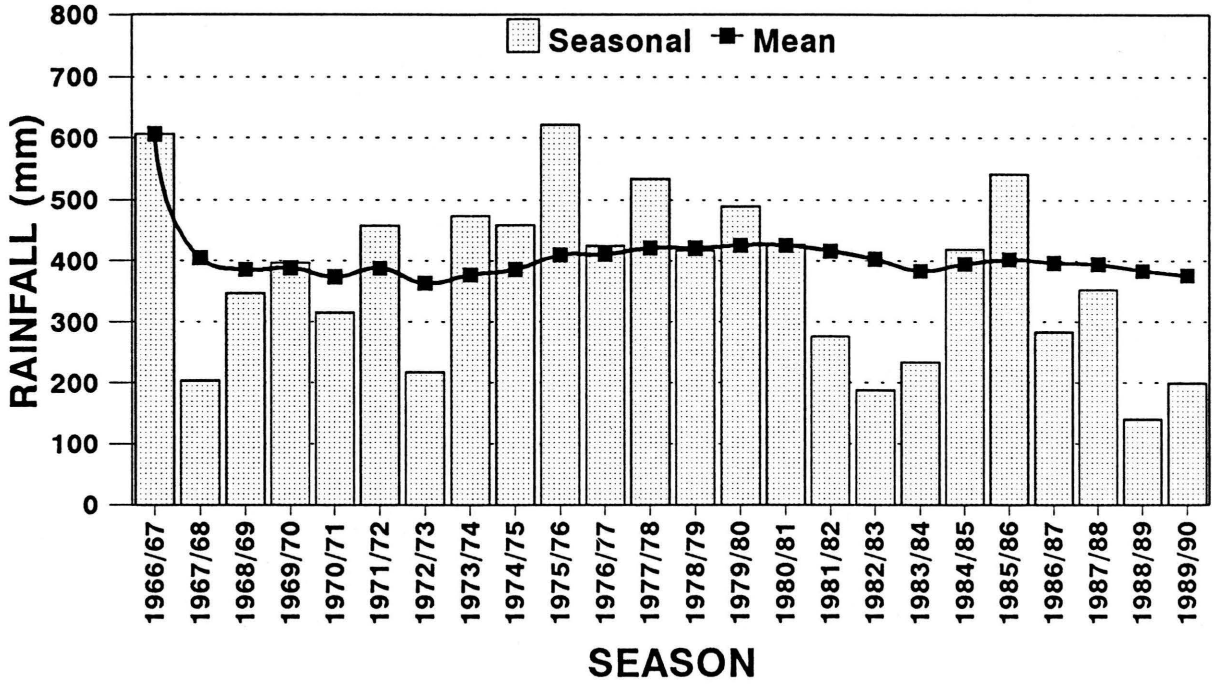


Figure 2.2 Seasonal and progressive seasonal mean rainfall (July-June) for the period 1966/67 to 1989/90, as measured at the Pontdrift border post approximately 14 km north-west of the study area.

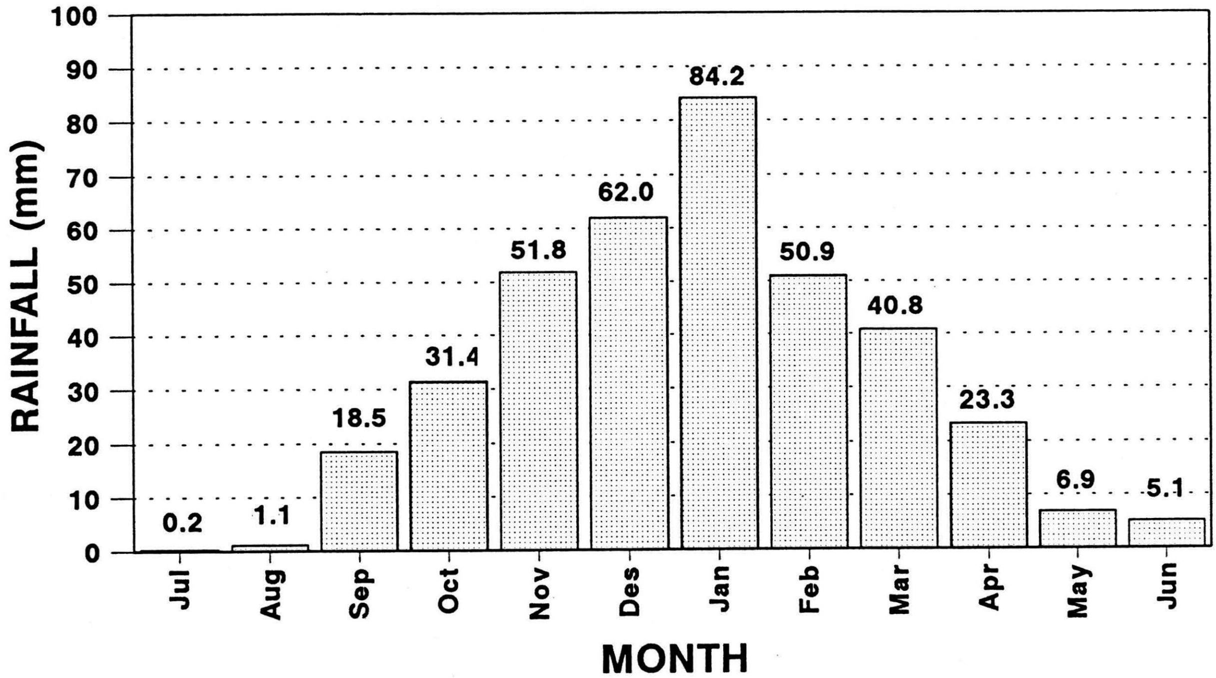


Figure 2.3 Mean monthly rainfall for the period 1966/67 to 1989/90, as measured at the Pontdrift border post approximately 14 km north-west of the study area.

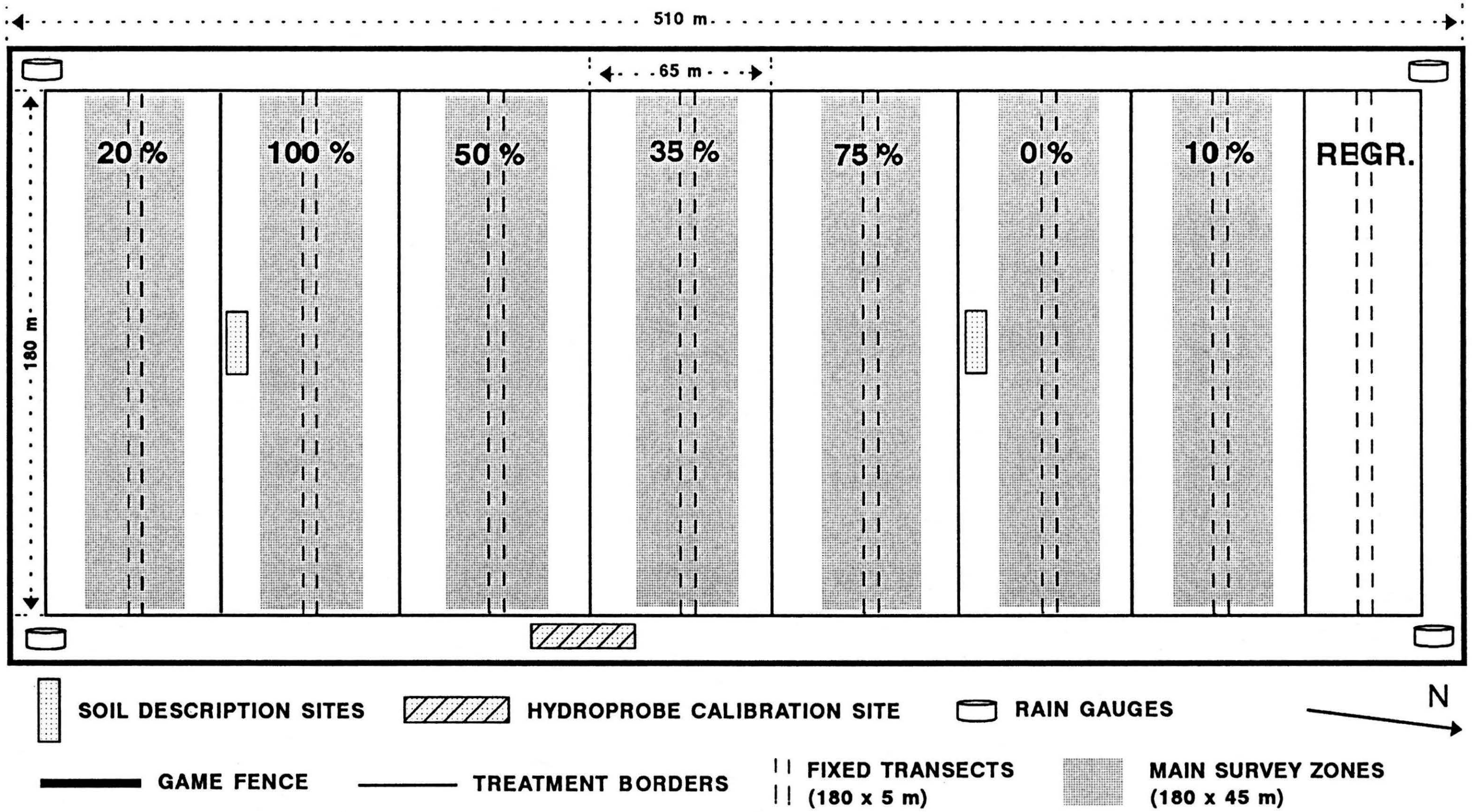


Figure 2.4 Illustration of the trial layout, indicating locations of treatments, fixed transects, main survey zones, soil description sites, hydroprobe calibration site and rain gauges.

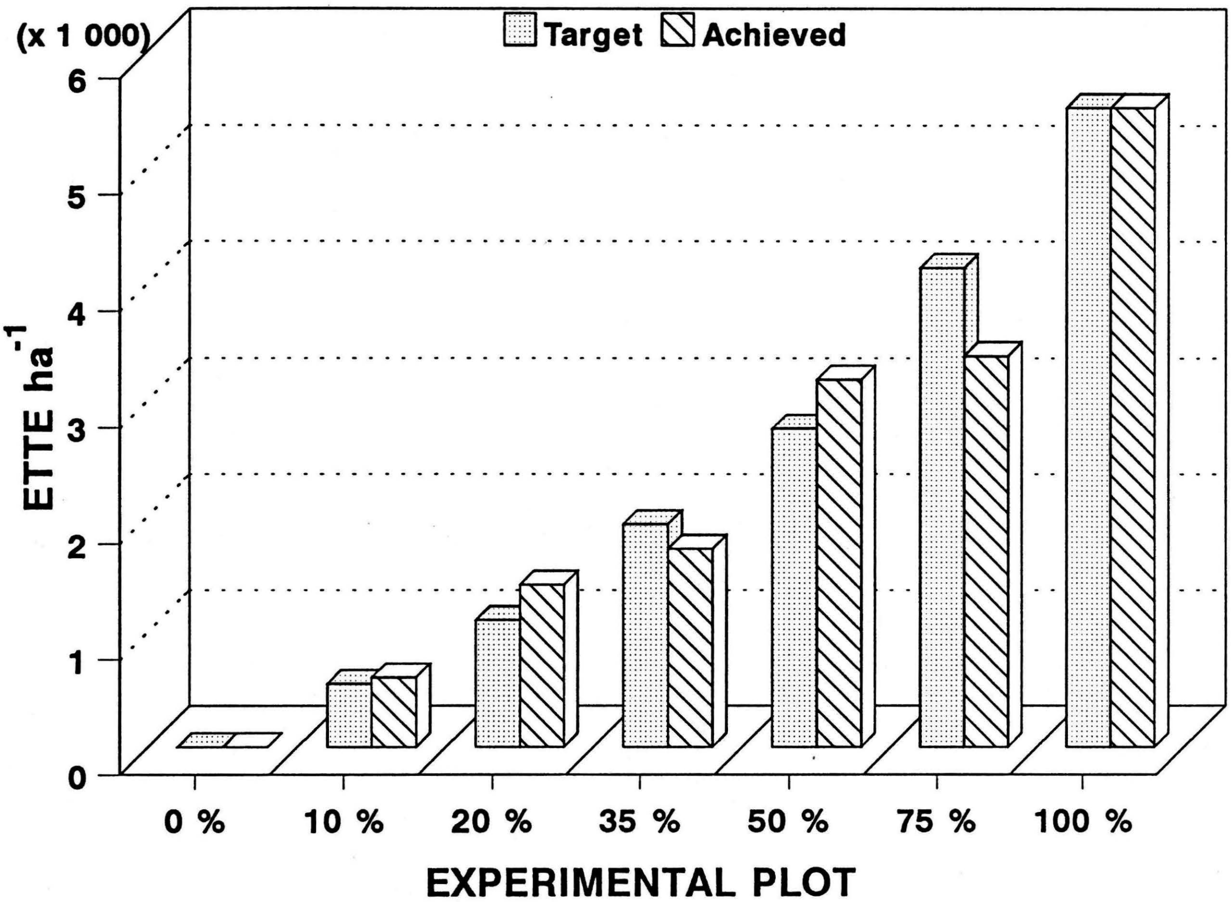


Figure 2.5 The required (target) and actual (achieved) leaf biomass of the *Colophospermum mopane* trees in each of the experimental plots immediately after thinning during 1989. Leaf biomass expressed as Evapotranspiration Tree Equivalents (ETTE) ha^{-1} (1 ETTE = 500 cm^3 leaf volume).

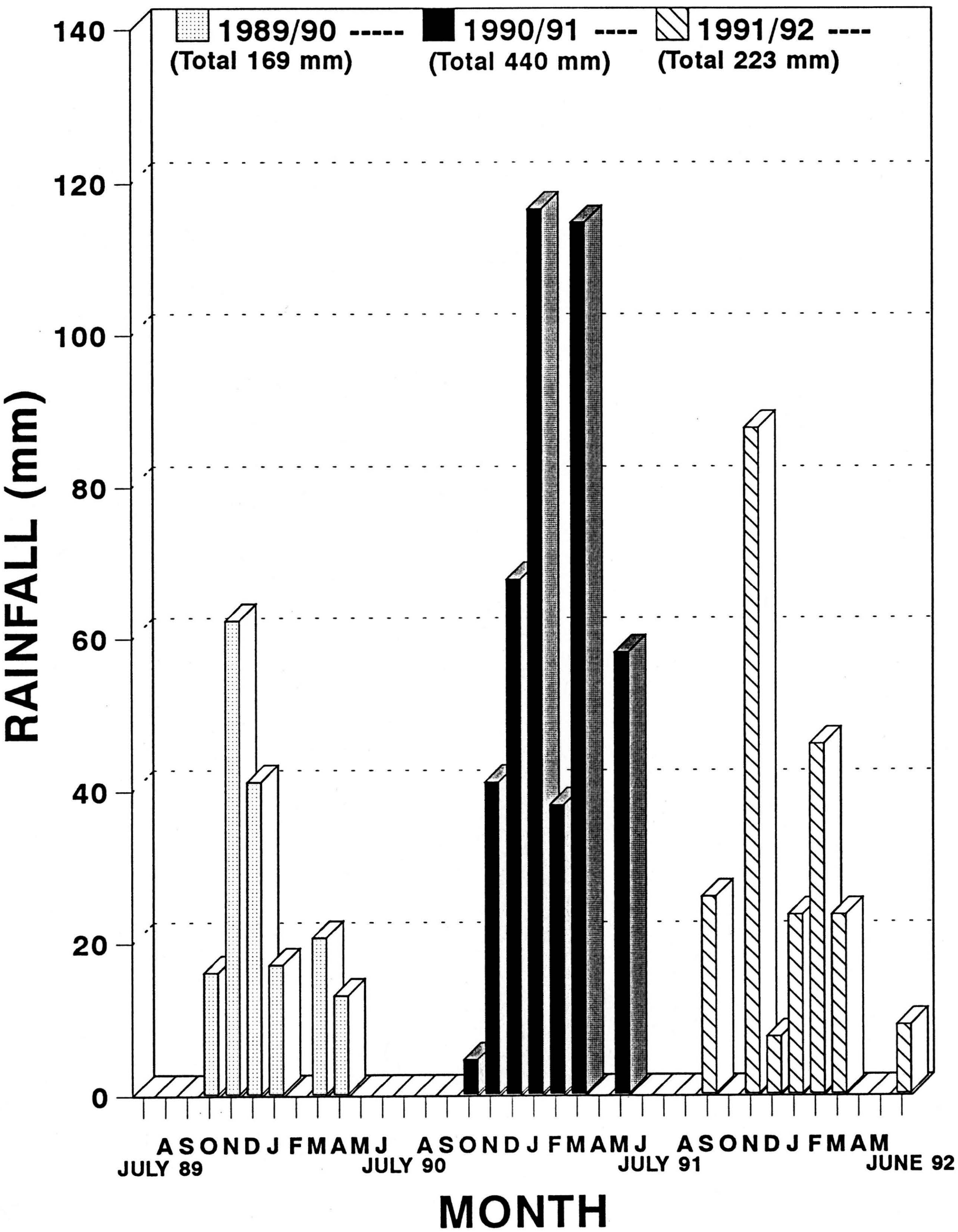


Figure 2.6 Monthly rainfall recorded at the experimental site during the three seasons (July-June) of the trial period (1989/90, 1990/91, 1991/92).

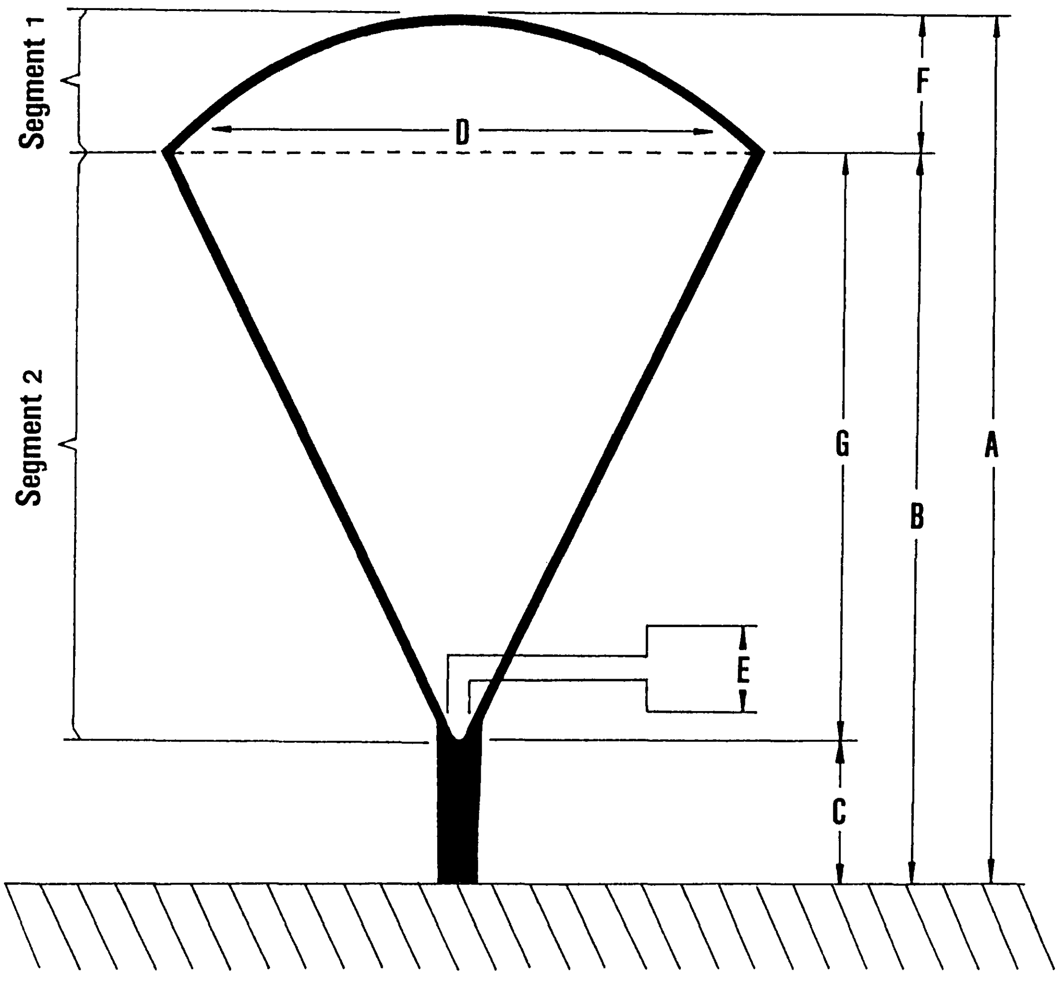


Figure 3.1 Schematic illustration of an ideal tree, its measurements and structure.

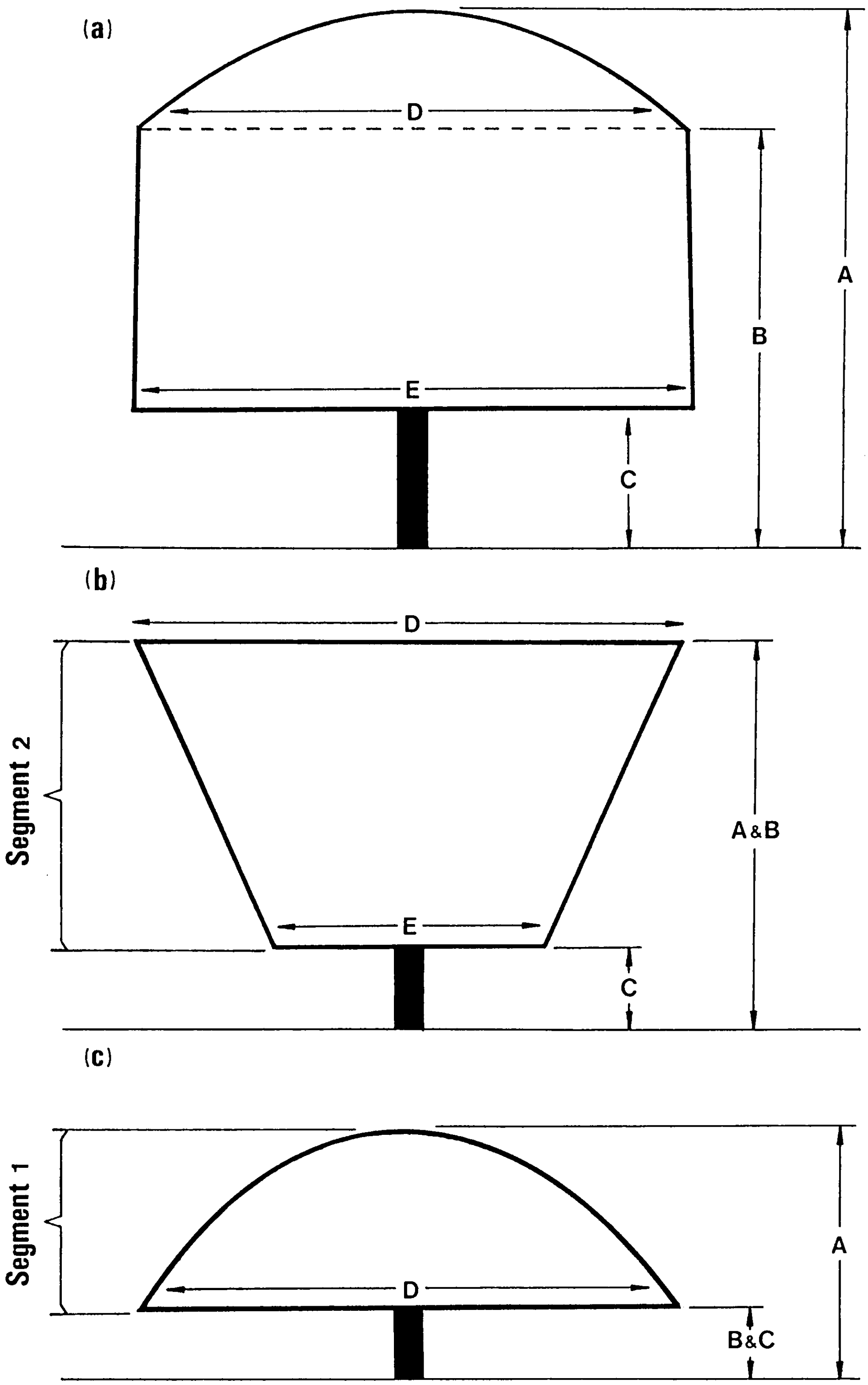


Figure 3.2 Schematic illustration of a few non-ideal trees, their measurements and structures.

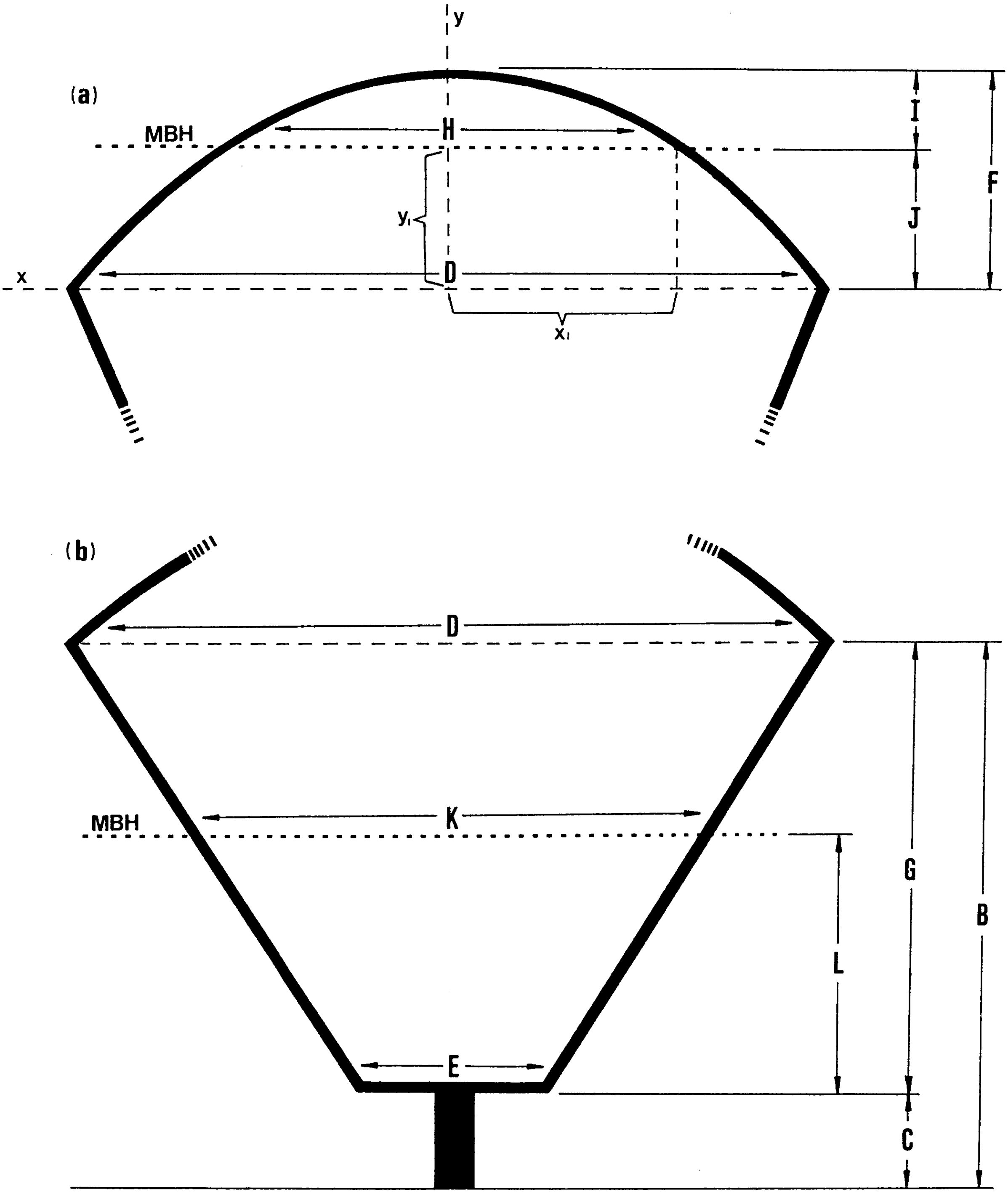


Figure 3.3 Examples of tree segment 1 divided by the maximum browse height (MBH) (a), and segment 2 divided by the MBH (b), showing the symbols referred to in the text.

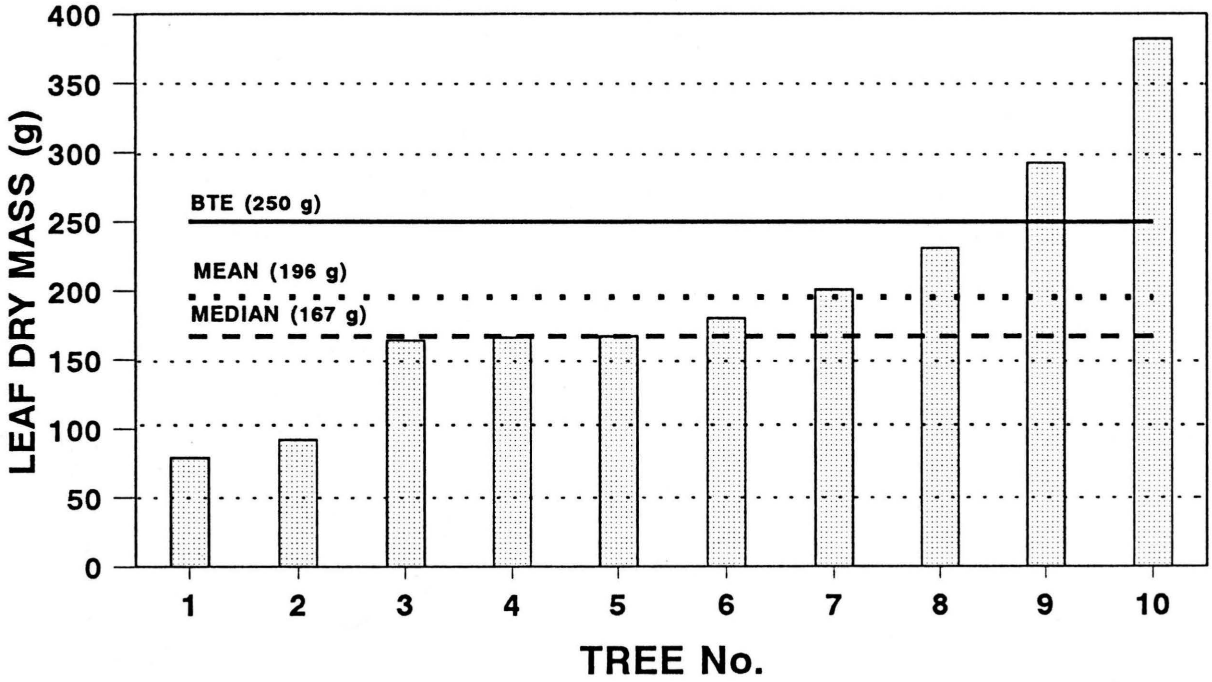


Figure 3.4 Graphic analysis of the true leaf dry mass of ten harvested 1.5 m *Colophospermum mopane* trees in comparison to the defined quantity of a BTE (1 BTE = 250 g leaf dry matter).

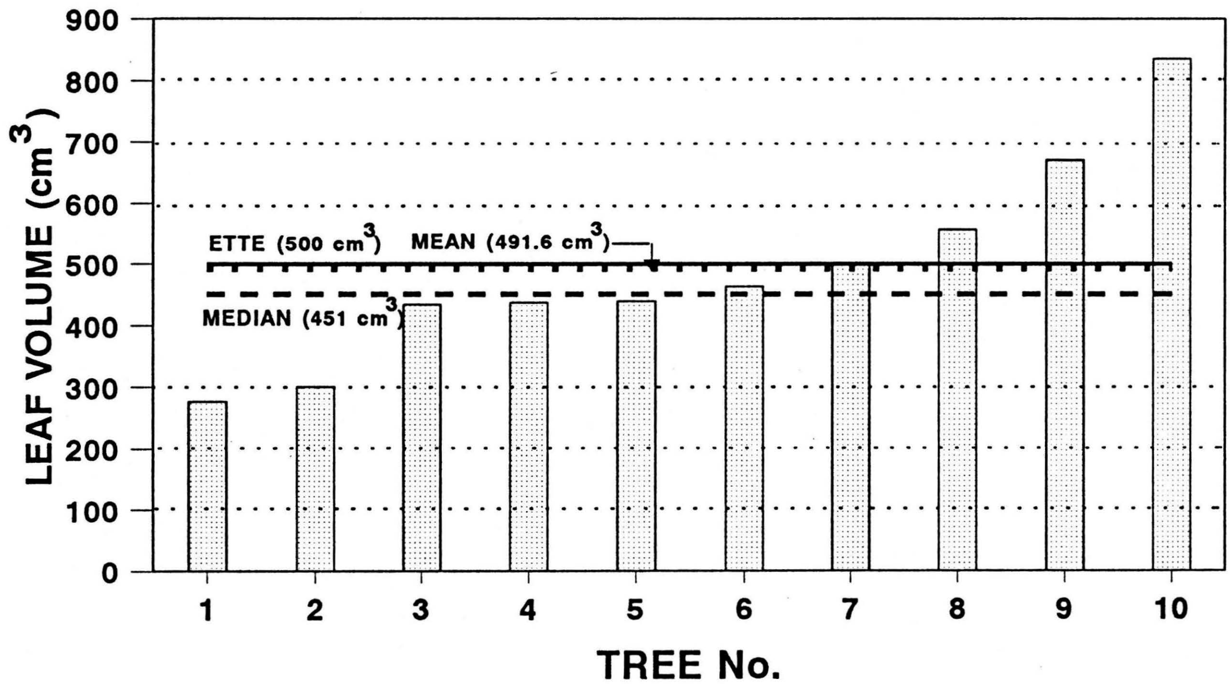


Figure 3.5 Graphic analysis of the true leaf volume of ten harvested 1.5 m *Colophospermum mopane* trees in comparison to the defined quantity of an ETTE (1 ETTE = 500 cm^3 leaf volume).

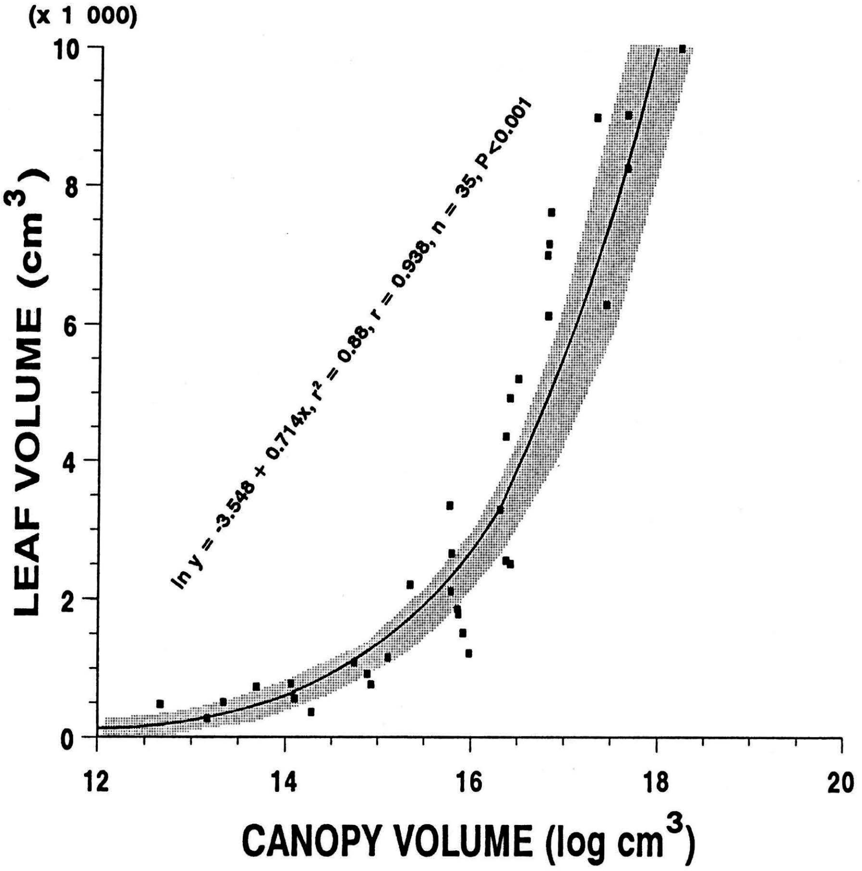


Figure 3.6 Regression analysis of the relation between spatial canopy volume (normal logarithm conversion) (independent variable) and leaf volume of *Colophospermum mopane* (shaded area: 95 % confidence limits).

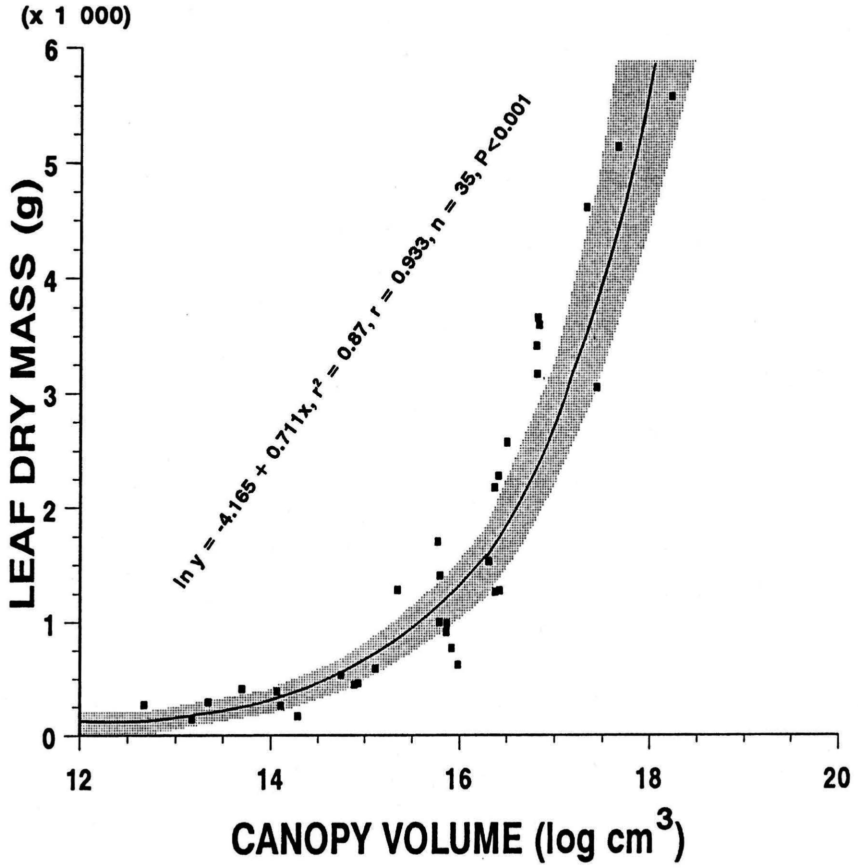


Figure 3.7 Regression analysis of the relation between spatial canopy volume (normal logarithm conversion) (independent variable) and leaf dry mass of *Colophospermum mopane* (shaded area: 95 % confidence limits).

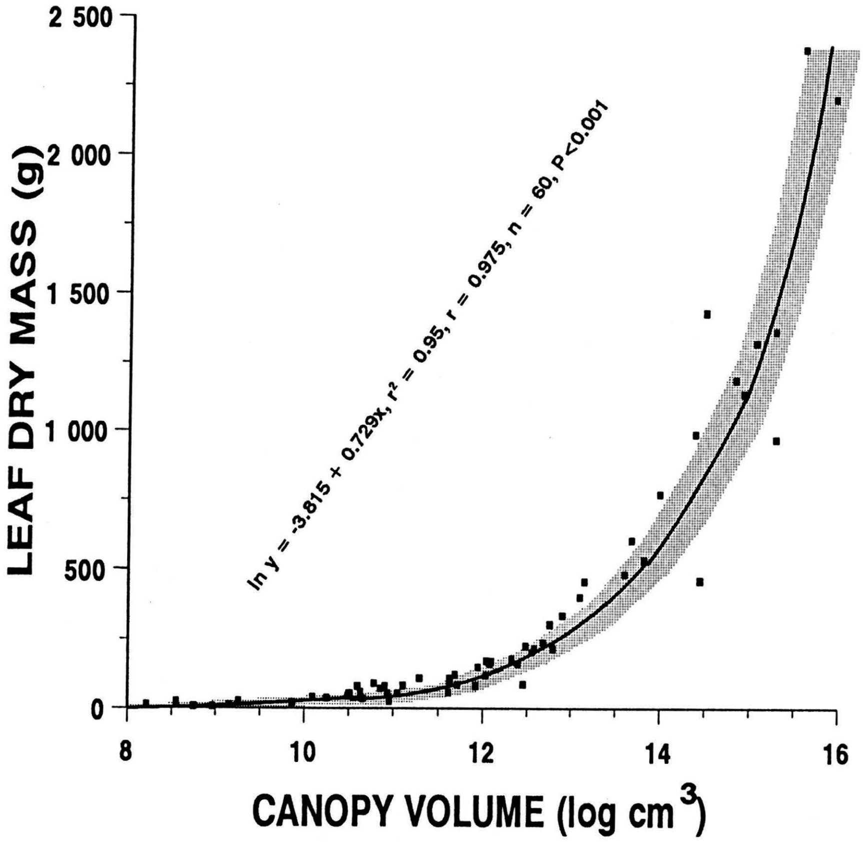


Figure 3.8 Regression analysis of the relation between spatial canopy volume (normal logarithm conversion) (independent variable) and leaf volume of *Colophospermum mopane* regrowth (shaded area: 95 % confidence limits).

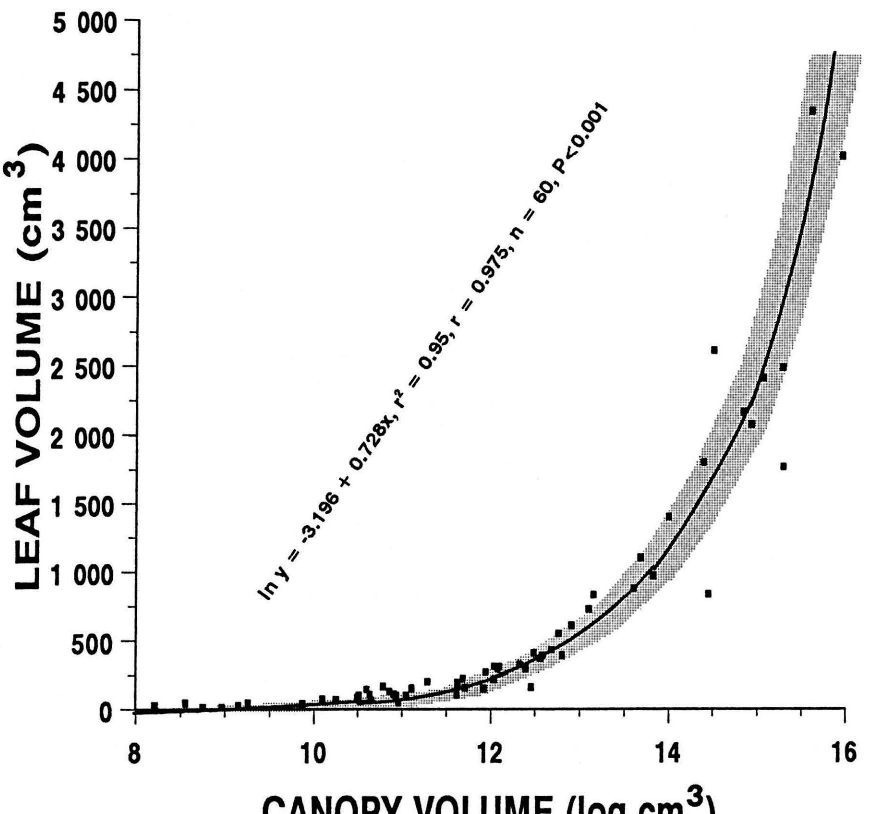


Figure 3.9 Regression analysis of the relation between spatial canopy volume (normal logarithm conversion) (independent variable) and leaf dry mass of *Colophospermum mopane* regrowth (shaded area: 95 % confidence limits).

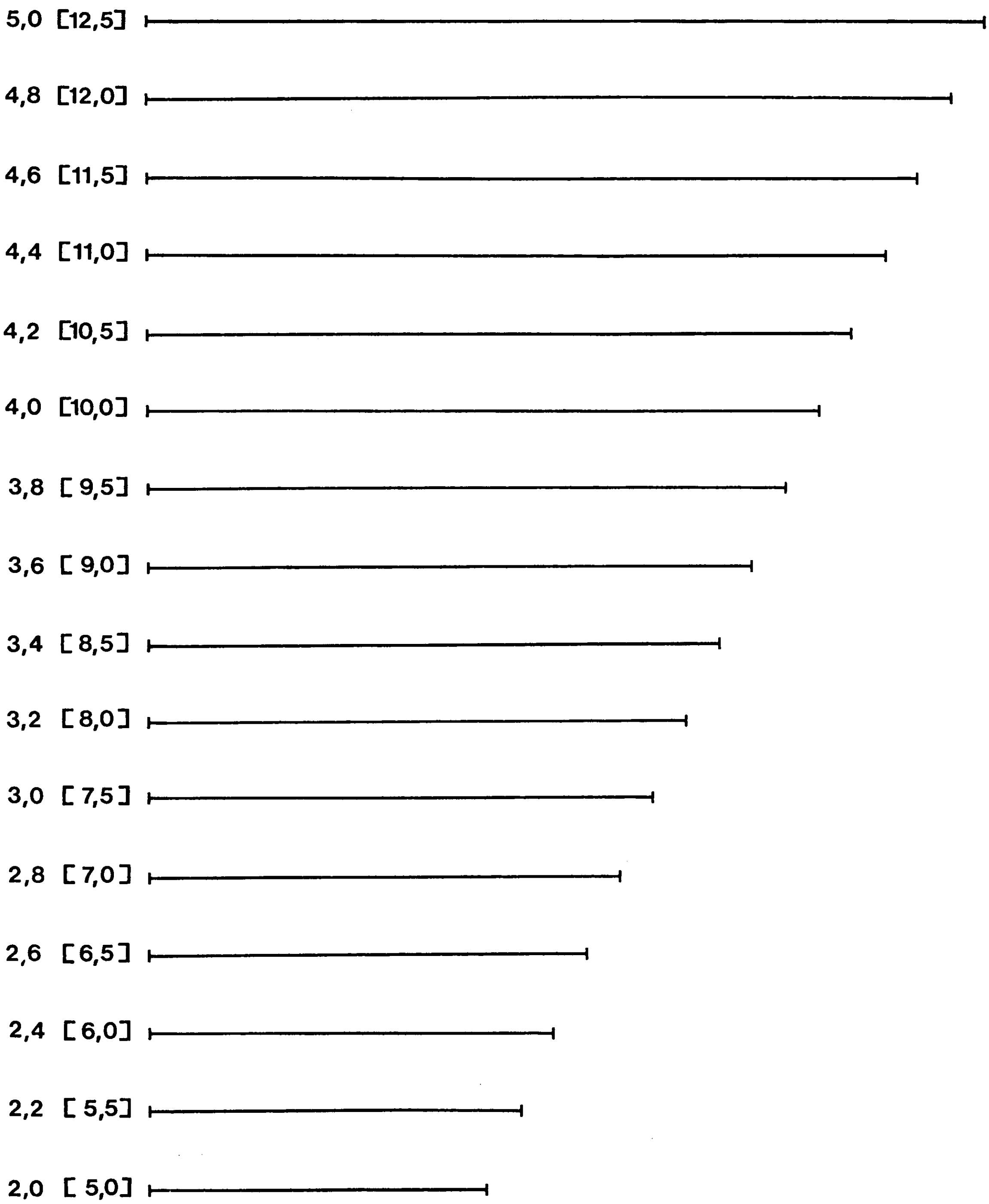


Figure 3.10 Length scales for linear estimates of 2.0 - 12.5 m.

Table 4.1 Descriptive unit values of the different methods of plant survey as applied to *Colophospermum mopane* in the various experimental plots during the period 1989 to 1992.

Year	Exp. plot	ETTE ha^{-1}	Trees ha^{-1}	Stems ha^{-1}	TE ha^{-1}	Canopy cover (%)
1989	10	605.5	300.0	711.1	881.7	3.0
1989	20	1 406.1	588.9	1 344.4	2 102.3	9.9
1989	35	1 717.4	744.4	1 455.6	2 631.8	20.4
1989	50	3 176.2	1 233.3	2 777.8	4 344.9	28.3
1989	75	3 376.7	1 977.8	4 044.4	5 185.1	43.9
1989	100	5 509.9	2 711.1	5 722.2	8 444.4	47.0
1990	10	707.5	311.1	677.8	853.9	2.5
1990	20	1 669.5	511.1	1 344.8	1 889.3	8.4
1990	35	2 008.0	733.3	1 422.2	2 453.6	22.4
1990	50	3 487.6	1 177.8	2 577.8	3 969.0	24.0
1990	75	3 602.9	1 944.4	4 011.1	5 003.0	43.2
1990	100	5 900.8	2 666.7	5 911.1	8 194.4	52.1
1991	10	809.9	311.1	633.3	815.0	3.2
1991	20	1 885.5	488.9	1 322.2	1 887.3	14.8
1991	35	2 136.1	688.9	1 377.8	2 464.9	20.1
1991	50	3 503.3	1 100.0	2 466.7	3 650.7	27.5
1991	75	3 769.3	1 766.7	3 877.8	4 708.0	41.6
1991	100	5 962.3	2 622.2	5 522.2	7 551.1	53.5
1992	10	998.4	300.0	655.6	840.8	7.6
1992	20	2 171.8	488.9	1 333.3	1 907.7	14.1
1992	35	2 540.8	711.1	1 477.8	2 459.7	22.0
1992	50	3 870.8	1 100.0	2 555.6	3 781.9	28.1
1992	75	4 197.2	1 822.2	3 722.2	4 666.8	46.8
1992	100	6 733.0	2 511.1	5 344.4	7 594.4	49.0

Table 4.2 Cross tabulation of the correlations (n = 24) between the various descriptive units of woody plant communities as applied to *Colophospermum mopane* in the various experimental plots during the period 1989 to 1992.

Unit → ↓	ETTE	TREES	STEMS	TE	COVER
ETTE	-	0.94 ***	0.95 ***	0.96 ***	0.93 ***
TREES	0.94 ***	-	0.99 ***	0.99 ***	0.96 ***
STEMS	0.95 ***	0.99 ***	-	0.99 ***	0.96 ***
TE	0.96 ***	0.99 ***	0.99 ***	-	0.94 ***
COVER	0.93 ***	0.96 ***	0.96 ***	0.94 ***	-

* = Significant ($P<0.05$); ** = Highly significant ($P<0.01$); *** = Highly significant ($P<0.001$)

(ETTE = Evapotranspiration Tree Equivalents ha^{-1}; TREES = Trees ha^{-1}; STEMS = Stems ha^{-1}; TE = Tree Equivalents ha^{-1}; COVER = Tree canopy cover (%)).

Table 4.3 Coefficients and r^2-values of multiple regression analysis with true leaf volume (cm^3) of the harvested trees as the independent variable (standard error of each coefficient indicated in brackets).

Constant	Canopy diameter	Tree height	r^2
-1 981.09 (406.36)	2 026.70 (142.29)		0.849
-2 626.06 (453.81)	1 670.44 (191.72)	431.02 (167.79)	0.873

Table 4.4 Additional regression equations for the transformation of values of any descriptive unit as applied to *Colophospermum mopane*.

Independent variable	Dependent variable	Regression equation (y = a + bx)	r^2	r	n	P
TE ha^{-1}	ETTE ha^{-1}	y = 366.34 + 0.713x	0.96	0.980	24	P<0.001
	Trees ha^{-1}	y = -74.65 + 0.347 x	0.98	0.990	24	P<0.001
	Stems ha^{-1}	y = -87.71 + 0.729x	0.98	0.990	24	P<0.001
	Canopy cover (%)	y = 1.698 + 0.0067 x	0.94	0.970	24	P<0.001
Trees ha^{-1}	ETTE ha^{-1}	y = 606.43 + 1.985x	0.94	0.970	24	P<0.001
	TE ha^{-1}	y = 316.34 + 2.801x	0.98	0.990	24	P<0.001
	Stems ha^{-1}	y = 86.69 + 2.089x	0.99	0.995	24	P<0.001
	Canopy cover (%)	y = 2.940 + 0.019x	0.96	0.980	24	P<0.001
Stems ha^{-1}	ETTE ha^{-1}	y = 507.97 + 0.956x	0.95	0.975	24	P<0.001
	TE ha^{-1}	y = 199.01 1.341x	0.98	0.990	24	P<0.001
	Stems ha^{-1}	y = -33.38 + 0.475 x	0.99	0.995	24	P<0.001
	Canopy cover (%)	y = 2.395 + 0.0092x	0.96	0.980	24	P<0.001
Canopy cover (%)	ETTE ha^{-1}	y = 439.84 + 96.72x	0.93	0.964	24	P<0.001
	TE ha^{-1}	y = 188.32 + 132.24x	0.94	0.970	24	P<0.001
	Trees ha^{-1}	y = -56.64 + 47.63x	0.96	0.980	24	P<0.001
	Stems ha^{-1}	y = -20.05 + 99.10x	0.96	0.980	24	P<0.001

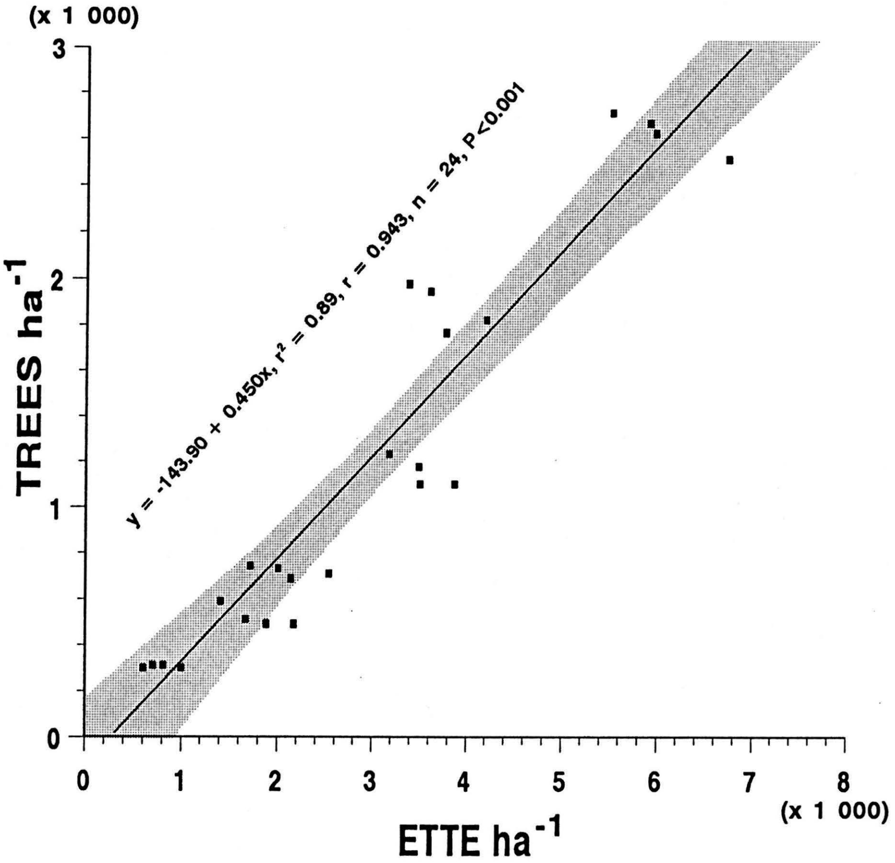


Figure 4.1 Regression analysis of the relation between Evapotranspiration Tree Equivalents (ETTE) ha^{-1} (independent variable) and trees ha^{-1} (shaded area: 95 % confidence limits).

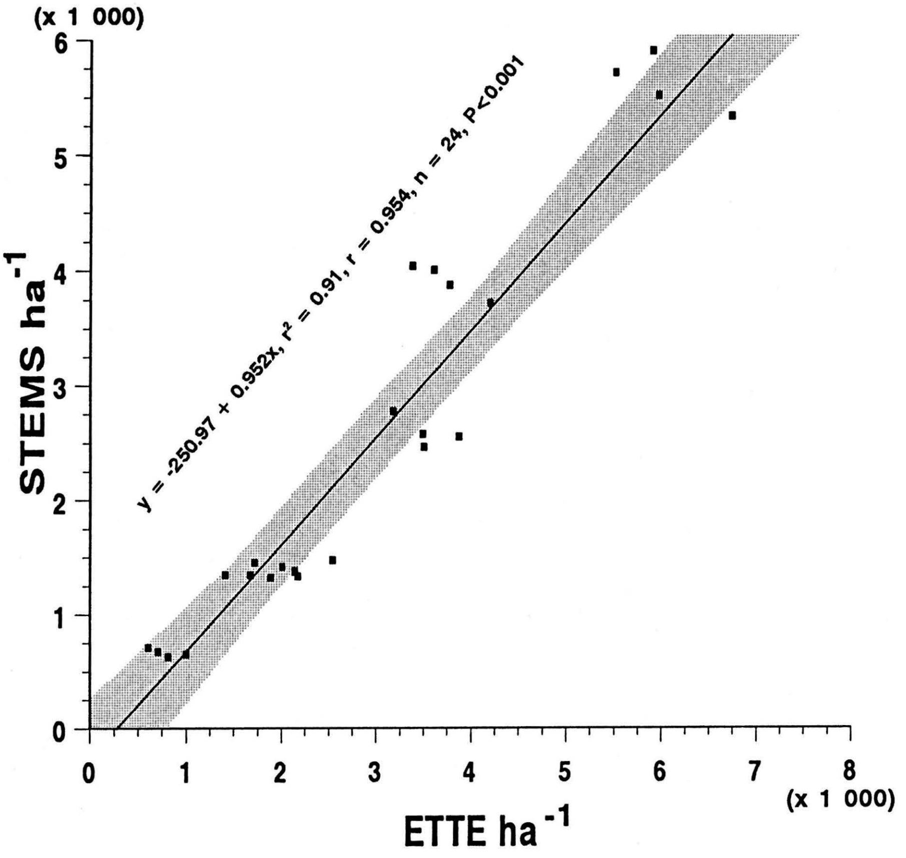


Figure 4.2 Regression analysis of the relation between Evapotranspiration Tree Equivalents (ETTE) ha^{-1} (independent variable) and stems ha^{-1} (shaded area: 95 % confidence limits).

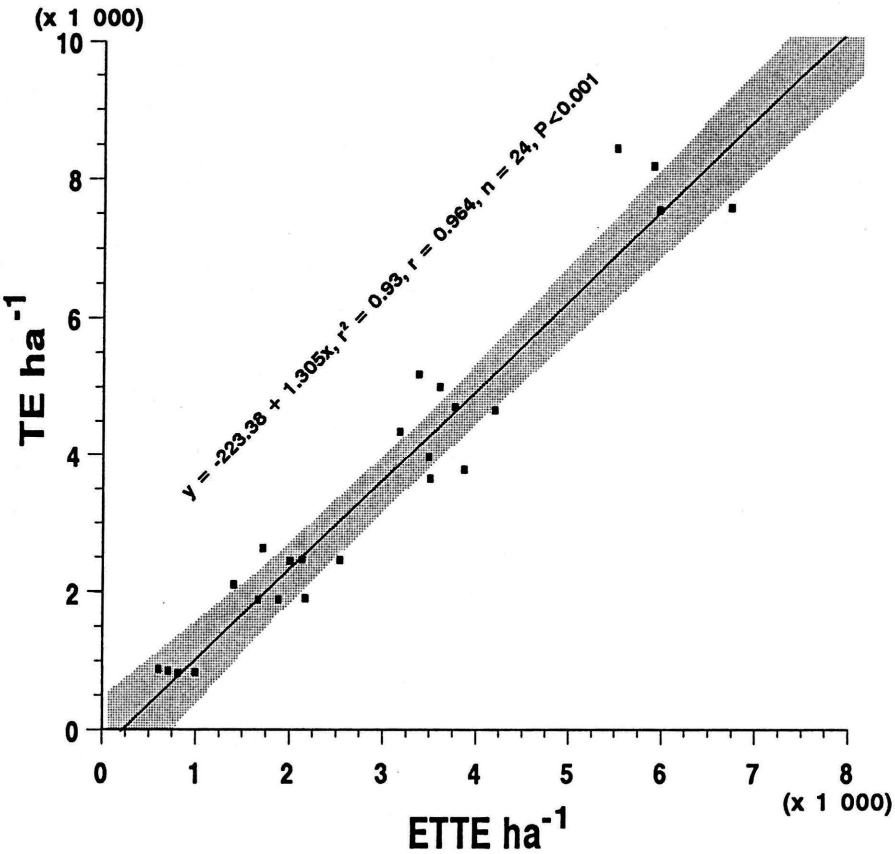


Figure 4.3 Regression analysis of the relation between Evapotranspiration Tree Equivalents (ETTE) ha^{-1} (independent variable) and Tree Equivalents (TE) ha^{-1} (shaded area: 95 % confidence limits).

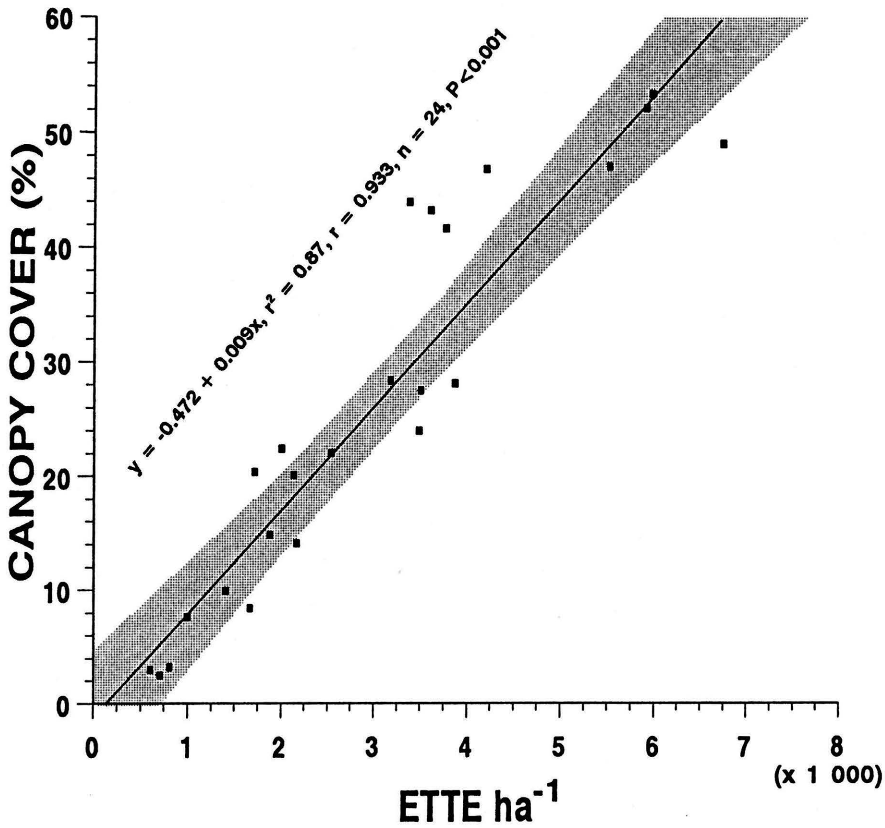


Figure 4.4 Regression analysis of the relation between Evapotranspiration Tree Equivalents (ETTE) ha^{-1} (independent variable) and % canopy cover (shaded area: 95 % confidence limits).

Table 5.1 Mean root biomass of the ten excavation plots by diameter class and vertical distribution (standard error of mean indicated in brackets).

Soil depth layer (cm)	Root diameter class												Total root DM (kg ha^{-1})
	0-1.0 mm			>1.0-5.0 mm			>5.0-10.0 mm			>10.0 mm			
	Root DM (kg ha^{-1})	% (*)	% (#)	Root DM (kg ha^{-1})	% (*)	% (#)	Root DM (kg ha^{-1})	% (*)	% (#)	Root DM (kg ha^{-1})	% (*)	% (#)	
0-20	1 309.0 (291.2)	39.62	53.30	739.0 (156.3)	21.01	30.09	203.0 (51.7)	7.23	8.27	205.0 (94.6)	2.65	8.35	2 456.0
20-40	1 155.0 (125.4)	34.96	19.63	1 304.0 (153.2)	37.07	22.17	1 008.0 (124.9)	35.88	17.13	2 416.0 (450.8)	31.28	41.07	5 883.0
40-60	464.0 (108.7)	14.04	10.95	824.0 (112.3)	23.42	19.45	680.0 (173.6)	24.21	16.05	2 269.0 (710.2)	29.38	53.55	4 237.0
60-80	268.0 (68.8)	8.11	8.35	374.0 (79.7)	10.63	11.65	616.0 (147.2)	21.93	19.18	1 953.0 (551.8)	25.29	60.82	3 211.0
80-100	108.0 (26.6)	3.27	6.89	277.0 (58.2)	7.87	17.68	302.0 (63.1)	10.75	19.27	880.0 (373.9)	11.39	56.16	1 567.0
Total	3 304.0			3 518.0			2 809.0			7 723.0			17 354.0

% (*) – percentage of all roots of that root diameter class
% (#) – percentage of all roots of that soil depth layer

Table 5.2 Root : leaf ratios based on the root dry mass and leaf dry mass of the ten excavation sites with subdivision by root diameter classes.

Excavation site	Root : leaf ratio						
	All roots	Fine roots (<5 mm)	Coarse roots (>5 mm)	Roots 0-1 mm	Roots >1-5 mm	Roots >5-10 mm	Roots >10 mm
1	16.66	9.15	7.51	4.54	4.61	4.40	3.11
2	24.70	8.11	16.59	2.54	5.58	3.44	13.14
3	17.95	6.13	11.82	2.70	3.43	2.25	9.56
4	12.58	7.59	4.99	3.37	4.22	2.94	2.05
5	25.58	7.94	17.64	3.92	4.02	2.67	14.97
6	17.74	5.78	11.97	3.30	2.47	3.19	8.78
7	10.85	3.54	7.31	1.69	1.85	1.58	5.73
8	11.54	5.55	5.99	2.71	2.84	2.09	3.90
9	18.24	6.75	11.49	4.14	2.61	2.88	8.60
10	13.70	5.97	7.74	2.49	3.48	2.25	5.49
Mean (SE)	16.95 (1.61)	6.65 (0.51)	10.30 (1.37)	3.14 (0.28)	3.51 (0.56)	2.77 (0.25)	7.53 (1.35)

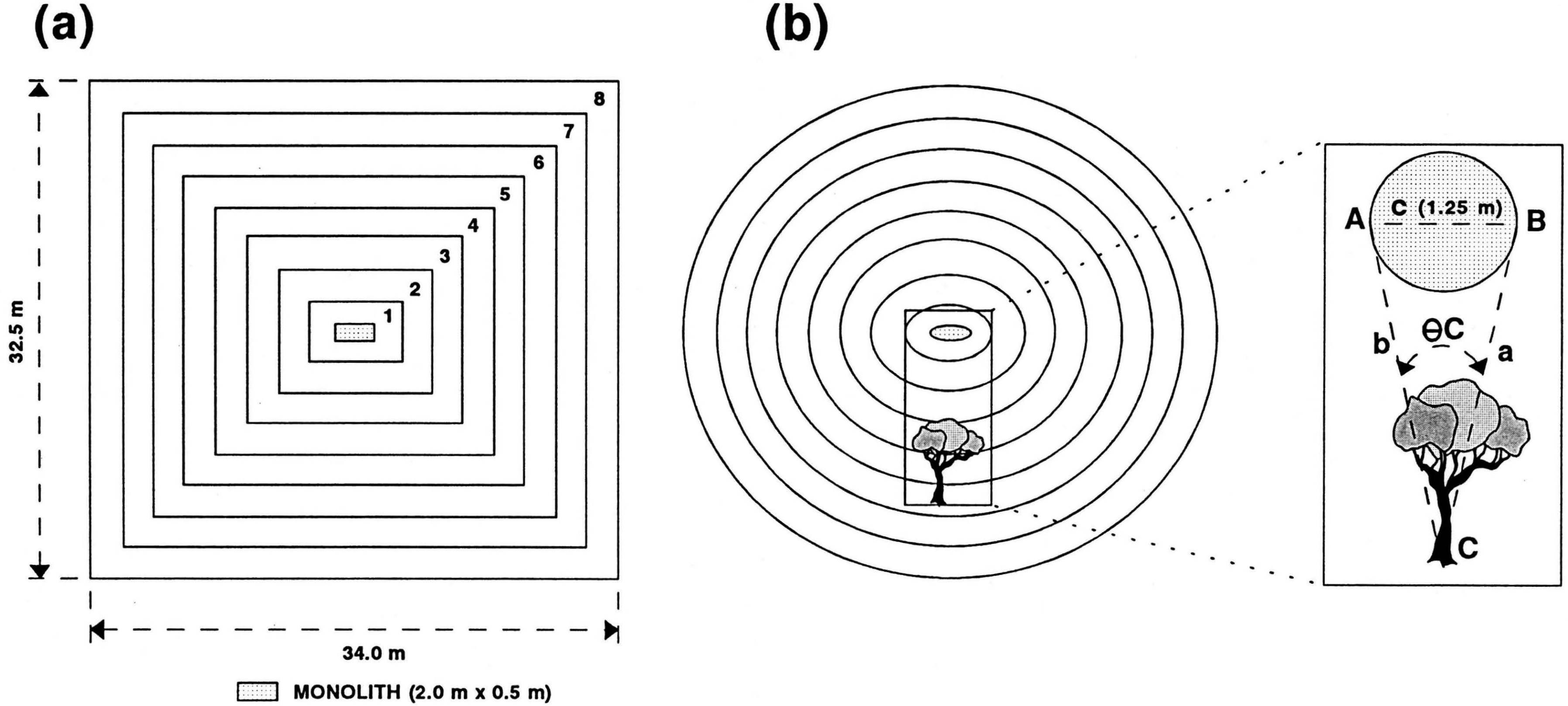
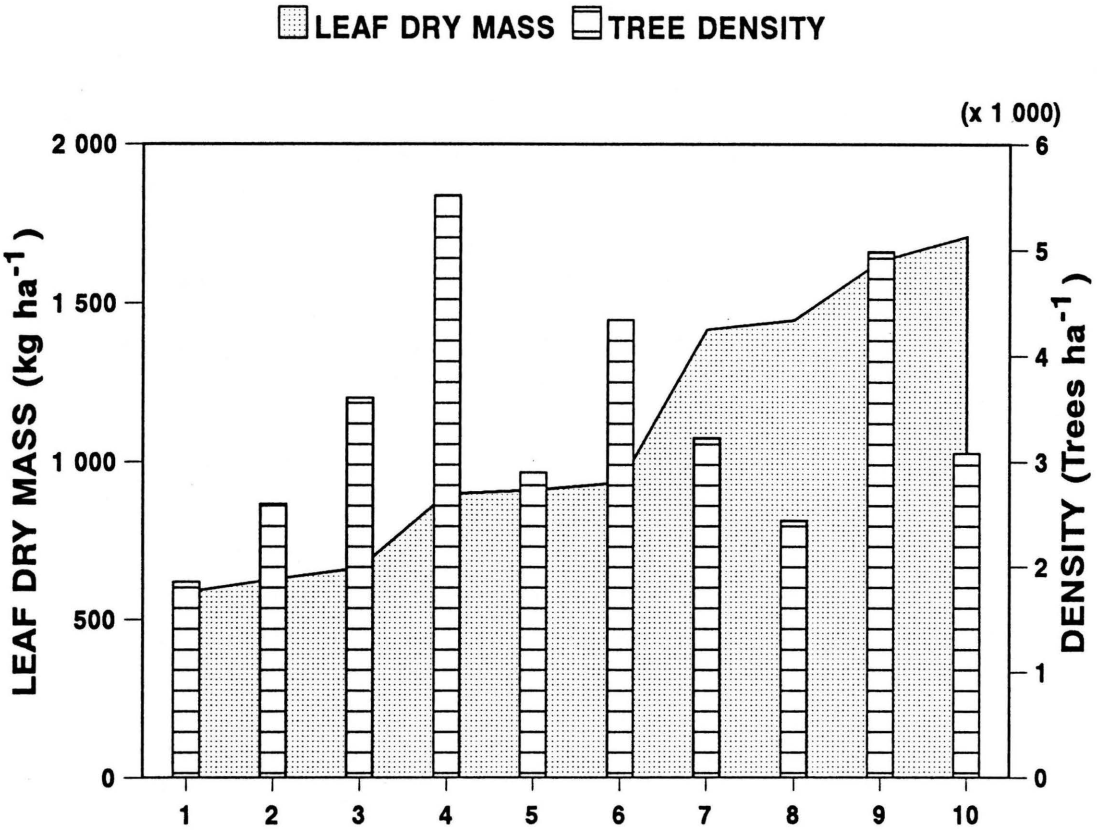


Figure 5.1 Graphic illustration of (a) the monolith in relation to the 8 blocks demarcated around it, and (b) the theoretical approach used in the calculation of leaf mass fractions of trees in relation to the position of the monolith (see text).



	1	2	3	4	5	6	7	8	9	10
TREE DENSITY	1,857	2,599	3,605	5,516	2,898	4,339	3,225	2,437	4,982	3,081
LEAF DRY MASS	586	627	662	898	910	935	1 416	1 445	1 633	1 709

PLOT

Figure 5.2 The estimated leaf biomass and densities of *Colophospermum mopane* trees of the total survey area demarcated around each root excavation site.

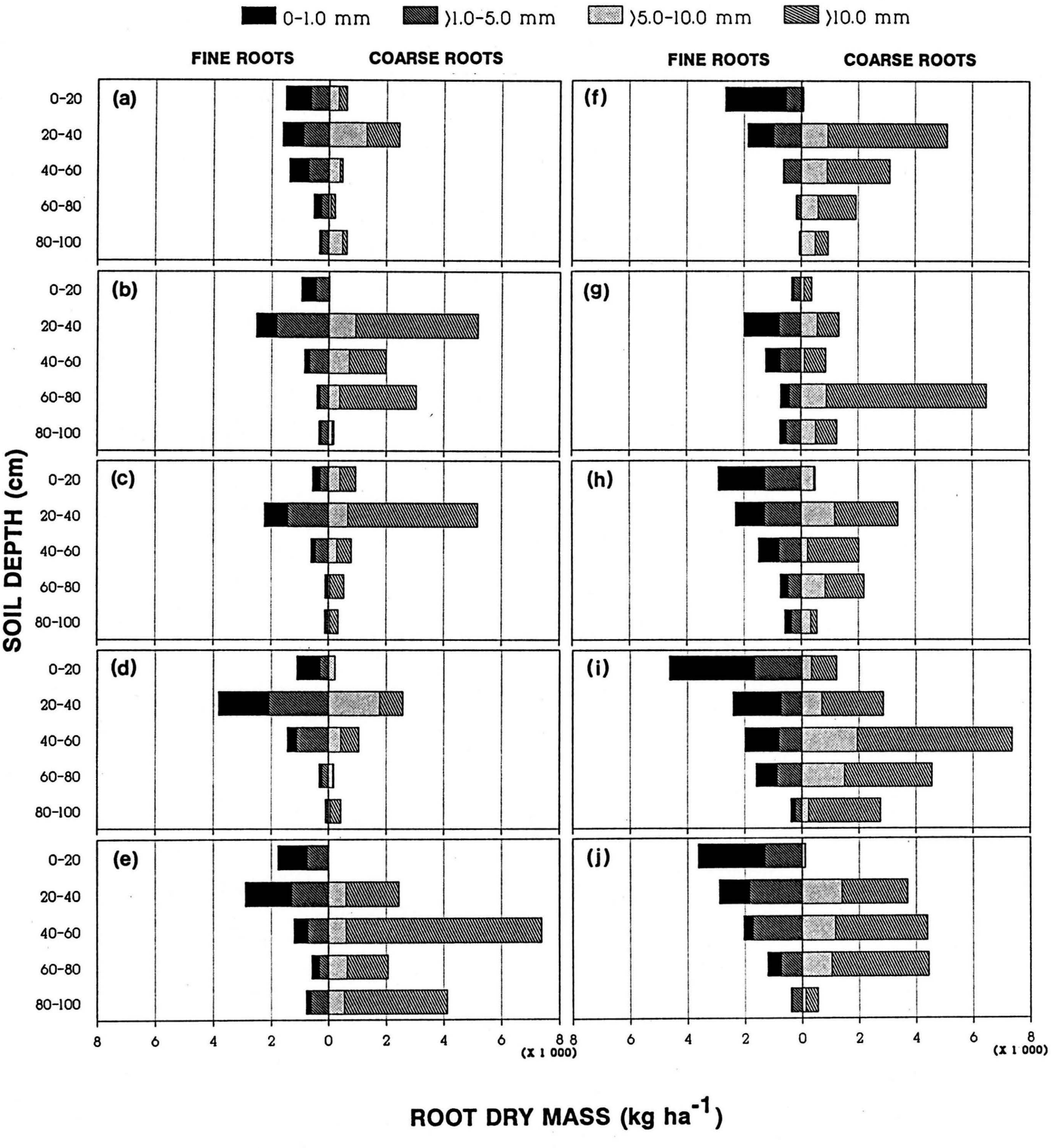


Figure 5.3 Root dry mass of the ten excavation plots by diameter class and vertical distribution.

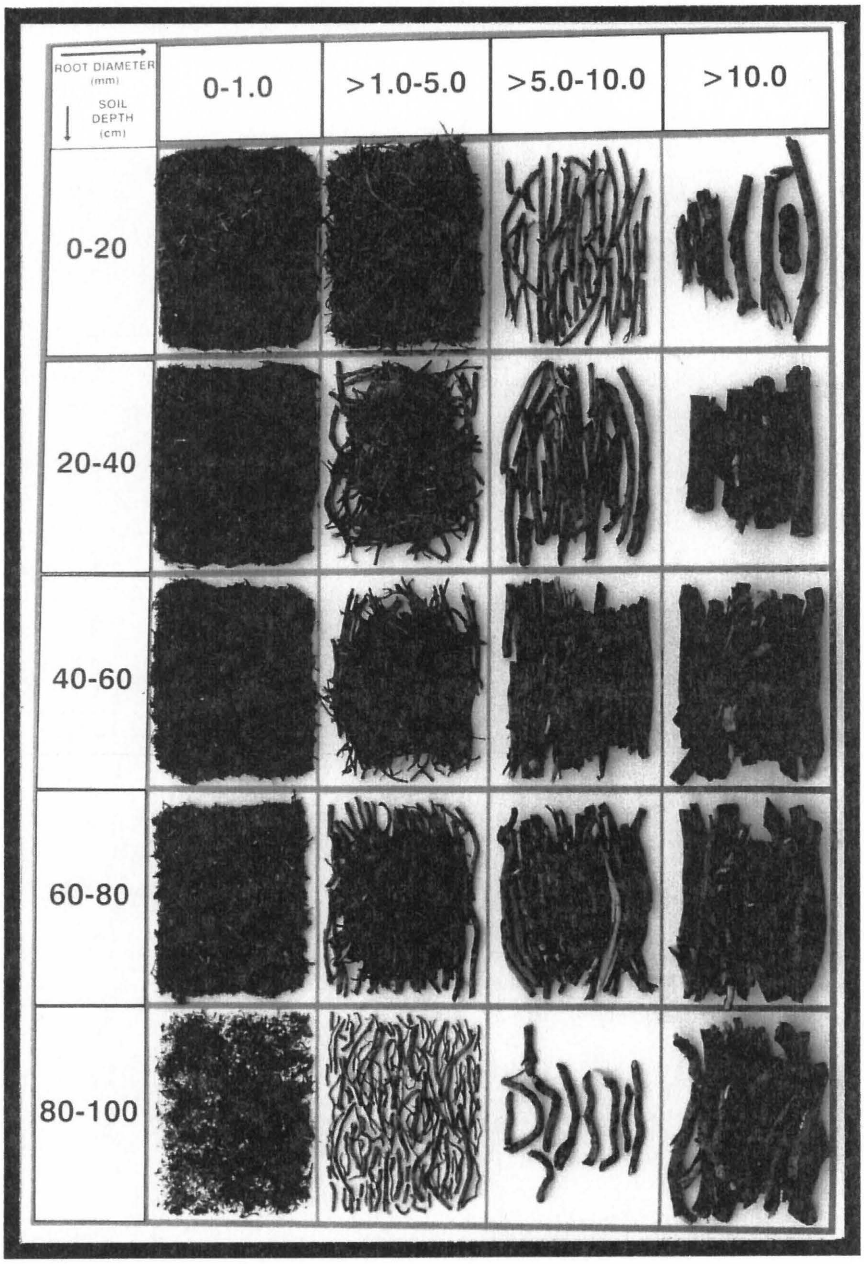


Figure 5.4 Illustration of the actual roots, by diameter class and vertical distribution, washed from the 1 m^3 monolith with the highest root biomass (plot 9).

Table 6.1 Mean tree height, mean tree canopy diameter and mean leaf dry mass of the *Colophospermum mopane* trees in the various experimental plots (standard errors of means indicated in brackets), with indication of the seasonal changes of these variables.

Exp. plot	Variable	n	1989	1989/90	1990/91	1991/92
10 %	TH (m)	28	2.24 (0.20)	2.24 (0.21)	2.24 (0.22)	2.37 (0.23)
	ΔTH (m)		-	0	0	0.13
	ΔTH (%)		-	0	0	5.80
	CD (m)	28	1.44 (0.16)	1.52 (0.16)	1.70 (0.16)	1.99 (0.17)
	ΔCD (m)		-	0.08	0.18	0.29
	ΔCD (%)		-	5.56	11.84	17.06
	DM (g)	28	520.5 (108)	586.3 (121)	671.0 (131)	857.7 (157)
	ΔDM (g)		-	65.8	84.7	186.7
	ΔDM (%)		-	12.6	14.5	27.8
20 %	TH (m)	47	2.55 (0.13)	2.70 (0.16)	2.73 (0.14)	2.76 (0.15)
	ΔTH (m)		-	0.15	0.03	0.03
	ΔTH (%)		-	5.88	1.11	1.10
	CD (m)	47	1.57 (0.12)	1.91 (0.13)	2.15 (0.13)	2.34 (0.14)
	ΔCD (m)		-	0.34	0.24	0.19
	ΔCD (%)		-	21.66	12.57	8.84
	DM (g)	47	615.5 (79)	841.8 (106)	993.9 (108)	1 144.7(125)
	ΔDM (g)		-	226.3	152.2	150.8
	ΔDM (%)		-	36.8	18.1	15.2
35 %	TH (m)	65	2.94 (0.15)	2.96 (0.15)	3.02 (0.13)	3.08 (0.14)
	ΔTH (m)		-	0.02	0.06	0.06
	ΔTH (%)		-	0.68	2.02	1.99
	CD (m)	65	1.45 (0.09)	1.62 (0.10)	1.80 (0.10)	1.89 (0.11)
	ΔCD (m)		-	0.17	0.18	0.09
	ΔCD (%)		-	11.72	11.11	5.00
	DM (g)	65	594.8 (66)	705.9 (75)	799.2 (76)	920.8 (90)
	ΔDM (g)		-	111.1	93.3	121.6
	ΔDM (%)		-	18.7	13.2	15.2
50 %	TH (m)	104	2.67 (0.12)	2.76 (0.14)	2.65 (0.14)	2.61 (0.14)
	ΔTH (m)		-	0.09	-0.11	-0.04
	ΔTH (%)		-	3.37	-4.0	-1.51
	CD (m)	104	1.61 (0.08)	1.74 (0.08)	1.89 (0.09)	1.98 (0.09)
	ΔCD (m)		-	0.13	0.15	0.09
	ΔCD (%)		-	8.07	8.62	4.76
	DM (g)	104	663.8 (61)	762.8 (68)	820.9 (68)	906.9 (84)
	ΔDM (g)		-	99.0	58.1	86.0
	ΔDM (%)		-	14.9	7.6	10.5

Table 6.1 continued .....

Table 6.1 continued ....

Exp. plot	Variable	n	1989	1989/90	1990/91	1991/92
75 %	TH (m)	169	2.04 (0.09)	2.09 (0.09)	2.15 (0.10)	2.06 (0.10)
	ΔTH (m)		-	0.05	0.06	-0.09
	ΔTH (%)		-	2.45	2.87	-4.19
	CD (m)	169	1.26 (0.06)	1.30 (0.06)	1.50 (0.06)	1.53 (0.07)
	ΔCD (m)		-	0.04	0.02	0.03
	ΔCD (%)		-	3.17	15.38	2.00
	DM (g)	169	440.3 (36)	477.7 (45)	550.0 (45)	593.8 (51)
	ΔDM (g)		-	37.4	72.3	43.8
	ΔDM (%)		-	8.5	15.1	8.0
100 %	TH (m)	237	2.48 (0.08)	2.47 (0.08)	2.40 (0.08)	2.46 (0.09)
	ΔTH (m)		-	-0.01	-0.07	0.06
	ΔTH (%)		-	-0.40	-0.83	2.50
	CD (m)	237	1.38 (0.05)	1.45 (0.05)	1.52 (0.05)	1.62 (0.06)
	ΔCD (m)		-	0.07	0.07	0.10
	ΔCD (%)		-	5.07	4.83	6.58
	DM (g)	237	524.0 (36)	570.5 (39)	586.2 (39)	691.1 (47)
	ΔDM (g)		-	46.5	15.7	104.9
	ΔDM (%)		-	8.9	2.8	17.9

TH - Mean tree height (m)
ΔTH - Mean change in tree height (m and %)
CD - Mean tree canopy diameter (m)
ΔCD - Mean change in tree canopy diameter (m and %)
DM - Mean leaf dry mass (g)
ΔDM - Mean change in leaf dry mass (g and %)

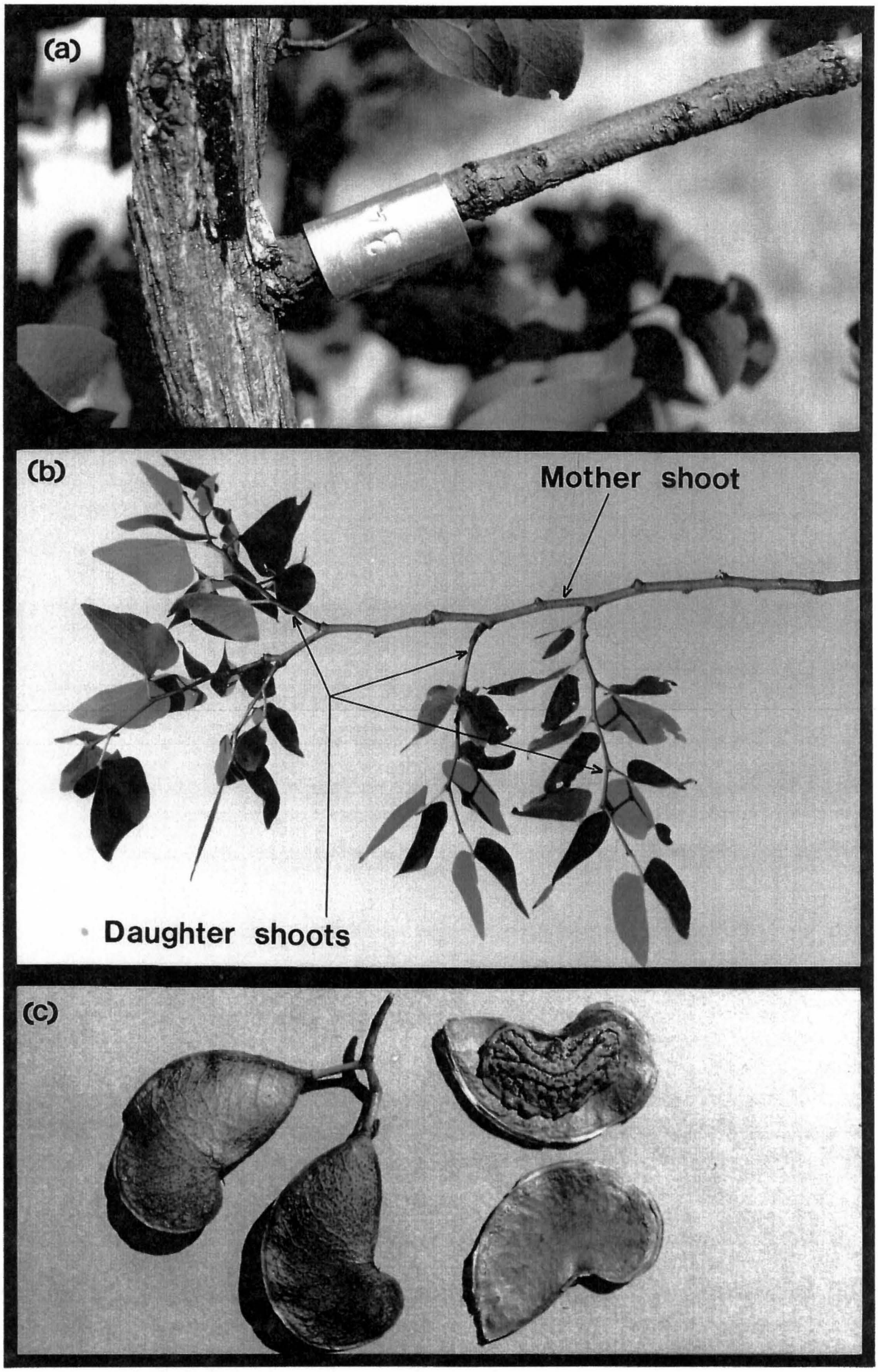


Figure 6.1 Illustration of (a) an aluminium ring used to mark individual shoots, (b) a typical shoot of *Colophospermum mopane* indicating the mother shoot and daughter shoots, and (c) typical seeds of *C. mopane* illustrating the pod and the actual seed.

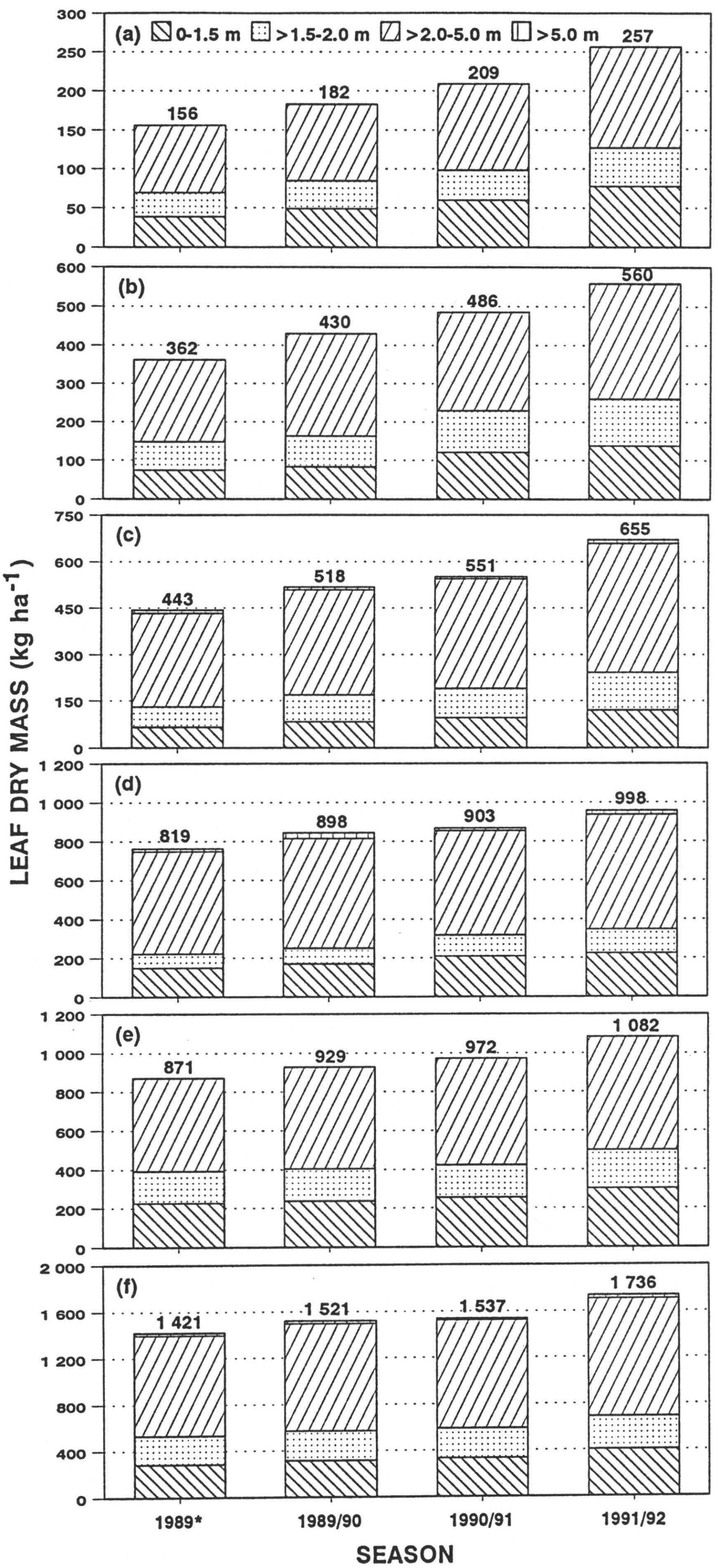


Figure 6.2 Estimates of the total leaf DM ha^{-1}, with subdivision into height stratums, of the remaining *Colophospermum mopane* trees of the experimental plots immediately after thinning (1989*) and at the end of the three succeeding growing seasons: (a) 10 % plot, (b) 20 % plot, (c) 35 % plot, (d) 50 % plot, (e) 75 % plot, (f) 100 % plot.

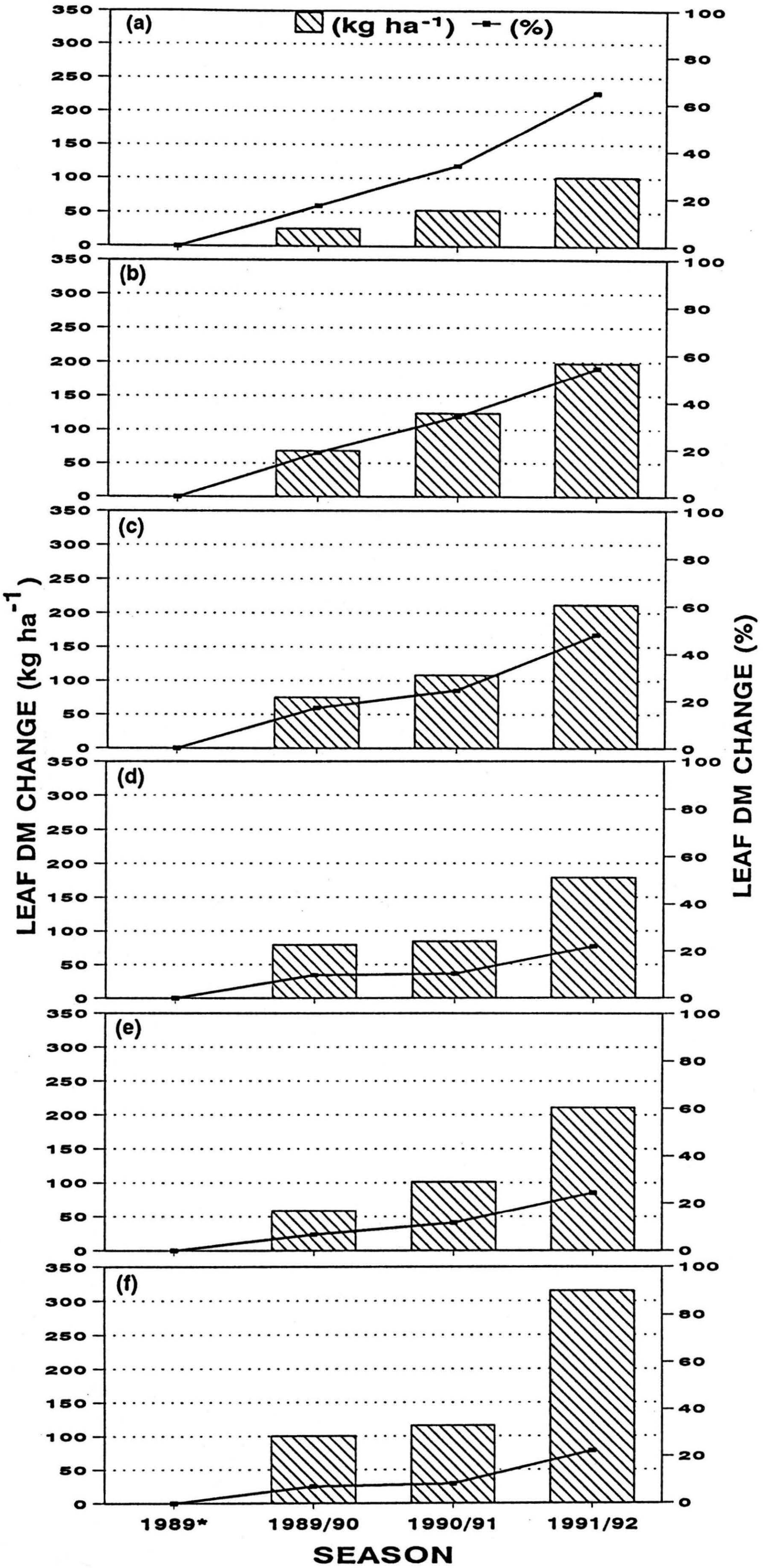


Figure 6.3 Cumulative changes in total leaf dry mass ha^{-1} of the remaining *Colophospermum mopane* trees, successive to the initial thinning during 1989*: (a) 10 % plot, (b) 20 % plot, (c) 35 % plot, (d) 50 % plot, (e) 75 % plot, (f) 100 % plot.

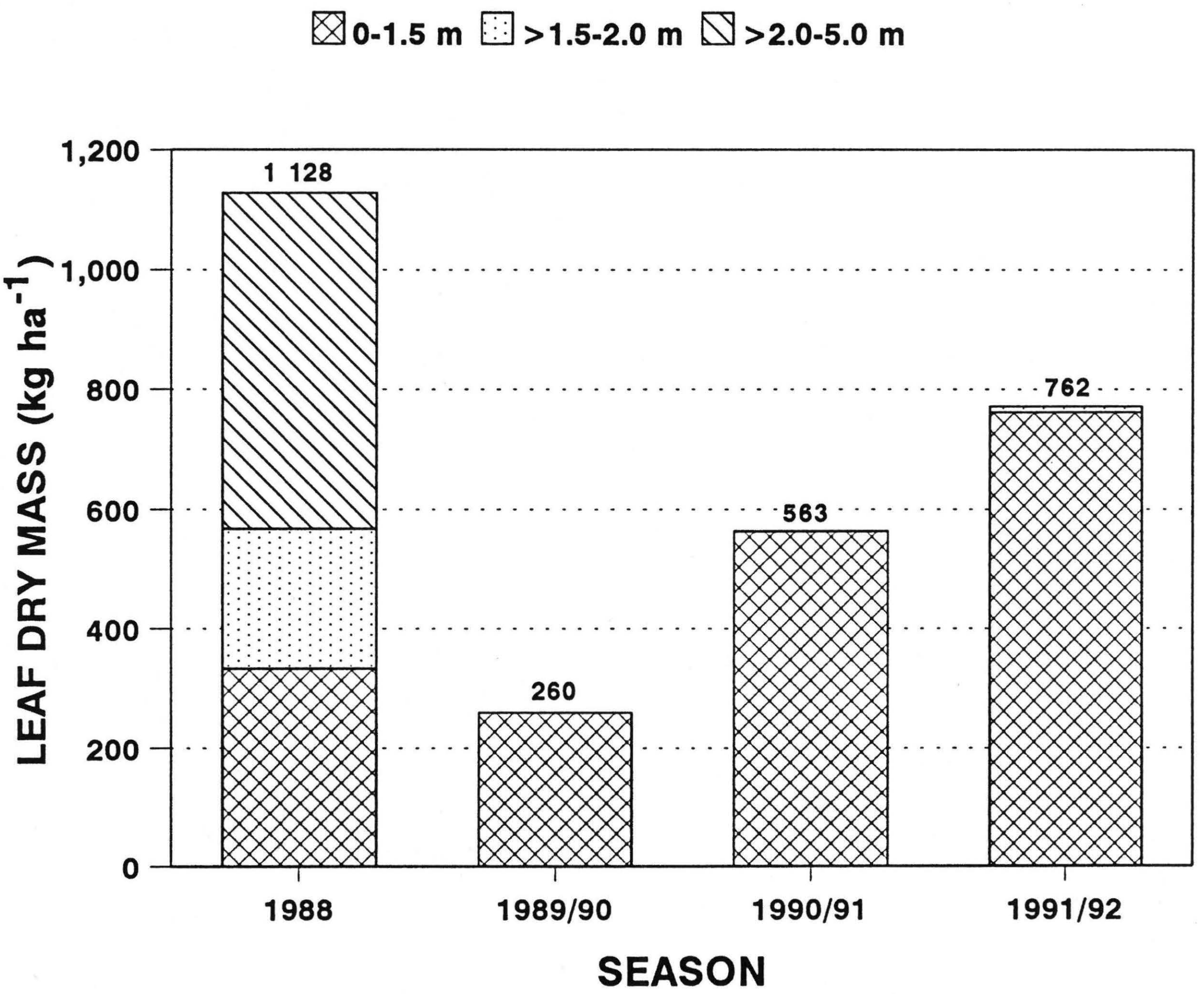


Figure 6.4 Estimates of the total leaf dry mass ha^{-1}, with subdivision into height stratums, of the coppiced *Colophospermum mopane* trees in the regrowth plot in comparison with the total leaf dry mass ha^{-1} before cutting (1988).

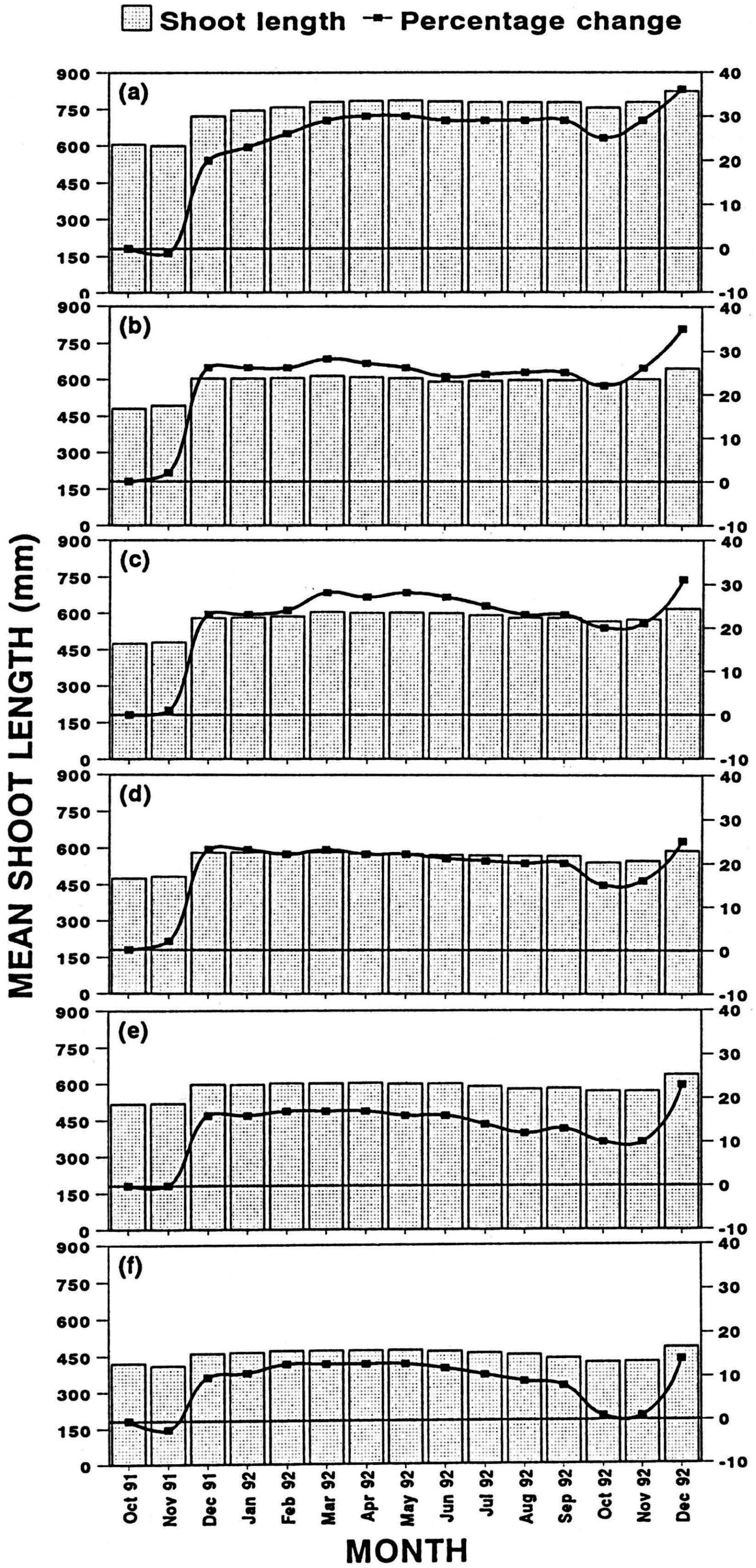


Figure 6.5 The monthly mean mother shoot lengths, as well as the mean percentage change in mother shoot lengths of marked trees in the different experimental plots: (a) 10 % plot, (b) 20 % plot, (c) 35 % plot, (d) 50 % plot, (e) 75 % plot, (f) 100 % plot.

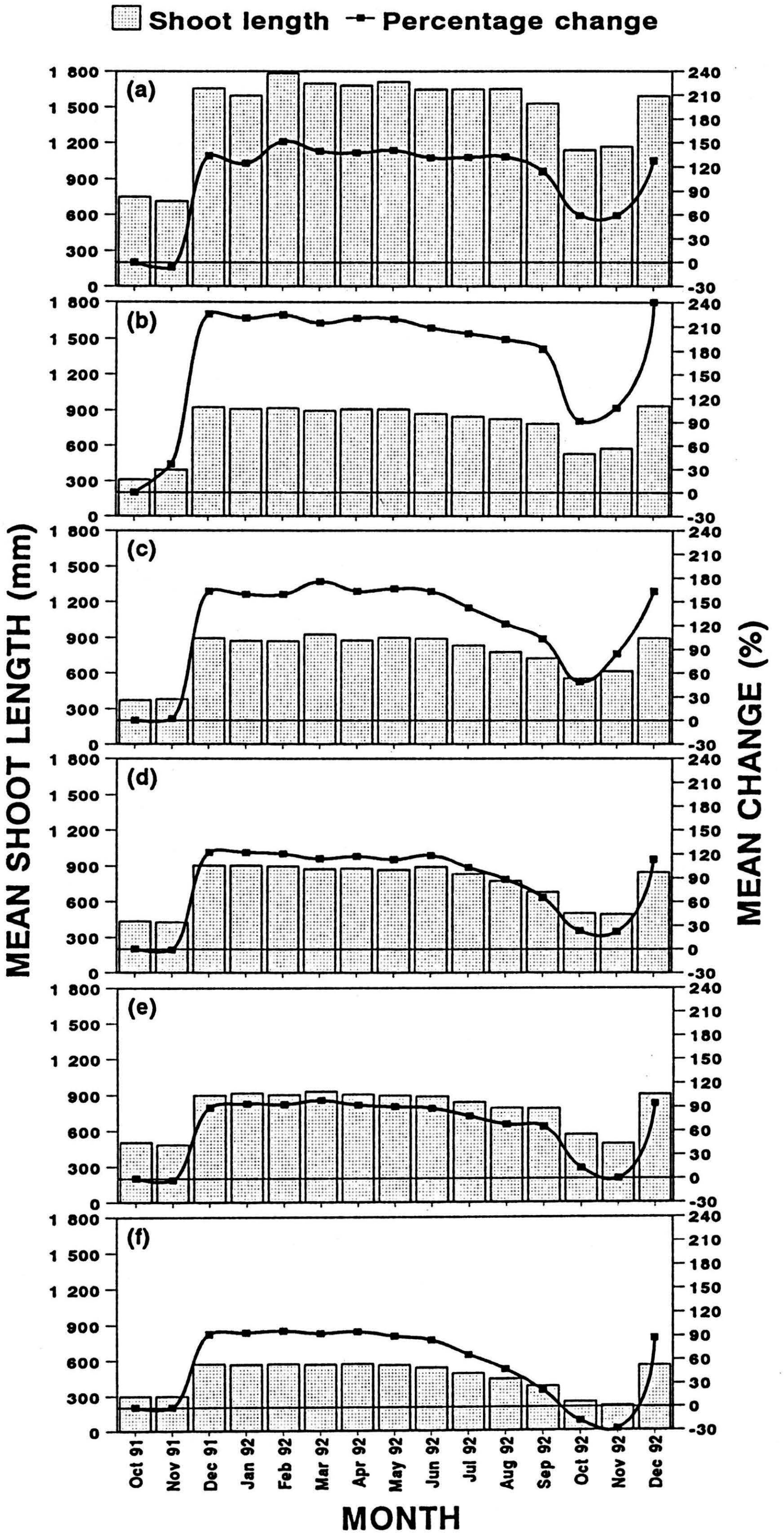


Figure 6.6 The monthly mean daughter shoot lengths, as well as the mean percentage change in daughter shoot lengths of marked trees in the different experimental plots (the combined length of all daughter shoots on a mother shoot was taken as a single daughter shoot length): (a) 10 % plot, (b) 20 % plot, (c) 35 % plot, (d) 50 % plot, (e) 75 % plot, (f) 100 % plot.

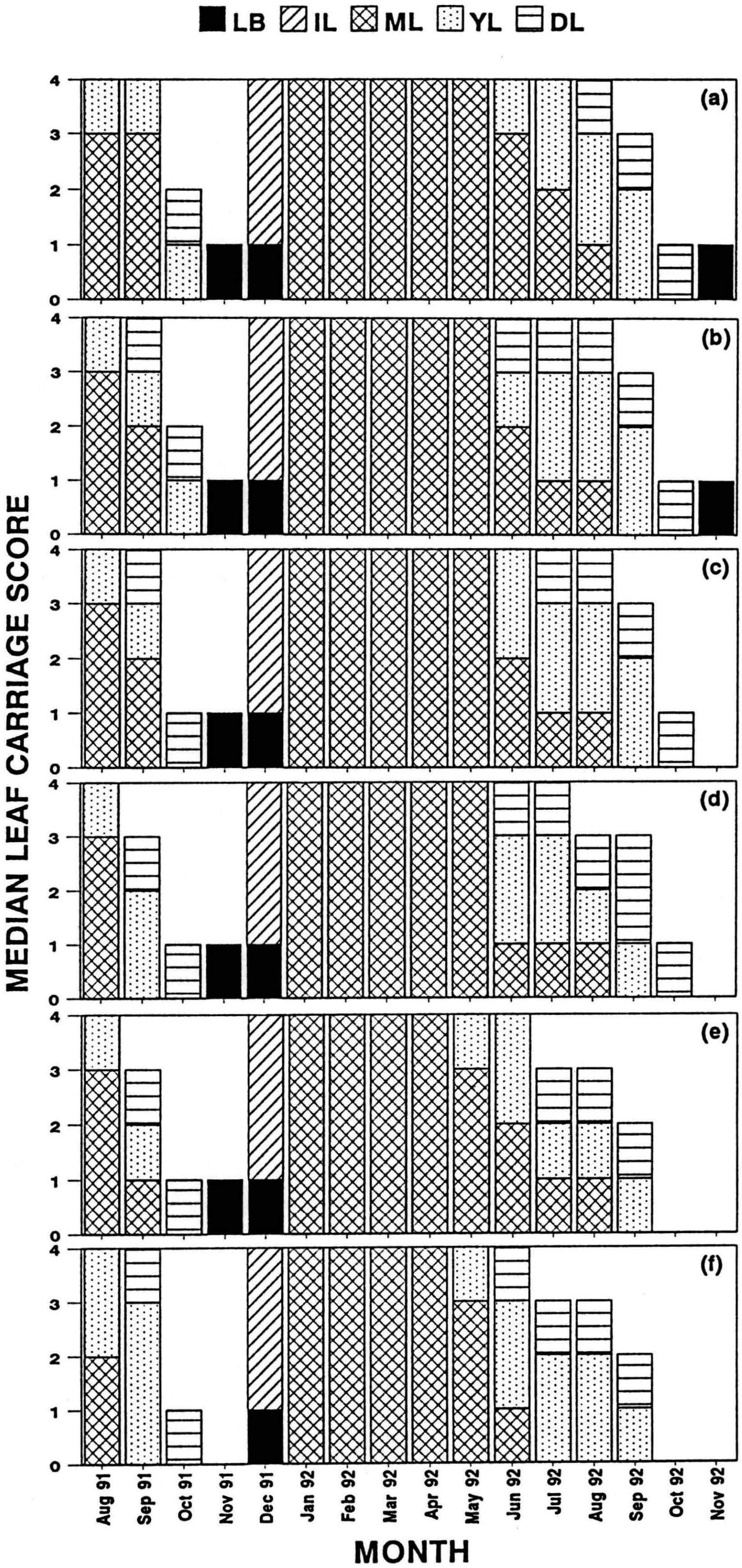


Figure 6.7 Median leaf carriage scores (0 = no leaves, and 1 = 1-10 %, 2 = 11-40 %, 3 = 41-70 % and 4 = 71-100 % of full leaf carriage respectively) of marked trees in the different experimental plots, with subdivision into leaf phenological states (LB = newly formed leaf buds, IL = immature green leaves, ML = mature green leaves, YL = yellowing, senescing leaves, DL = dry, senescing leaves): (a) 10 % plot, (b) 20 % plot, (c) 35 % plot, (d) 50 % plot, (e) 75 % plot, (f) 100 % plot.

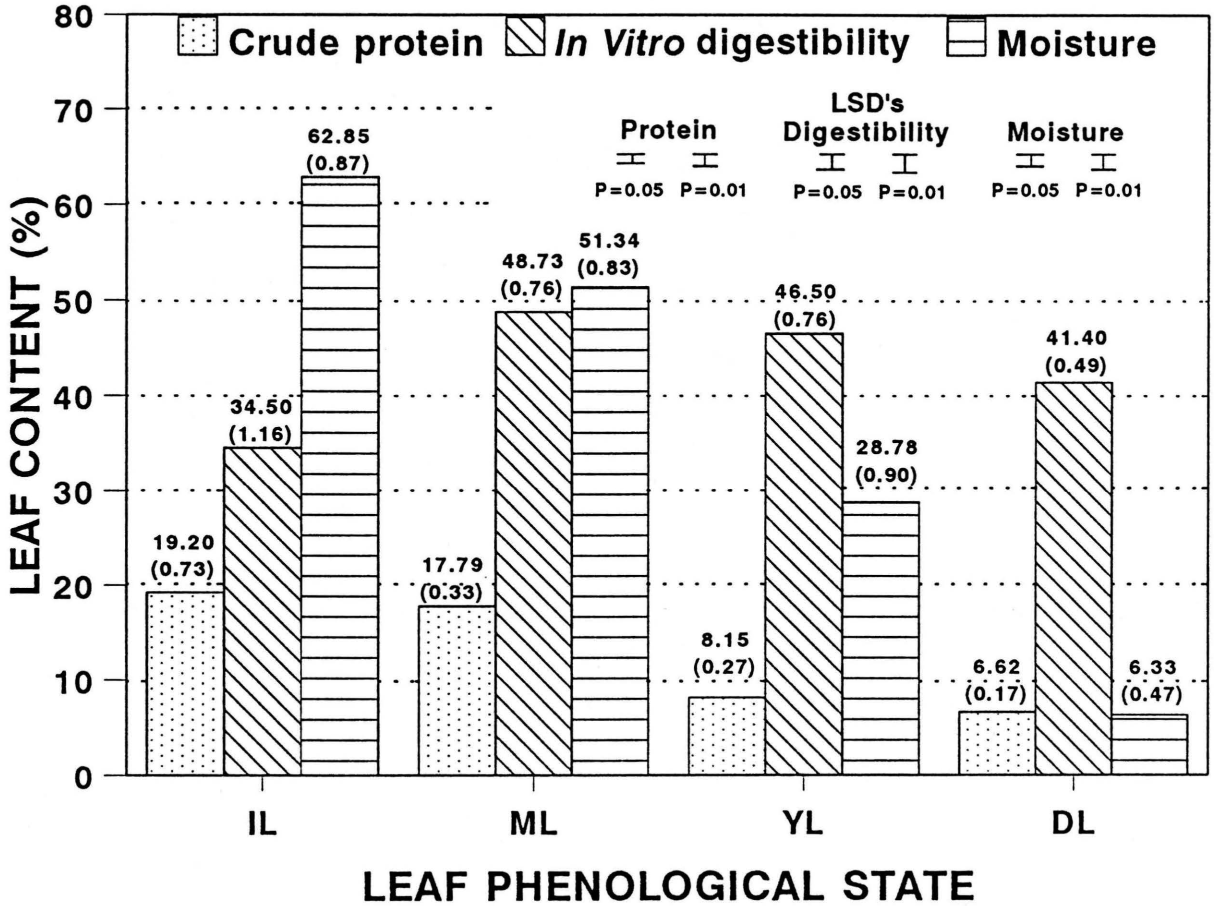


Figure 6.8 The crude protein content, *in vitro* digestibility and moisture content of *Colophospermum mopane* leaves in the different defined phenological states: IL = immature green leaves; ML = mature green leaves; YL = yellowing, senescing leaves: DL = dry, senescing leaves retained on the tree.

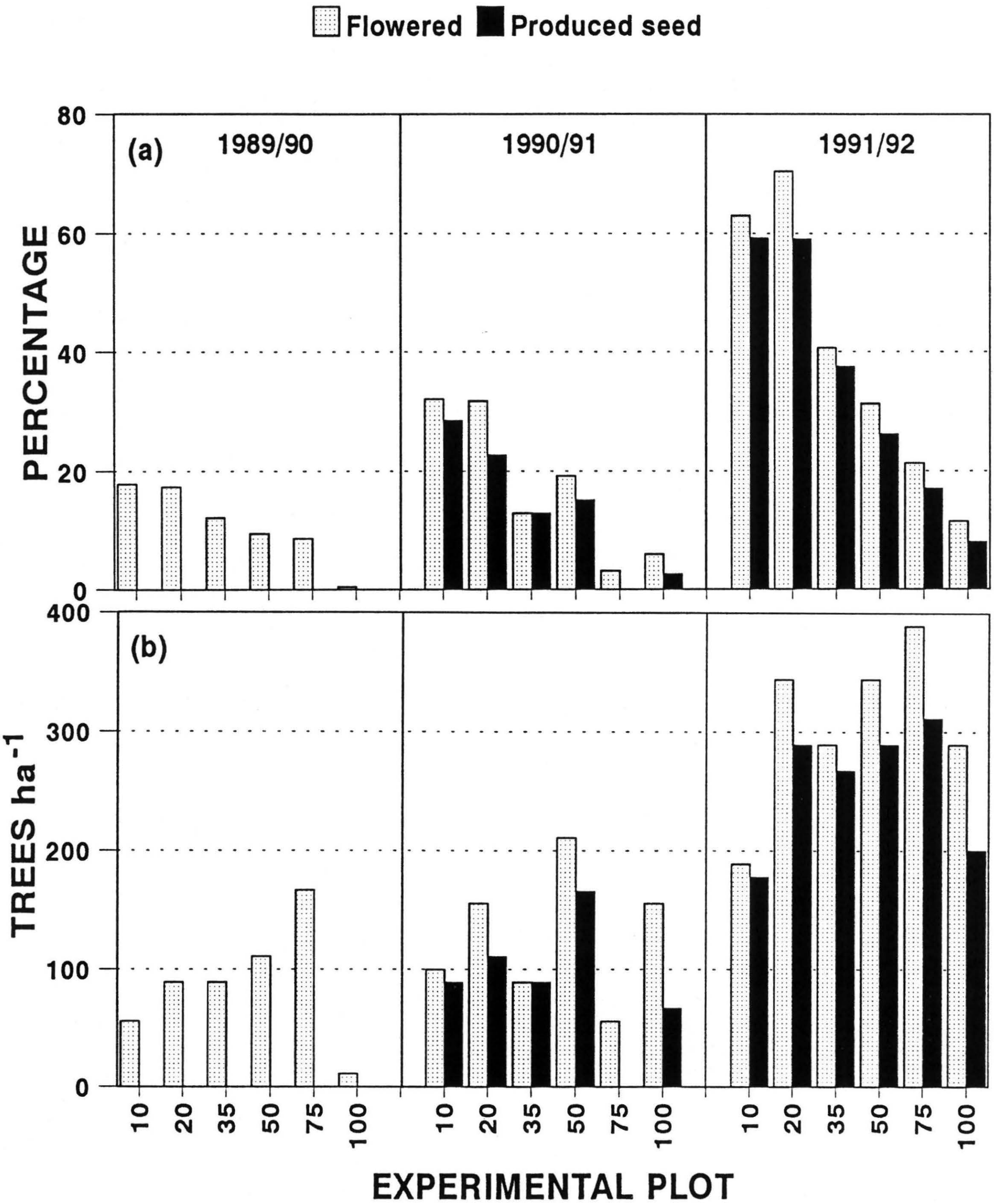


Figure 6.9 The percentage (a) and number (b) of *Colophospermum mopane* trees that has flowered and produced seeds in the various experimental plots during the 1989/90, 1990/91 and 1991/92 seasons (seed bearing not recorded during 1989/90).

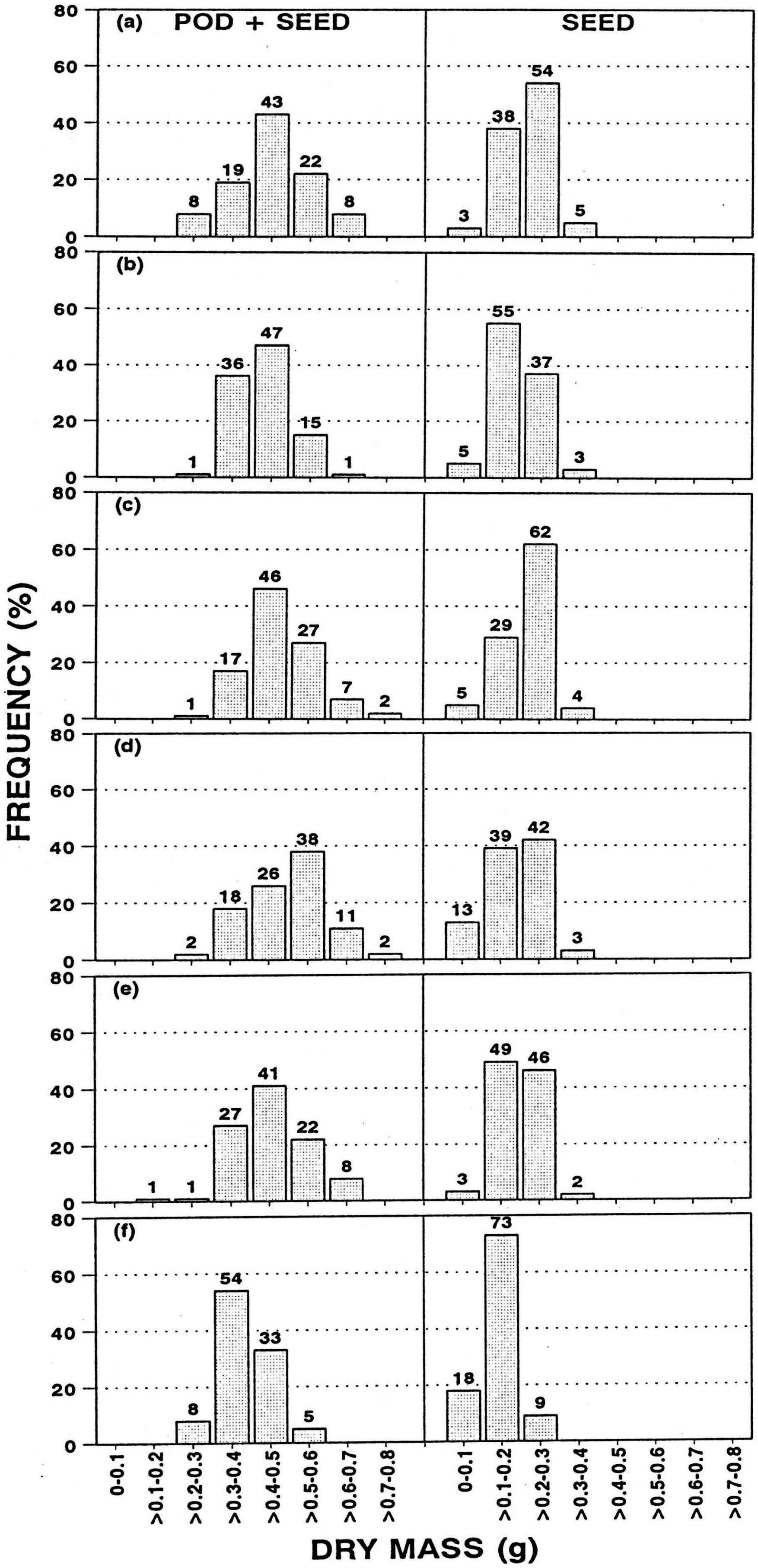


Figure 6.10 The frequency distributions of *Colophospermum mopane* seeds from trees of the different experimental plots, with and without their pod covers, within eight dry mass classes: (a) 10 % plot, (b) 20 % plot, (c) 35 % plot, (d) 50 % plot, (e) 75 % plot, (f) 100 % plot.

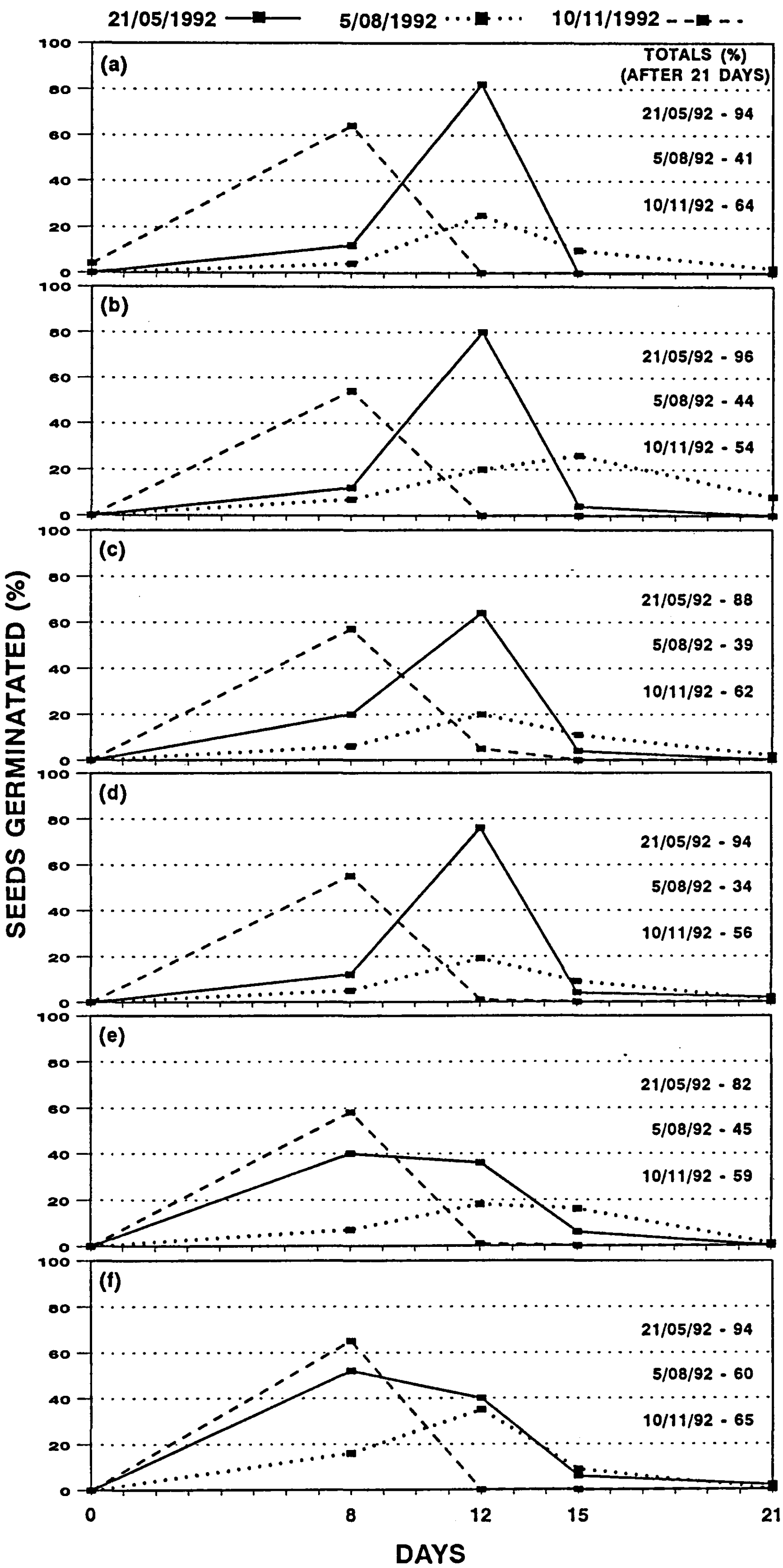


Figure 6.11 Results of the germination potential assessments of *Colophospermum mopane* seeds harvested at three different dates (seasons) in each of the experimental plots: (a) 10 % plot, (b) 20 % plot, (c) 35 % plot, (d) 50 % plot, (e) 75 % plot, (f) 100 % plot.

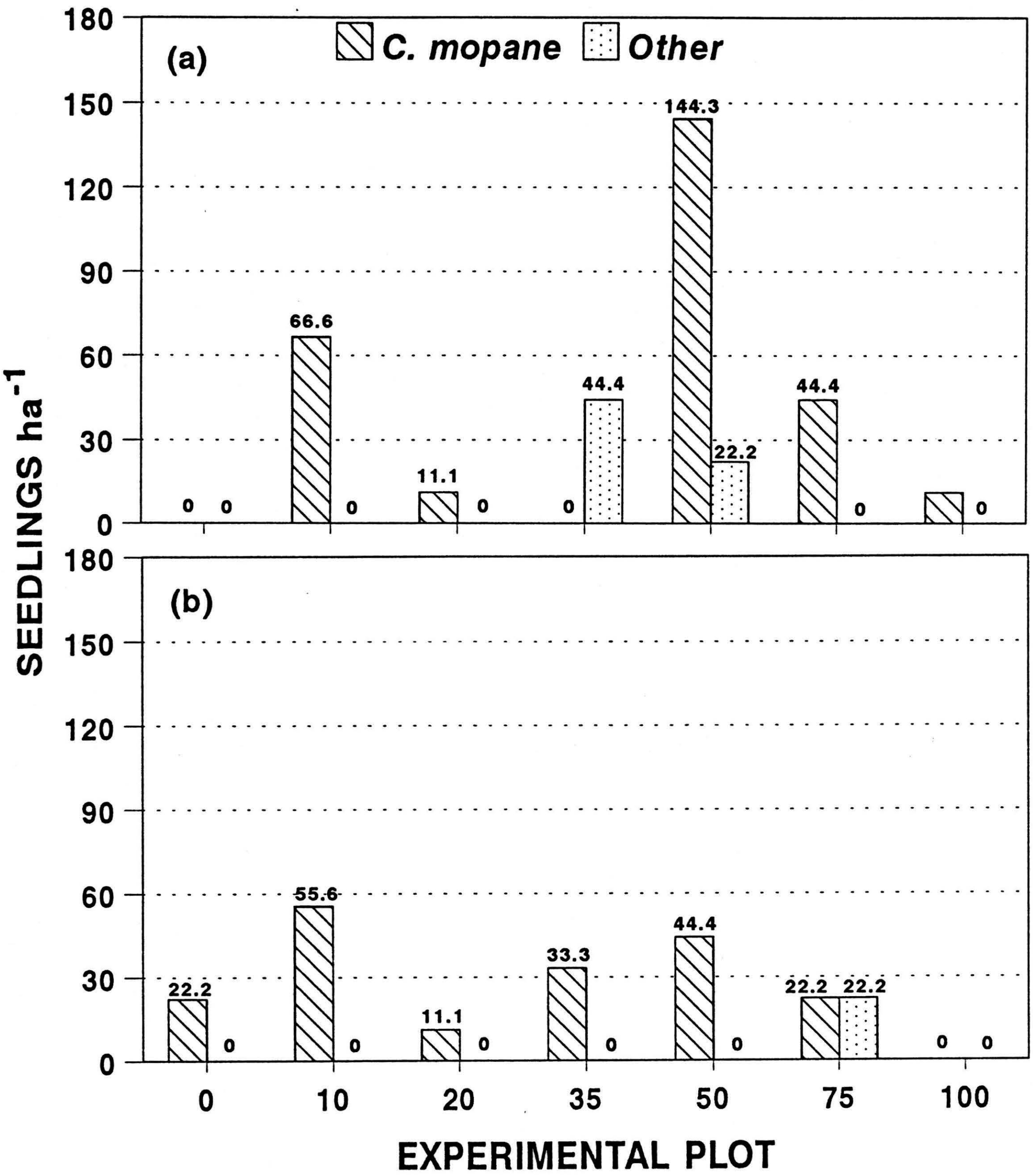


Figure 6.12 The number of tree seedlings ha^{-1} counted within the transects of the different experimental plots: (a) end of 1990/91 season, (b) end of 1991/92 season.

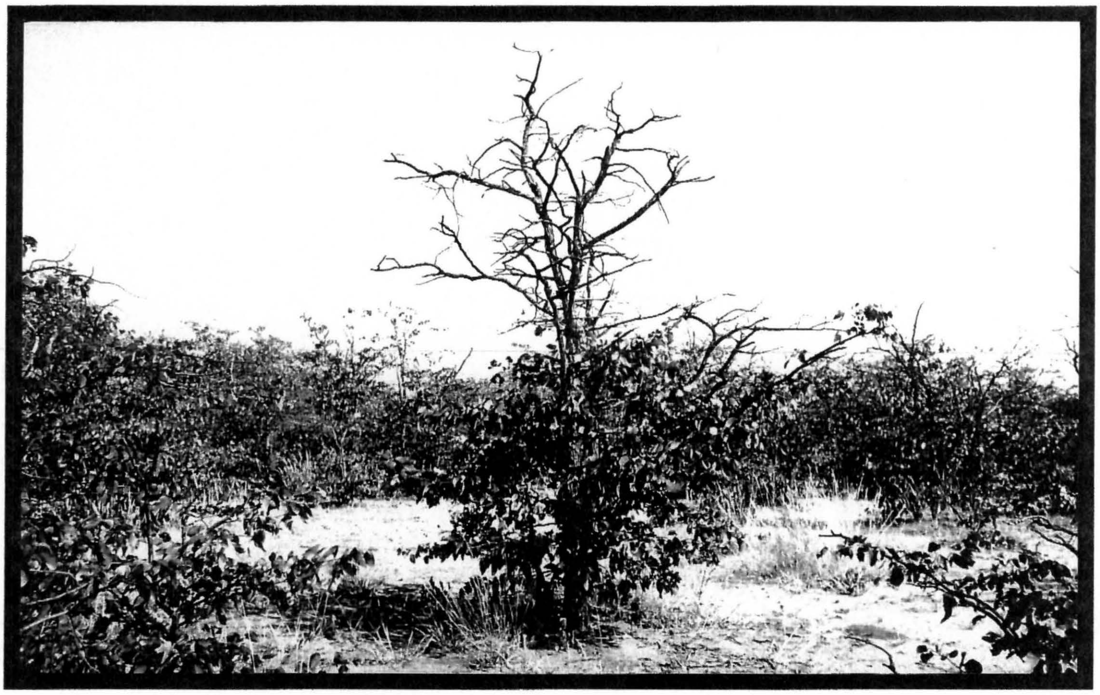


Figure 6.13 An example of the die-off of shoots at the top of the *Colophospermum mopane* trees in the densely wooded plots.

Table 7.1 Herbaceous species recorded on the *Colophospermum mopane*-habitat within the study area in order of importance based on their mean abundance during the trial period (first reading = all herbaceous species; second reading = grasses only, excluding *Oropetium capense*; third reading = perennial grasses only, excluding *O. capense*).

First reading **Species (status)**	**Second reading** **Species (status)**	**Third reading** **Species (status)**
Oropetium capense (P)	*Tragus berteronianus* (A)	*Digitaria eriantha* (P)
Enneapogon cenchroides (A)	*Enneapogon cenchroides* (A)	*Bothriochloa radicans* (P)
Tragus berteronianus (A)	*Aristida* species (A)	*Sporobolus ioclados* (P)
Aristida species (A)	*Brachiaria deflexa* (A)	*Cenchrus ciliaris* (P)
Forbs (A/P)	*Digitaria eriantha* (P)	*Eragrostis lehmanniana* (P)
Brachiaria deflexa (A)	*Bothriochloa radicans* (P)	*Panicum maximum* (P)
Digitaria eriantha (P)	*Sporobolus ioclados* (P)	*Stipagrostis uniplumis* (P)
Bothriochloa radicans (P)	*Urochloa mosambicensis* (A)	*Enteropogon macrostachys* (P)
Sporobolus ioclados (P)	*Eragrostis lehmanniana* (P)	
Urochloa mosambicensis (A)	*Cenchrus ciliaris* (P)	
Cenchrus ciliaris (P)	*Panicum maximum* (P)	
Eragrostis lehmanniana (P)	*Stipagrostis uniplumis* (P)	
Panicum maximum (P)	*Eragrostis porosa* (A)	
Eragrostis porosa (A)		

(P) = Perennial (A) = Annual

Table 7.2 Herbaceous species recorded on the *Salvadora angustifolia*-habitat within the study area in order of importance based on their mean abundance during the trial period (first reading = all herbaceous species; second reading = grasses only, excluding *Oropetium capense*; third reading = perennial grasses only, excluding *O. capense*).

First reading Species (status)	Second reading Species (status)	Third reading Species (status)
Enneapogon cenchroides (A)	*Enneapogon cenchroides* (A)	*Cenchrus ciliaris* (P)
Brachiaria deflexa (A)	*Brachiaria deflexa* (A)	*Bothriochloa radicans* (P)
Cenchrus ciliaris (P)	*Cenchrus ciliaris* (P)	*Panicum maximum* (P)
Tragus berteronianus (A)	*Tragus berteronianus* (A)	*Digitaria eriantha* (P)
Forbs (A/P)	*Aristida* species (A)	*Sporobolus ioclados* (P)
Aristida species (A)	*Bothriochloa radicans* (P)	*Chloris roxburgiana* (P)
Bothriochloa radicans (P)	*Panicum maximum* (P)	*Eragrostis lehmanniana* (P)
Panicum maximum (P)	*Digitaria eriantha* (P)	
Digitaria eriantha (P)	*Sporobolus ioclados* (P)	
Sporobolus ioclados (P)	*Chloris roxburgiana* (P)	
Chloris roxburgiana (P)	*Urochloa mosambicensis* (A)	
Urochloa mosambicensis (A)	*Eragrostis lehmanniana* (P)	
Eragrostis lehmanniana (P)		

(P) = Perennial (A) = Annual

Table 7.3 Correlation analyses (n = 7) of relations between percentage herbaceous species composition of the *Colophospermum mopane*-habitat (including percentage bare patches) and tree density (expressed as Evapotranspiration Tree Equivalents).

Species	1989/90 r	1989/90 Significance	1990/91 r	1990/91 Significance	1991/92 r	1991/92 Significance
First reading of point-observaions						
Bare patches	0.959	***	0.930	***	0.968	***
All herbaceous plants	-0.957	***	-0.930	***	-0.969	***
Oropetium capense	0.076	ns	0.570	ns	0.739	*
Forbs	0.676	ns	0.691	ns	0.791	*
Second reading of point-observations						
Bare patches	0.895	***	0.929	**	0.947	**
All grasses (Annual + Per)	-0.895	**	-0.928	**	-0.947	**
All annual grasses	-0.907	**	-0.938	**	-0.954	***
Tragus berteronianus	-0.862	*	-0.873	*	-0.818	*
Enneapogon cenchroides	-0.862	*	-0.896	**	-0.953	***
Aristida species	-0.813	*	-0.819	*	-0.804	*
Brachiaria deflexa	0.138	ns	0.681	ns	0.338	ns
Third reading of point-observations						
Bare patches	-0.599	ns	-0.297	ns	0.484	ns
All grasses (Perennial)	0.562	ns	0.312	ns	-0.475	ns
Digitaria eriantha	0.504	ns	0.655	ns	0.695	*
Cenchrus ciliaris	0.476	ns	-0.640	ns	-0.471	ns
Sporobolus ioclados	0.026	ns	-0.511	ns	-0.638	ns
Bothriochloa radicans	0.190	ns	0.465	ns	-0.295	ns

* = Significant (P<0.05); ** = Highly significant (P<0.01); *** = Highly significant (P<0.001)

Table 7.4 Correlation analyses (n = 7) of relations between percentage herbaceous species composition of the *Salvadora angustifolia*-habitat (including percentage bare patches) and tree density (expressed as Evapotranspiration Tree Equivalents).

Species	1989/90		1990/91		1991/92	
	r	Significance	r	Significance	r	Significance
First reading of point-observaions						
Bare patches	0.819	*	0.920	**	-0.186	ns
All herbaceous plants	-0.819	*	-0.920	**	-0.186	ns
Forbs	0.061	ns	0.188	ns	-0.112	ns
Second reading of point-observations						
Bare patches	0.706	*	0.920	**	-0.135	ns
All grasses (Annual + Per)	-0.706	*	-0.920	**	-0.135	ns
All annual grasses	-0.788	*	-0.952	***	-0.665	ns
Enneapogon cenchroides	-0.738	*	-0.909	**	-0.906	**
Tragus berteronianus	-0.334	ns	-0.547	ns	-0.169	ns
Brachiaria deflexa	0.652	ns	-0.978	***	0.909	**
Aristida species	0.173	ns	0.264	ns	0.372	ns
Third reading of point-observations						
Bare patches	-0.361	ns	-0.485	ns	-0.584	ns
All grasses (Perennial)	0.361	ns	0.485	ns	0.584	ns
Cenchrus ciliaris	0.236	ns	0.251	ns	0.594	ns
Bothriochloa radicans	0.330	ns	0.561	ns	0.015	ns
Panicum maximum	0.491	ns	-0.248	ns	0.103	ns
Digitaria eriantha	-0.048	ns	0.457	ns	0.465	ns

* = Significant (P<0.05); ** = Highly significant (P<0.01); *** = Highly significant (P<0.001)

Table 7.5 Cross tabulation of the correlations (n = 21) between the percentage composition of the more important herbaceous species of the *Colophospermum mopane*-habitat as they occurred in the various experimental plots during the 1989/90, 1990/91 and 1991/92 seasons.

					Species					
Species	**Forbs**	**O cap**	**T ber**	**B def**	**A spp**	**E cen**	**C cil**	**S ioc**	**D eri**	**B rad**
Forbs	-	0.39 (**)	-0.46 (***)	0.30 (ns)	-0.59 (***)	-0.55 (***)	-0.09 (ns)	-0.31 (*)	0.09 (ns)	0.16 (ns)
O cap	0.39 (**)	-	-0.15 (ns)	0.59 (***)	-0.72 (***)	-0.77 (***)	-0.52 (***)	-0.33 (*)	-0.06 (ns)	-0.33 (*)
T ber	-0.46 (***)	-0.15 (ns)	-	0.05 (ns)	0.14 (ns)	0.0 (ns)	-0.08 (ns)	-0.11 (ns)	-0.47 (***)	-0.36 (**)
B def	0.30 (ns)	0.59 (***)	0.05 (ns)	-	-0.46 (***)	-0.64 (***)	-0.44 (***)	-0.45 (***)	-0.35 (**)	0.04 (ns)
A spp	-0.59 (***)	-0.72 (***)	0.14 (ns)	-0.46 (***)	-	0.71 (***)	0.42 (***)	0.36 (**)	-0.08 (ns)	0.23 (ns)
E cen	-0.55 (***)	-0.77 (***)	0.0 (ns)	-0.64 (***)	0.71 (***)	-	0.60 (***)	0.68 (***)	-0.10 (ns)	0.16 (ns)
C cil	-0.09 (ns)	-0.52 (***)	-0.08 (ns)	-0.44 (***)	0.42 (***)	0.60 (***)	-	0.77 (***)	0.0 (ns)	-0.08 (ns)
S ioc	-0.31 (*)	-0.33 (*)	-0.11 (ns)	-0.45 (***)	0.36 (**)	0.68 (***)	0.77 (***)	-	-0.03 (ns)	-0.09 (ns)
D eri	0.09 (ns)	-0.06 (ns)	-0.47 (***)	-0.35 (**)	-0.08 (ns)	-0.10 (ns)	0.77 (***)	-0.03 (ns)	-	0.11 (ns)
B rad	0.16 (ns)	-0.33 (*)	-0.36 (**)	0.04 (ns)	0.23 (ns)	0.16 (ns)	-0.08 (ns)	-0.09 (ns)	0.11 (ns)	-

* = Significant (P<0.05); ** = Highly significant (P<0.01); *** = Highly significant (P<0.001)

(**O cap** = *Oropetium capense*; **T ber** = *Tragus berteronianus;* **B def** = *Brachiaria deflexa;* **A spp** = *Aristida* species; **E cen** = *Enneapogon cenchroides;* **C cil** = *Cenchrus ciliaris;* **S ioc** = *Sporobolus ioclados;* **D eri** = *Digitaria eriantha;* **B rad** = *Bothriochloa radicans*)

Table 7.6 Cross tabulation of the correlations (n = 21) between the percentage composition of the more important herbaceous species of the *Salvadora angustifolia*-habitat as they occurred in the various experimental plots during the 1989/90, 1990/91 and 1991/92 seasons.

	Species								
Species	**Forbs**	**T ber**	**B def**	**A spp**	**E cen**	**C cil**	**P max**	**D eri**	**B rad**
Forbs	-	-0.24 (ns)	0.63 (***)	-0.28 (ns)	-0.31 (*)	-0.12 (ns)	0.41 (***)	0.24 (ns)	0.05 (ns)
T ber	-0.24 (ns)	-	-0.03 (ns)	-0.19 (ns)	0.36 (**)	-0.43 (***)	-0.32 (*)	-0.13 (ns)	-0.36 (**)
B def	0.63 (***)	-0.03 (ns)	-	-0.23 (ns)	-0.55 (***)	-0.27 (ns)	0.54 (***)	0.42 (***)	0.15 (ns)
A spp	-0.28 (ns)	-0.19 (ns)	-0.23 (ns)	-	-0.17 (ns)	0.25 (ns)	-0.28 (ns)	-0.14 (ns)	-0.08 (ns)
E cen	-0.32 (*)	0.36 (**)	-0.55 (***)	-0.17 (ns)	-	-0.46 (***)	-0.29 (ns)	-0.21 (ns)	-0.27 (ns)
C cil	-0.13 (ns)	-0.43 (***)	-0.27 (ns)	0.25 (ns)	-0.46 (***)	-	0.04 (ns)	-0.21 (ns)	0.31 (*)
P max	0.41 (***)	-0.32 (*)	0.54 (***)	-0.28 (ns)	-0.29 (ns)	0.04 (ns)	-	0.52 (***)	0.59 (***)
D eri	0.24 (ns)	-0.13 (ns)	0.42 (***)	-0.14 (ns)	-0.21 (ns)	-0.21 (ns)	0.52 (***)	-	0.43 (***)
B rad	0.05 (ns)	-0.36 (**)	0.15 (ns)	-0.08 (ns)	-0.27 (ns)	0.31 (*)	0.59 (***)	0.43 (***)	-

* = Significant (P<0.05); ** = Highly significant (P<0.01); *** = Highly significant (P<0.001)

(**T ber** = *Tragus berteronianus;* **B def** = *Brachiaria deflexa;* **A spp** = *Aristida* species; **E cen** = *Enneapogon cenchroides;* **C cil** = *Cenchrus ciliaris;* **P max** = *Panicum maximum;* **D eri** = *Digitaria eriantha;* **B rad** = *Bothriochloa radicans*)

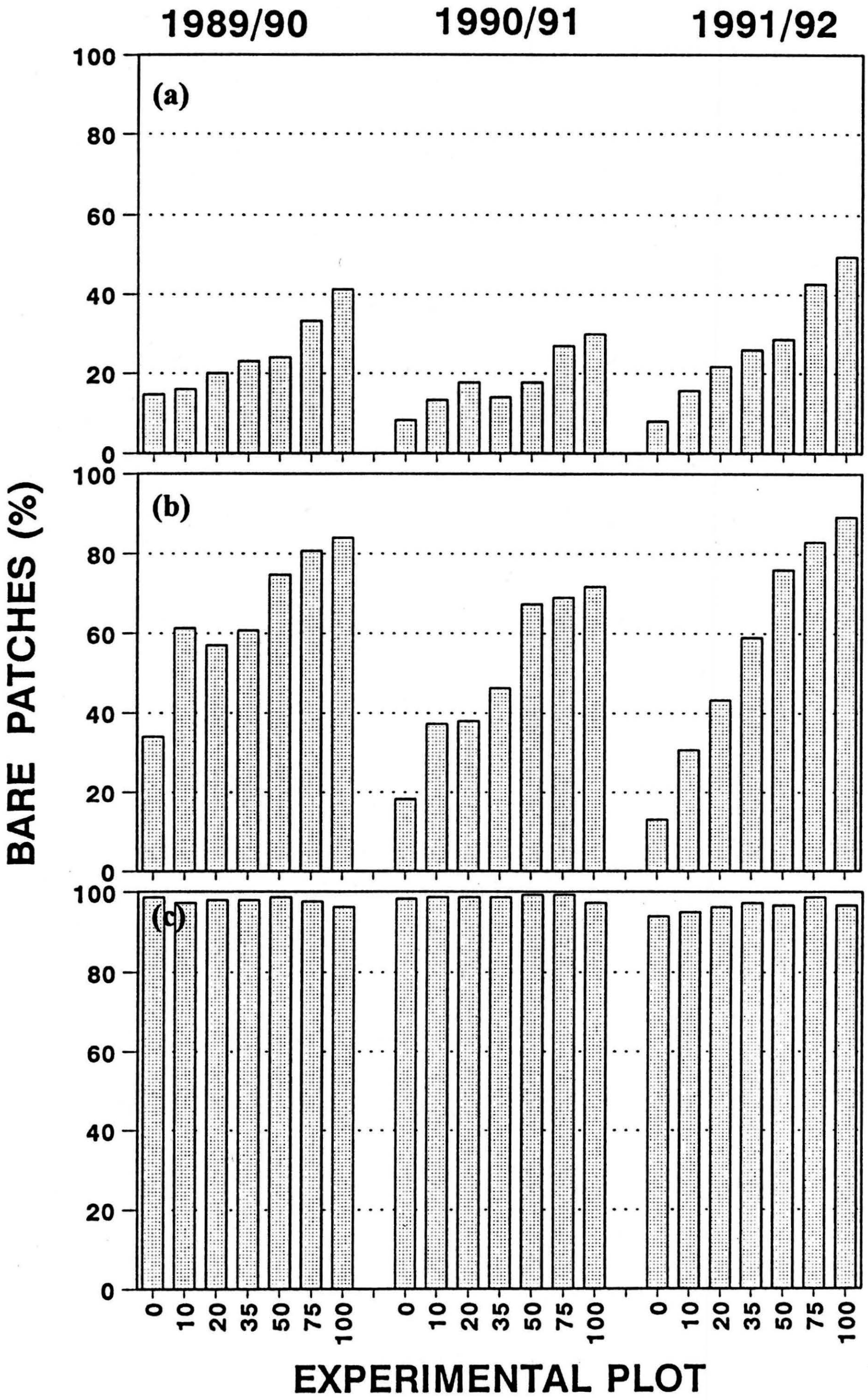


Figure 7.1 Percentage bare patches (based on circular areas with a diameter of 60 cm with no herbaceous plant of the given criteria) recorded on the *Colophospermum mopane*-habitat: (a) all herbaceous plants, (b) grasses only, excluding *Oropetium capense*, (c) perennial grasses only, excluding *O. capense*.

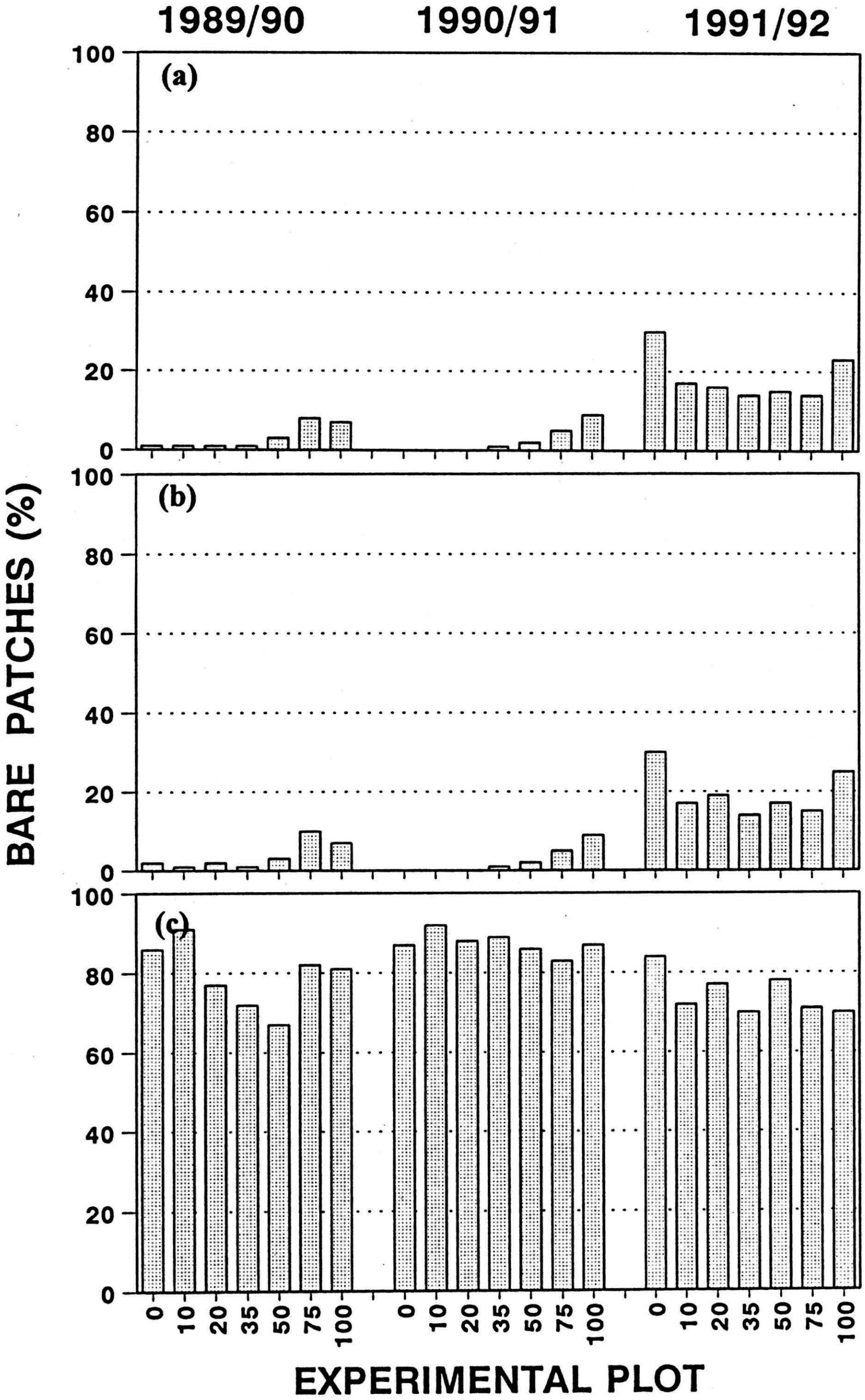


Figure 7.2 Percentage bare patches (based on circular areas with a diameter of 60 cm with no herbaceous plant of the given criteria) recorded on the *Salvadora angustifolia*-habitat: (a) all herbaceous plants, (b) grasses only, excluding *Oropetium capense*, (c) perennial grasses only, excluding *O. capense*.

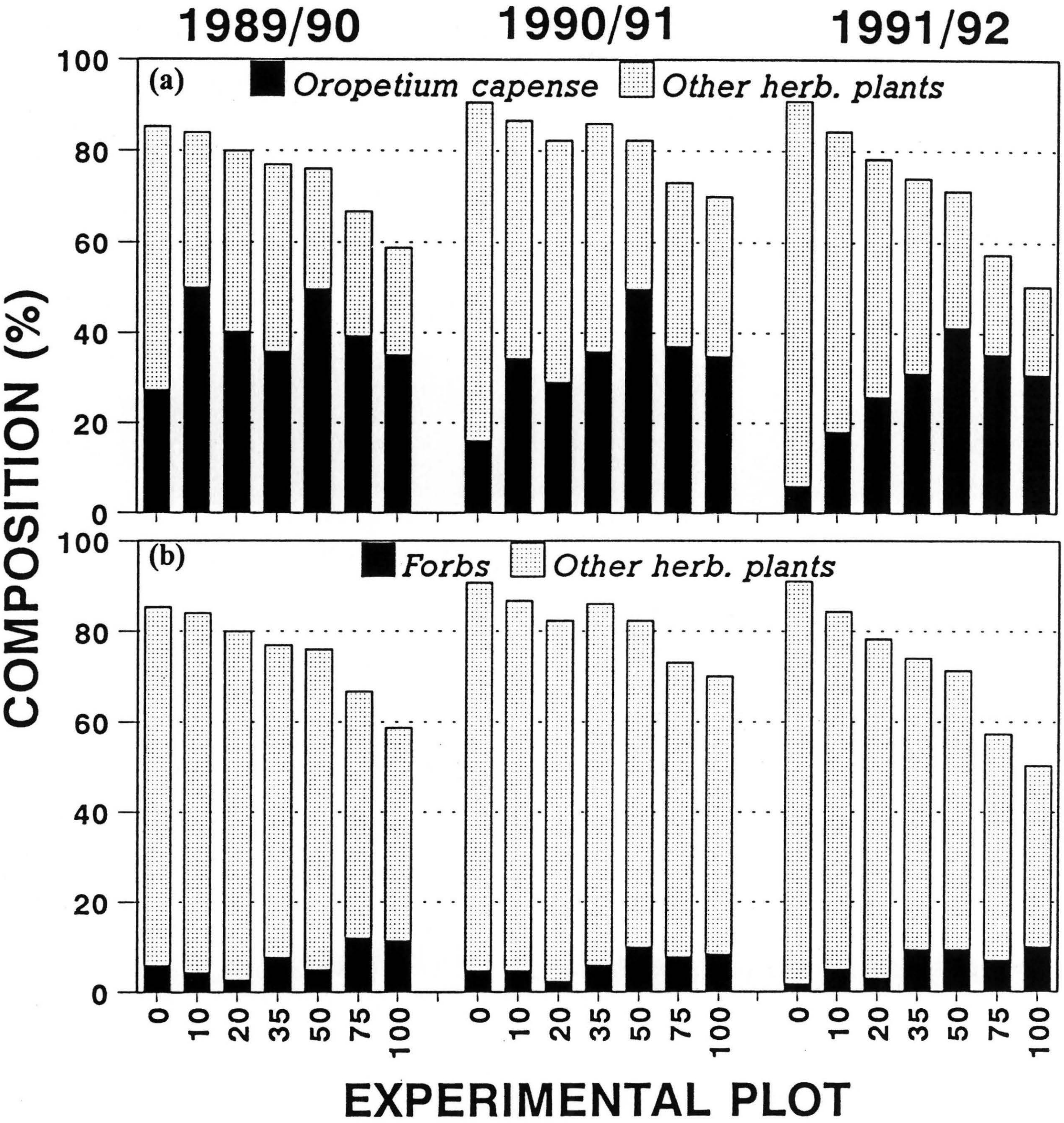


Figure 7.3 Percentage species composition of (a) *Oropetium capense* and (b) Forbs in the *Colophospermum mopane*-habitat, in relation to other recorded herbaceous plants (based on the first reading of the point-observations).

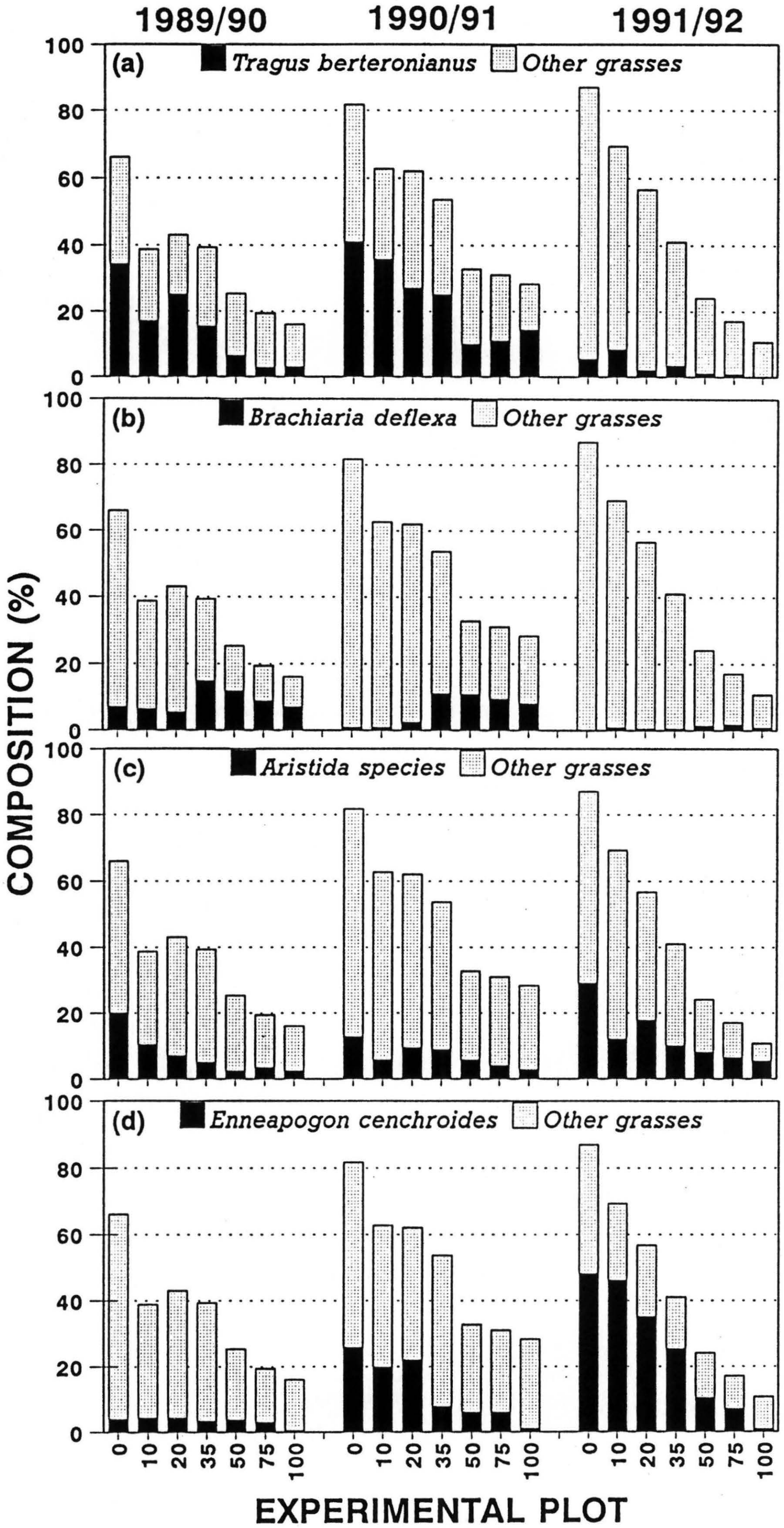


Figure 7.4 Percentage species composition of (a) *Tragus berteronianus,* (b) *Brachiaria deflexa,* (c) *Aristida* species and (d) *Enneapogon cenchroides* in the *Colophospermum mopane*-habitat in relation to other recorded grasses (based on the second reading of the point-observations).

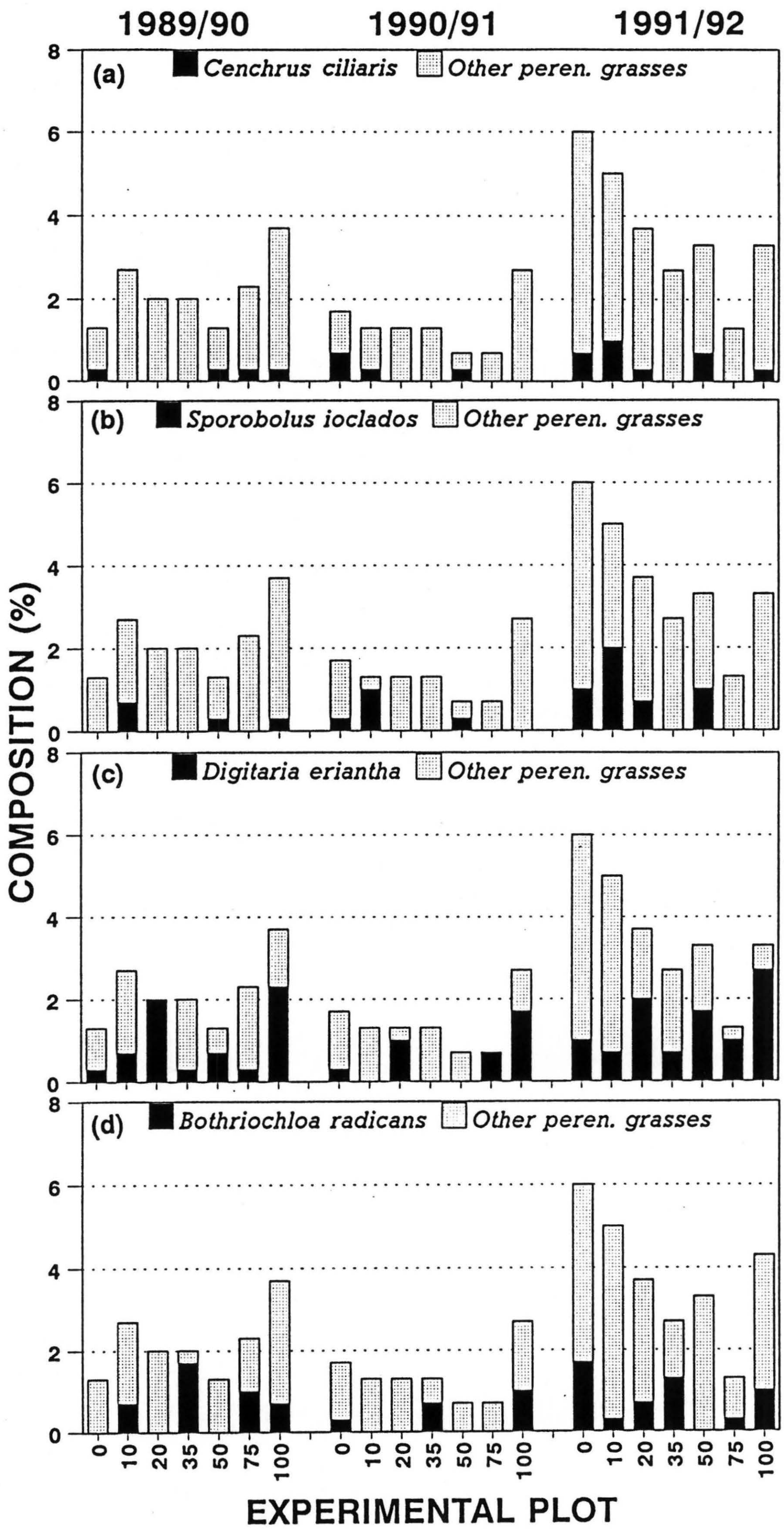


Figure 7.5 Percentage species composition of (a) *Cenchrus ciliaris*, (b) *Sporobolus ioclados* (c) *Digitaria eriantha* and (d) *Bothriochloa radicans* in the *Colophospermum mopane*-habitat in relation to other recorded perennial grasses (based on the third reading of the point-observations).

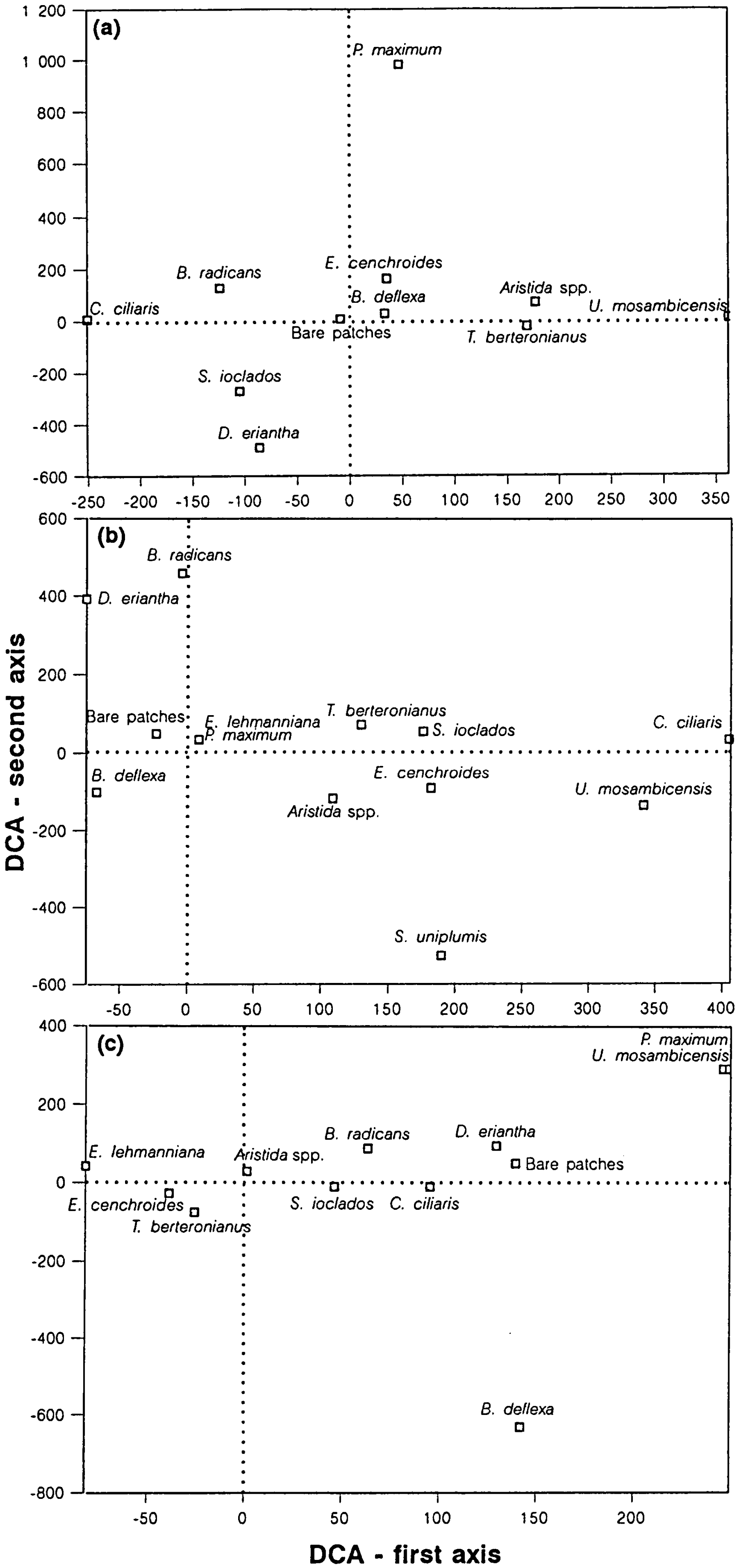


Figure 7.6 Detrended correspondence ordination of grass species of the *Colophospermum mopane*-habitat (based on the second reading of the point observations): (a) 1989/90 season, (b) 1990/91 season, (c) 1991/92 season.

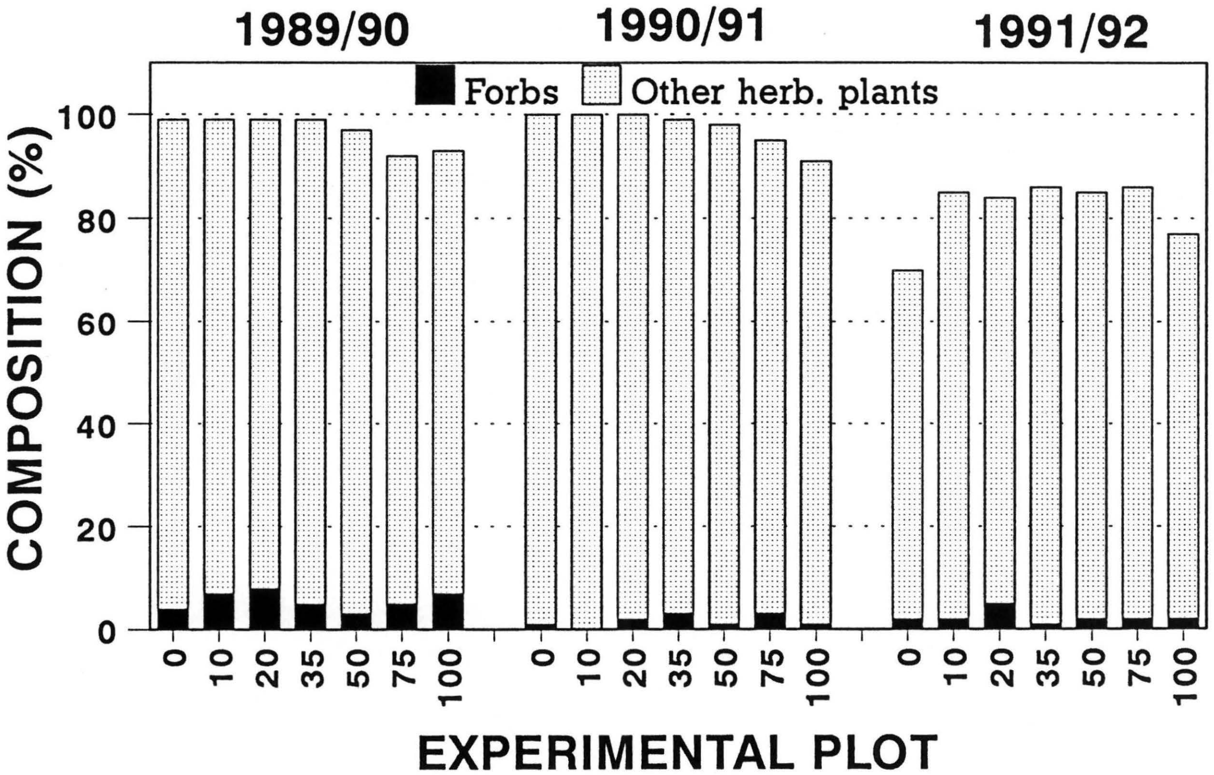


Figure 7.7 Percentage species composition of Forbs in the *Salvadora angustifolia*-habitat in relation to other recorded herbaceous plants (based on the first reading of the point-observations).

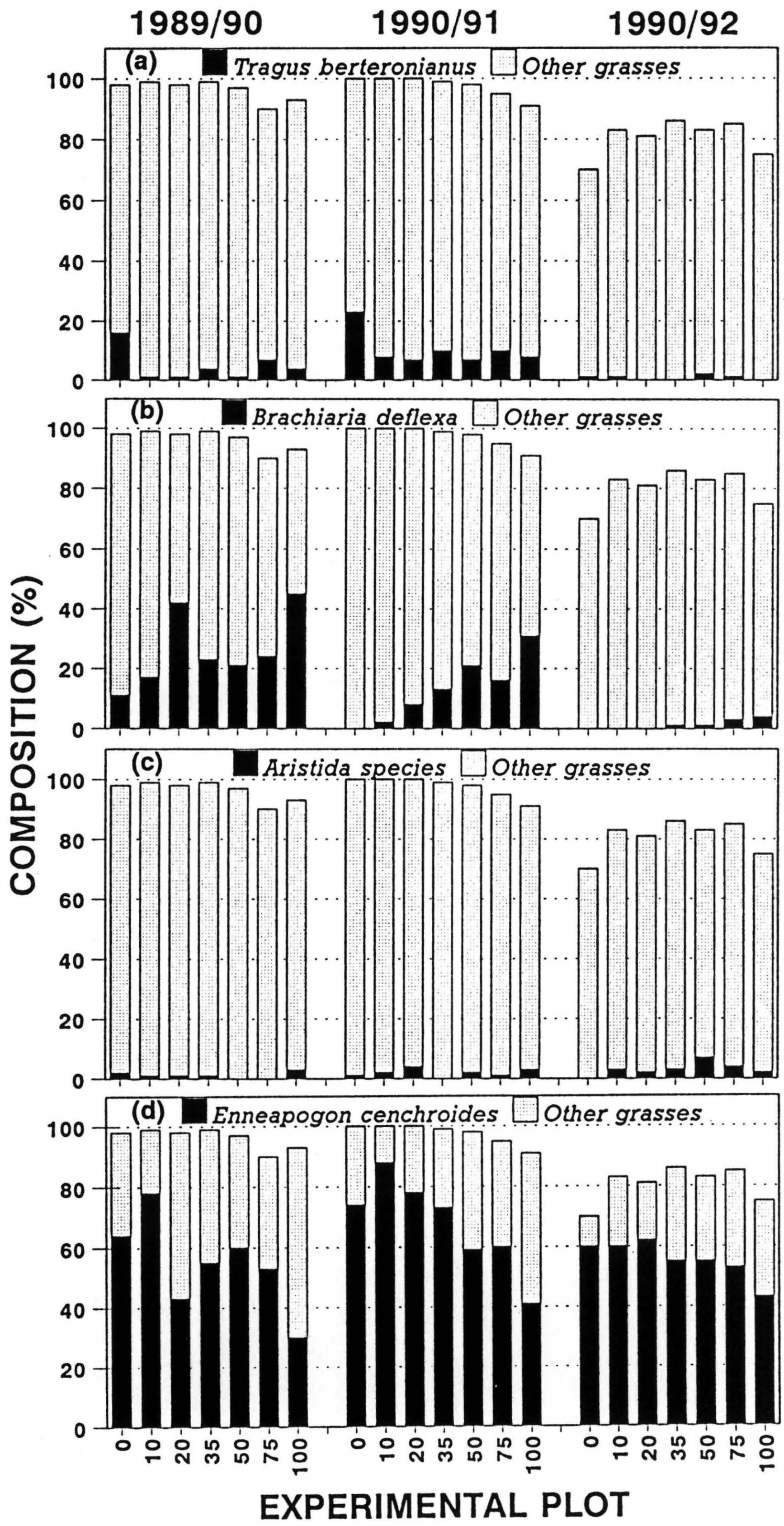


Figure 7.8 Percentage species composition of (a) *Tragus berteronianus*, (b) *Brachiaria deflexa,* (c) *Aristida* species and (d) *Enneapogon cenchroides* in the *Salvadora angustifolia*-habitat in relation to other recorded grasses (based on the second reading of the point-observations).

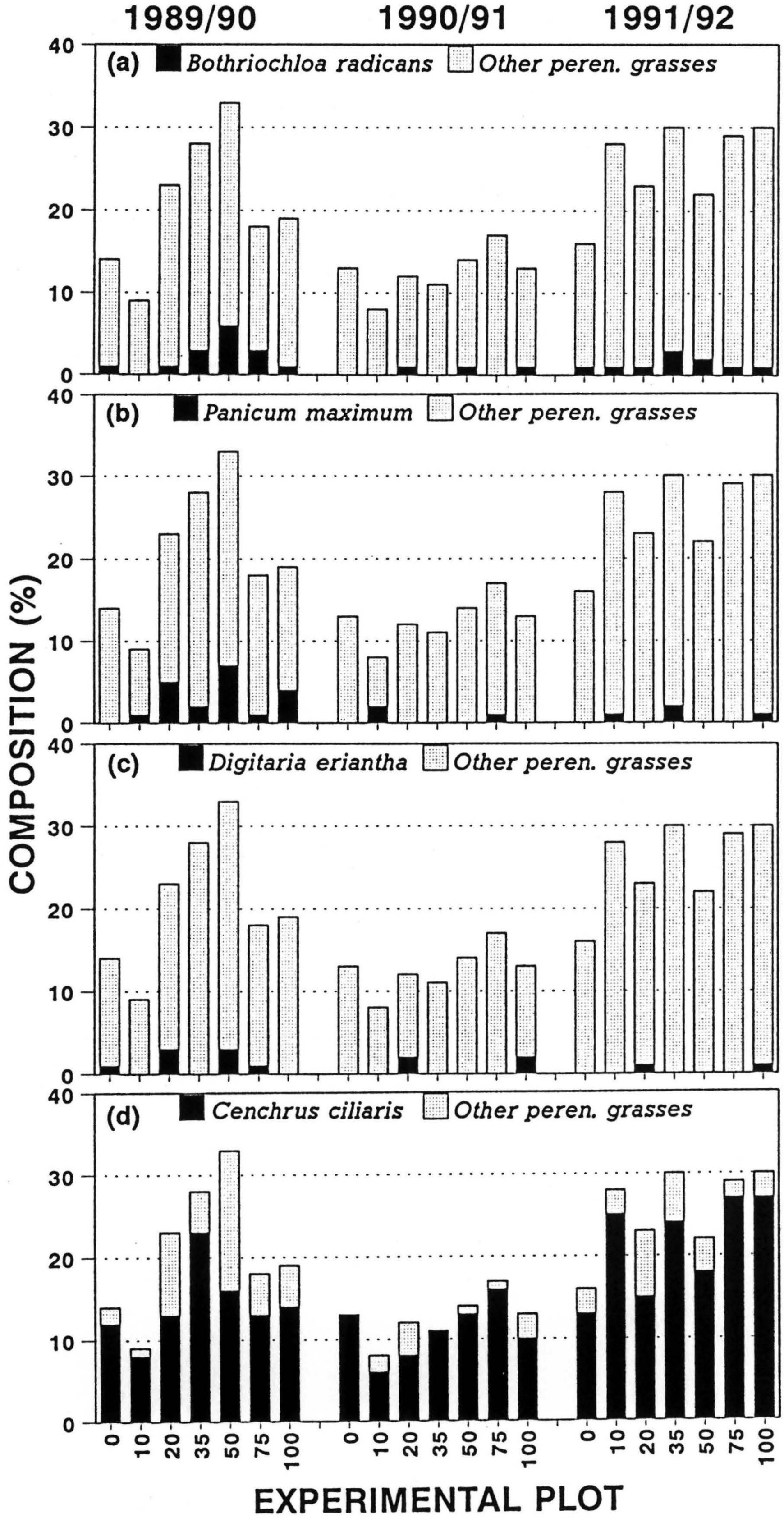


Figure 7.9 Percentage species composition of (a) *Bothriochloa radicans*, (b) *Panicum maximum,* (c) *Digitaria eriantha* and (d) *Cenchrus ciliaris* in the *Salvadora angustifolia*-habitat in relation to other recorded perennial grasses (based on the third reading of the point-observations).

Table 8.1 Percentages of the total surface area covered by the various habitats and subhabitats in each of the experimental plots.

Habitat	Subhabitat	Experimental plot	Area (%)
Colophospermum mopane	Between trees	0 %	87.10
”	”	10 %	86.58
”	”	20 %	83.99
”	”	35 %	86.65
”	”	50 %	87.46
”	”	75 %	85.92
”	”	100 %	82.92
”	Under trees	0 %	0.00
”	”	10 %	1.64
”	”	20 %	4.42
”	”	35 %	4.54
”	”	50 %	7.16
”	”	75 %	8.58
”	”	100 %	13.91
”	Where trees were removed	0 %	7.77
”		10 %	7.10
”	”	20 %	5.86
”	”	35 %	5.22
”	”	50 %	2.07
”	”	75 %	2.36
”	”	100 %	0.00
Salvadora angustifolia	-	0 %	5.13
”	-	10 %	4.68
”	-	20 %	5.73
”	-	35 %	3.59
”	-	50 %	3.31
”	-	75 %	3.14
”	-	100 %	3.17

Table 8.2 Results of the regression analyses of the relations between the DM yields of grasses within the defined subhabitats of the *Colophospermum mopane*-habitat (dependent variable) and Evapotranspiration Tree Equivalents (ETTE) ha^{-1} (independent variable).

Subhabitat	Season	Regression equation	r^2	r	n	P
Between trees (UCA)	1989/90	y = 57.188 – 0.00765x	0.282	–0.532	7	0.220 ns
	1990/91	ln y = 7.017 – 0.000510x	0.861	–0.928	7	0.003 **
	1991/92	ln y = 6.708 – 0.000579x	0.828	–0.910	7	0.004 **
Under trees (CA)	1989/90	ln y = 5.052 – 0.000274x	0.679	–0.824	7	0.044 *
	1990/91	ln y = 6.936 – 0.000257x	0.662	–0.814	7	0.049 *
	1991/92	ln y = 6.099 – 0.000349x	0.567	–0.753	7	0.084 ns
Trees removed (RCA)	1989/90	y = 274.648 – 0.0479x	0.358	–0.599	7	0.209 ns
	1990/91	ln y = 7.745 – 0.000284x	0.868	–0.932	7	0.007 **
	1991/92	ln y = 6.936 – 0.000466x	0.980	–0.990	7	0.002 **

Table 8.3 Results of the regression analyses of the relations between the DM yields of forbs within the defined habitats and subhabitats (dependent variable) and Evapotranspiration Tree Equivalents (ETTE) ha^{-1} (independent variable).

(Sub)habitat	Season	Regression equation	r^2	r	n	P
C. mopane combined	1989/90	y = 12.223 + 0.02171x	0.424	0.651	7	0.113 ns
	1990/91	y = 39.752 + 0.02029x	0.470	0.685	7	0.089 ns
	1991/92	ln y = 3.938 + 0.000195x	0.225	0.474	7	0.282 ns
Between trees (UCA)	1989/90	ln y = 2.756 + 0.000214x	0.137	0.370	7	0.414 ns
	1990/91	y = 43.396 + 0.01467x	0.272	0.521	7	0.230 ns
	1991/92	ln y = 3.911 + 0.000156x	0.126	0.355	7	0.434 ns
Under trees (CA)	1989/90	y = –65.59 + 0.12309x	0.675	0.822	7	0.045 *
	1990/91	y = 90.378 + 0.05286x	0.813	0.902	7	0.014 *
	1991/92	y = 139.76 + 0.04719x	0.416	0.645	7	0.167 ns
Trees removed (RCA)	1989/90	y = 21.291 + 0.00130x	0.021	0.146	7	0.783 ns
	1990/91	y = 72.022 – 0.01599x	0.537	–0.733	7	0.098 ns
	1991/92	ln y = 0.888 + 0.000824x	0.611	0.781	7	0.066 ns
	1989/90	y = 50.652 – 0.00643x	0.443	–0.666	7	0.102 ns
S. angustifolia	1990/91	y = –17.22 + 0.01398x	0.627	0.792	7	0.034 *
	1991/92	ln y = 1.816 – 0.000235x	0.073	–0.271	7	0.557

Table 8.4 Seasonal grazing capacity values calculated for the various experimental plots (see text) based on the total grass DM yields of each plot (habitats and subhabitats combined), as well as estimates of the number of AU's that a farm of 3 500 ha can carry on veld at the various grazing capacity values.

Season	Experimental plot	Grazing capacity (ha AU^{-1})	AU 3 500 ha^{-1}
1989/90	0 %	72.5	48.3
,,	10 %	268.1	13.1
,,	20 %	112.0	31.2
,,	35 %	186.9	18.7
,,	50 %	150.7	23.2
,,	75 %	459.4	7.6
,,	100 %	382.0	9.2
1990/91	0 %	9.4	371.3
,,	10 %	12.4	282.9
,,	20 %	12.3	284.9
,,	35 %	23.6	148.4
,,	50 %	25.5	137.5
,,	75 %	59.2	59.1
,,	100 %	81.7	42.8
1991/92	0 %	9.9	354.1
,,	10 %	22.5	155.7
,,	20 %	29.1	120.4
,,	35 %	17.7	197.4
,,	50 %	112.0	31.2
,,	75 %	235.4	14.9
,,	100 %	174.1	20.1

Table 8.5 Mean percentage contribution (on a dry mass basis) of the most abundant grass species to the total grass DM yield within the defined subhabitats of the *Colophospermum mopane*-habitat.

Grass species	Exp. plot	Mean % contribution (standard error) Between trees (UCA)	Under trees (CA)	Trees removed (RCA)
Tragus berteronianus	0 %	14.70 (7.30)	-	7.23 (4.55)
,,	10 %	8.30 (4.33)	4.30 (3.09)	5.73 (5.29)
,,	20 %	19.03 (12.97)	6.50 (3.26)	13.40 (6.95)
,,	35 %	28.57 (14.32)	9.03 (4.12)	7.03 (6.54)
,,	50 %	14.23 (7.23)	3.57 (2.51)	5.13 (4.84)
,,	75 %	11.00 (6.32)	3.60 (2.75)	5.90 (5.55)
,,	100 %	10.87 (8.76)	2.10 (2.10)	-
Aristida species	0 %	56.80 (2.59)	-	10.53 (1.43)
,,	10 %	38.23 (2.69)	12.93 (7.35)	6.23 (1.53)
,,	20 %	31.17 (4.93)	14.33 (5.80)	6.90 (3.58)
,,	35 %	8.97 (2.41)	5.23 (3.25)	8.27 (3.93)
,,	50 %	12.00 (6.89)	6.57 (3.31)	5.47 (2.39)
,,	75 %	23.37 (20.02)	4.53 (2.58)	9.37 (7.00)
,,	100 %	23.73 (7.05)	0.13 (0.13)	-
Oropetium capensis	0 %	1.93 (1.41)	-	0.13 (0.13)
,,	10 %	3.47 (1.09)	0.70 (0.60)	0.27 (0.22)
,,	20 %	6.33 (4.16)	2.17 (1.31)	0.03 (0.03)
,,	35 %	9.37 (4.27)	3.67 (1.95)	0.17 (0.17)
,,	50 %	14.17 (3.68)	3.90 (1.57)	0.10 (0.10)
,,	75 %	35.60 (15.69)	5.97 (0.85)	0.00 (0.00)
,,	100 %	21.83 (2.28)	4.93 (2.17)	-
Cenchrus ciliaris	0 %	1.67 (1.67)	-	2.10 (1.24)
,,	10 %	0.00 (0.00)	0.00 (0.00)	2.97 (1.49)
,,	20 %	0.00 (0.00)	7.63 (3.71)	1.20 (1.20)
,,	35 %	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
,,	50 %	0.00 (0.00)	4.33 (4.33)	0.00 (0.00)
,,	75 %	0.00 (0.00)	10.77 (9.21)	0.50 (0.50)
,,	100 %	0.00 (0.00)	19.63 (11.67)	-
Digitaria eriantha	0 %	0.00 (0.00)	-	1.87 (1.13)
,,	10 %	1.20 (1.20)	6.00 (3.81)	2.00 (0.91)
,,	20 %	0.00 (0.00)	6.50 (1.50)	8.17 (3.13)
,,	35 %	0.00 (0.00)	2.10 (2.10)	2.80 (0.90)
,,	50 %	0.00 (0.00)	17.60 (10.49)	8.80 (4.28)
,,	75 %	0.00 (0.00)	10.10 (3.26)	9.93 (8.52)
,,	100 %	2.37 (2.37)	40.10 (15.54)	-

Table 8.5 continued .....

Table 8.5 Continued ...

Grass species	Exp. plot	Mean % contribution (standard error) Between trees (UCA)	Under trees (CA)	Trees removed (RCA)
Panicum maximum	0 %	0.00 (0.00)	-	6.53 (6.53)
”	10 %	0.00 (0.00)	12.60 (12.60)	0.00 (0.00)
”	20 %	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
”	35 %	0.00 (0.00)	7.43 (7.43)	2.60 (2.60)
”	50 %	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
”	75 %	0.00 (0.00)	3.57 (3.57)	3.83 (3.83)
”	100 %	0.00 (0.00)	0.00 (0.00)	-
Brachiaraia deflexa	0 %	4.93 (3.79)	-	15.40 (11.72)
”	10 %	6.40 (3.13)	21.33 (11.18)	18.77 (15.40)
”	20 %	1.17 (0.69)	15.67 (10.05)	11.87 (7.89)
”	35 %	12.10 (6.14)	26.57 (13.32)	30.40 (19.93)
”	50 %	25.77 (12.91)	36.60 (20.58)	35.77 (15.44)
”	75 %	21.57 (12.27)	41.00 (21.95)	30.23 (13.99)
”	100 %	10.60 (6.74)	26.40 (19.59)	-
Enneapogon cenchroides	0 %	16.57 (8.67)	-	47.10 (13.78)
”	10 %	36.63 (2.47)	38.83 (13.97)	51.63 (21.41)
”	20 %	37.57 (13.30)	42.40 (9.12)	54.20 (17.82)
”	35 %	12.03 (6.03)	29.20 (17.05)	39.53 (16.10)
”	50 %	26.03 (12.07)	18.77 (12.37)	42.83 (15.25)
”	75 %	6.23 (3.83)	20.57 (12.13)	36.30 (5.18)
”	100 %	0.60 (0.60)	6.30 (5.33)	-
Bothriochloa radicans	0 %	0.00 (0.00)	-	0.00 (0.00)
”	10 %	0.00 (0.00)	0.00 (0.00)	9.13 (9.13)
”	20 %	4.43 (4.43)	4.83 (4.25)	0.00 (0.00)
”	35 %	7.37 (2.35)	14.40 (9.46)	9.23 (3.38)
”	50 %	4.17 (2.77)	0.00 (0.00)	0.00 (0.00)
”	75 %	2.30 (2.30)	0.00 (0.00)	1.00 (1.00)
”	100 %	19.97 (10.38)	0.50 (0.50)	-
Sporobolus ioclados	0 %	0.00 (0.00)	-	6.63 (6.63)
”	10 %	5.83 (5.83)	1.97 (1.82)	3.30 (2.10)
”	20 %	0.00 (0.00)	0.00 (0.00)	1.67 (1.67)
”	35 %	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
”	50 %	1.33 (1.33)	0.00 (0.00)	1.97 (1.97)
”	75 %	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
”	100 %	0.00 (0.00)	0.00 (0.00)	-
Urochloa mosambicensis	0 %	3.40 (1.76)	-	2.40 (1.88)
”	10 %	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
”	20 %	0.00 (0.00)	0.00 (0.00)	2.60 (2.60)
”	35 %	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
”	50 %	2.30 (2.30)	0.00 (0.00)	0.00 (0.00)
”	75 %	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
”	100 %	0.00 (0.00)	0.00 (0.00)	-

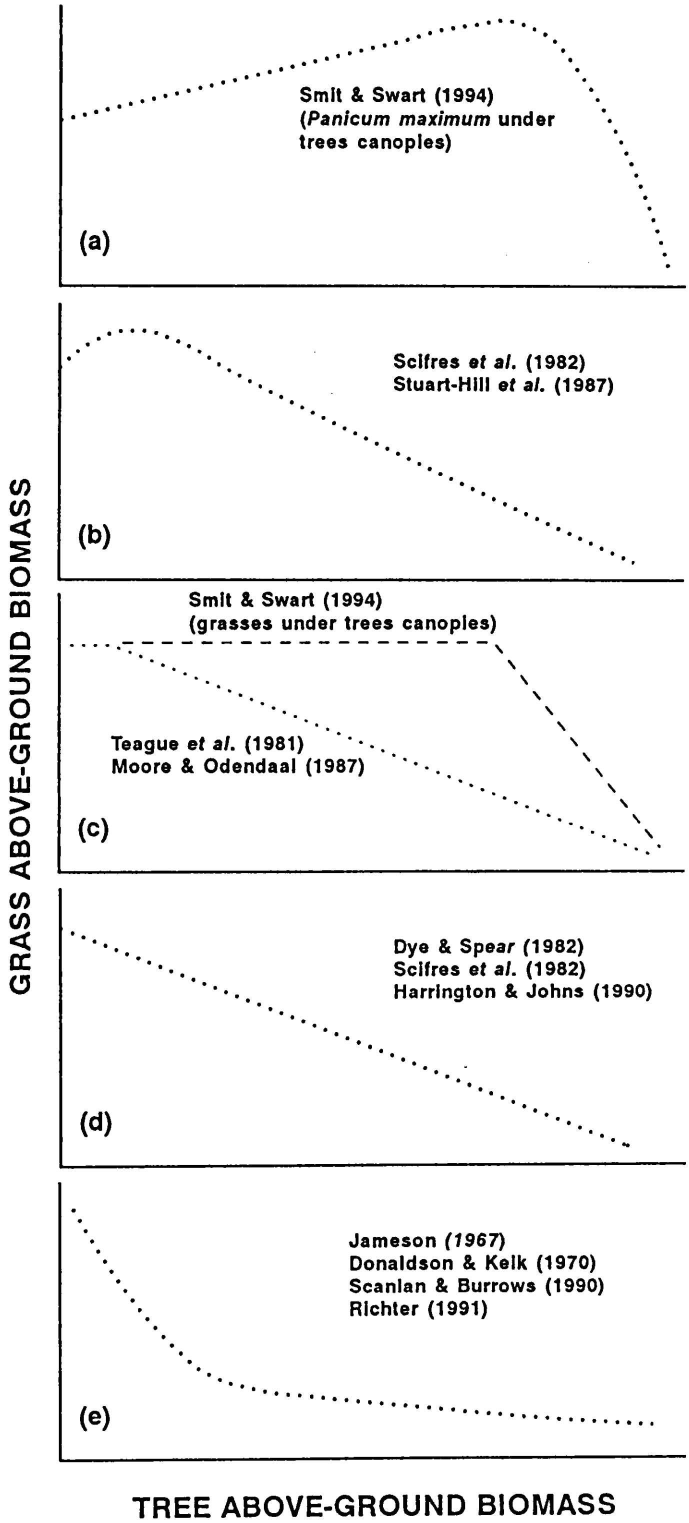


Figure 8.1 Summary of the relations between tree above-ground biomass and grass above-ground biomass as reported in the literature.

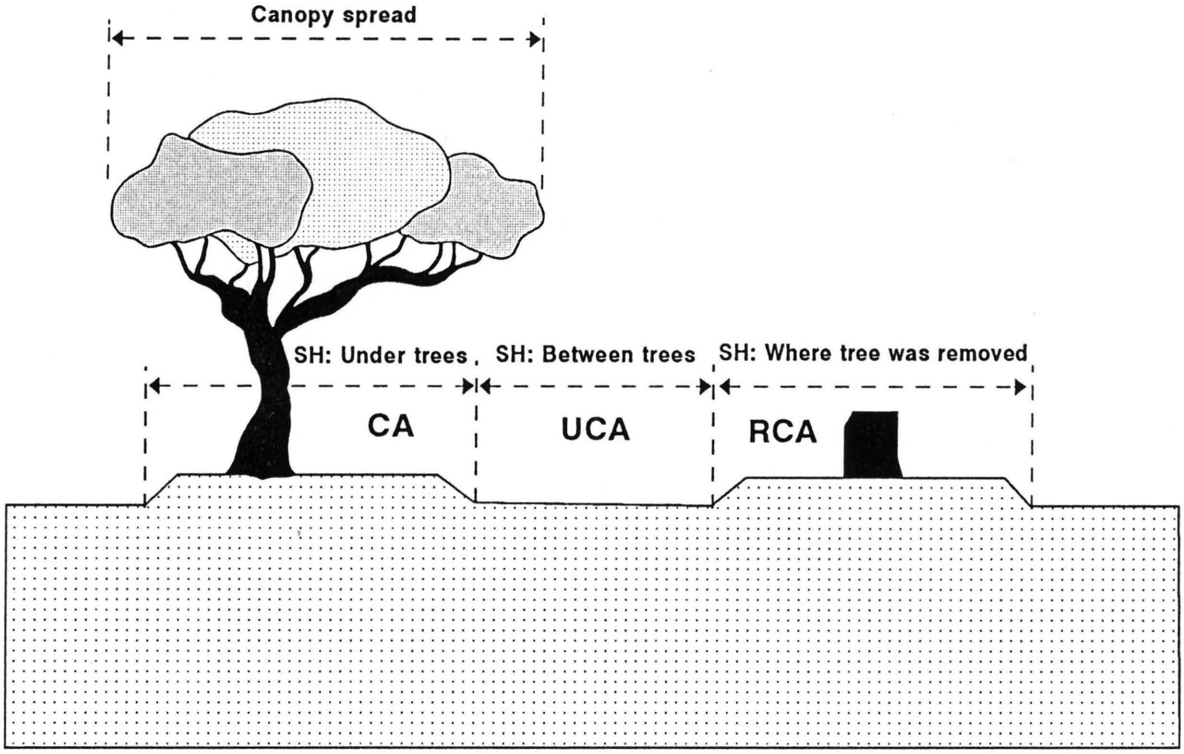


Figure 8.2 Schematic illustration of the criteria for judging the areas thats being representative of the various defined subhabitats of the *Colophospermum mopane*-habitat.

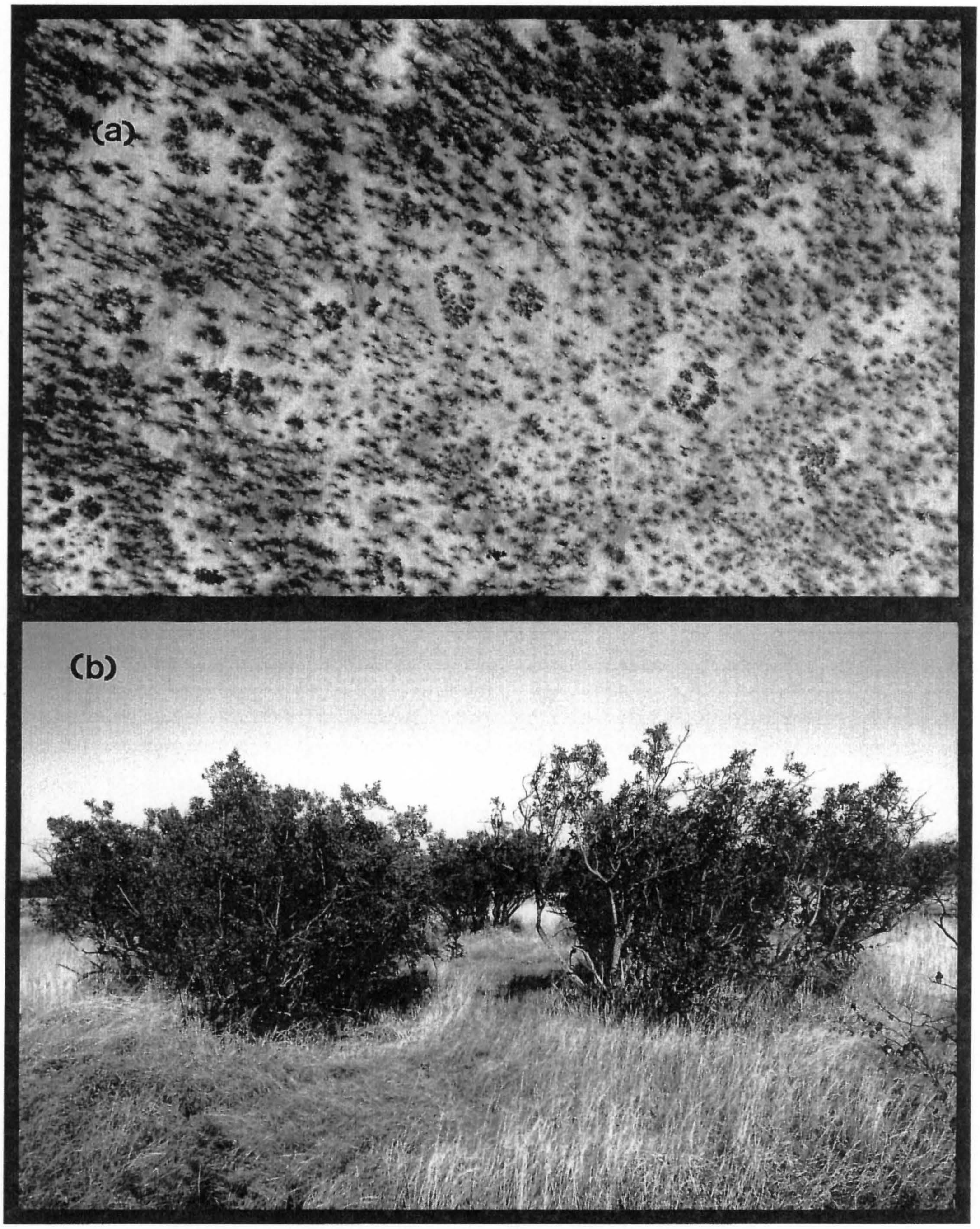


Figure 8.3 Examples of the distinctive *Salvadora angustifolia* communities: (a) aerial photo (from a height of 200 m) of the study area with the circular *S. angustifolia* communities clearly visible, and (b) a *S. angustifolia* community at ground level.

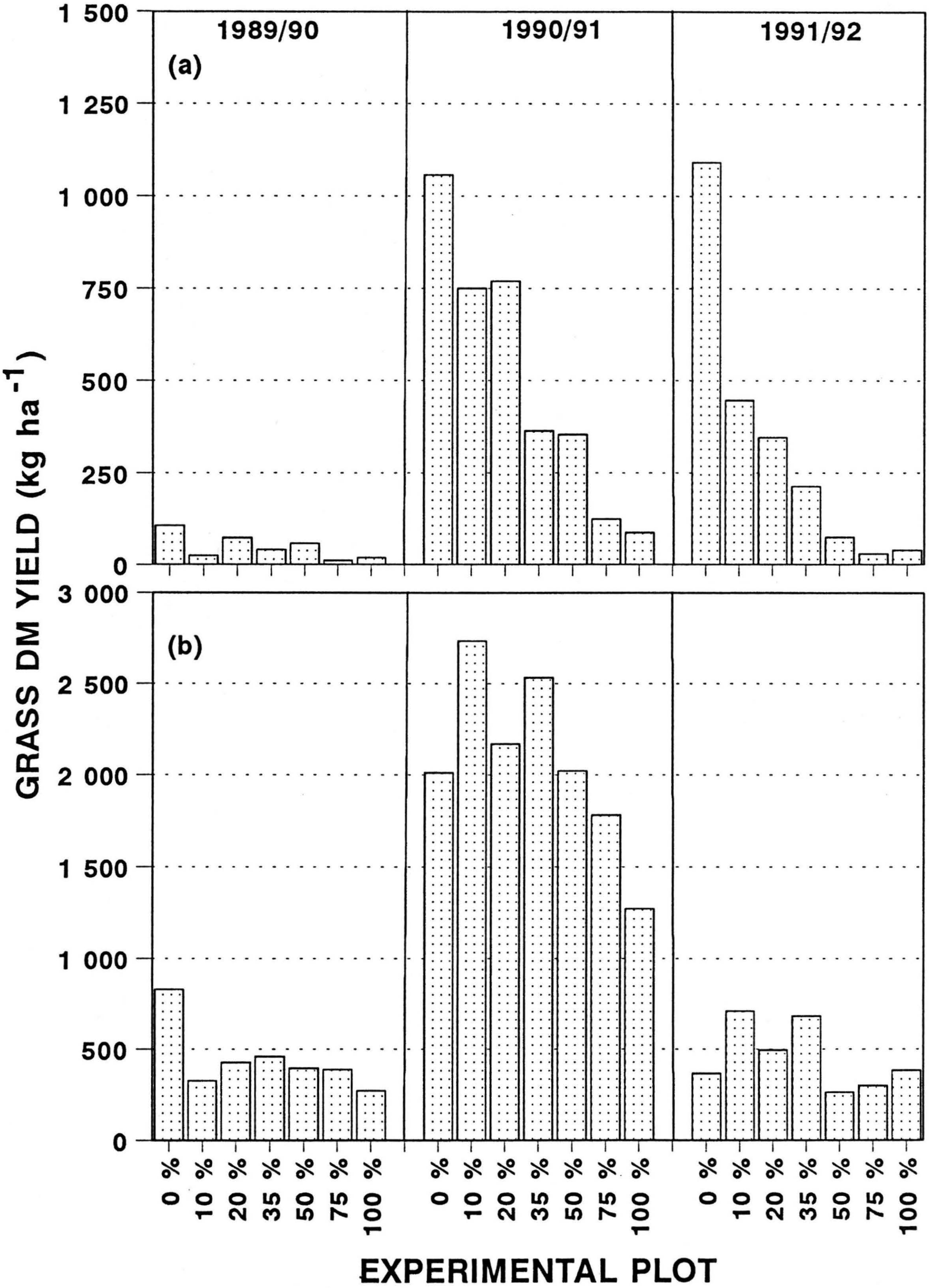


Figure 8.4 Total seasonal DM yields of grasses of (a) the *Colophospermum mopane*-habitat (subhabitats combined) and (b) the *Salvadora angustifolia*-habitat (note difference in scale of y-axis).

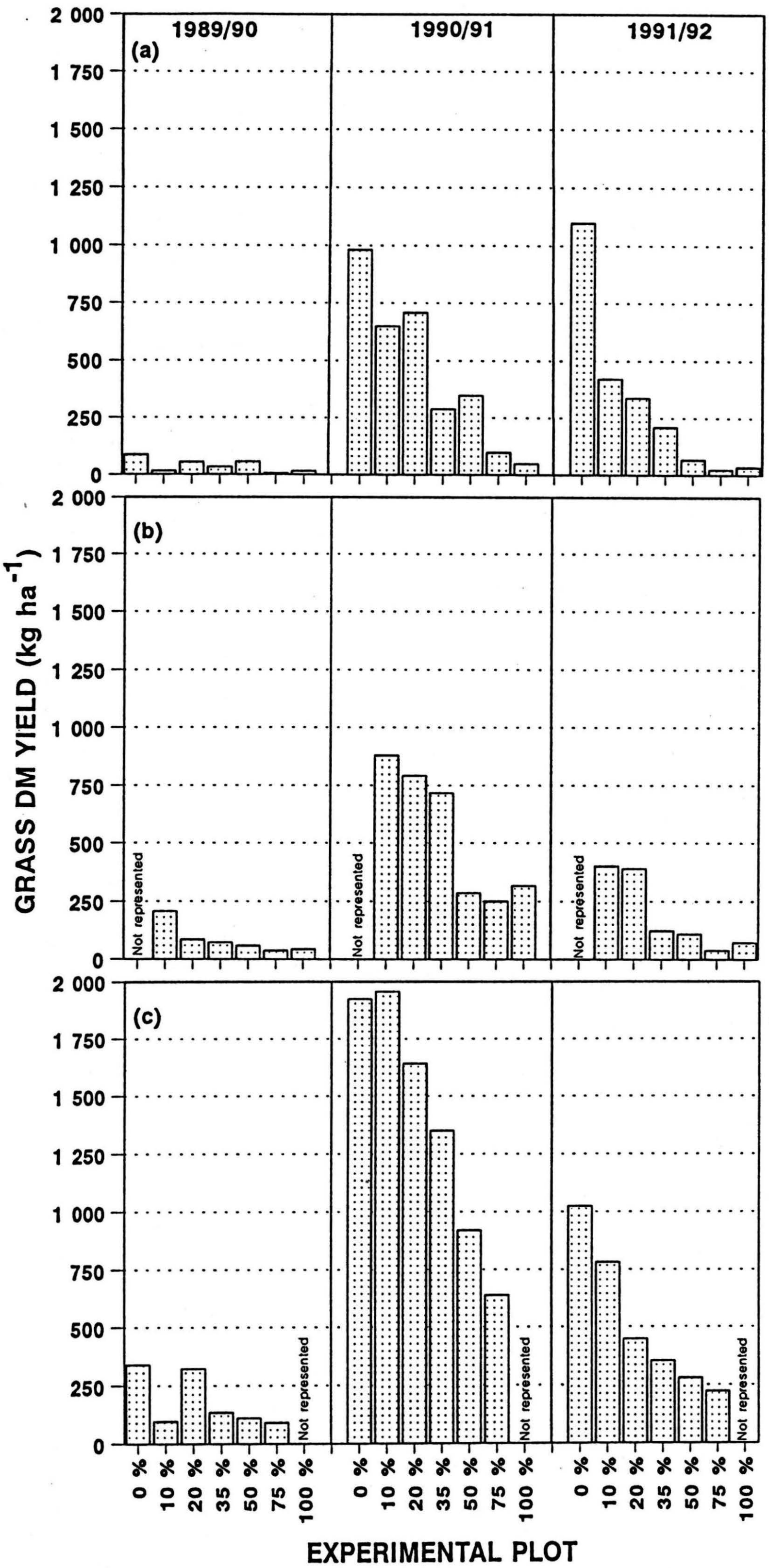


Figure 8.5 Total seasonal DM yields of grasses within the defined subhabitats of the *Colophospermum mopane*-habitat: (a) between tree canopies (uncanopied), (b) under trees (canopied), and (c) where trees have been removed (removed canopy).

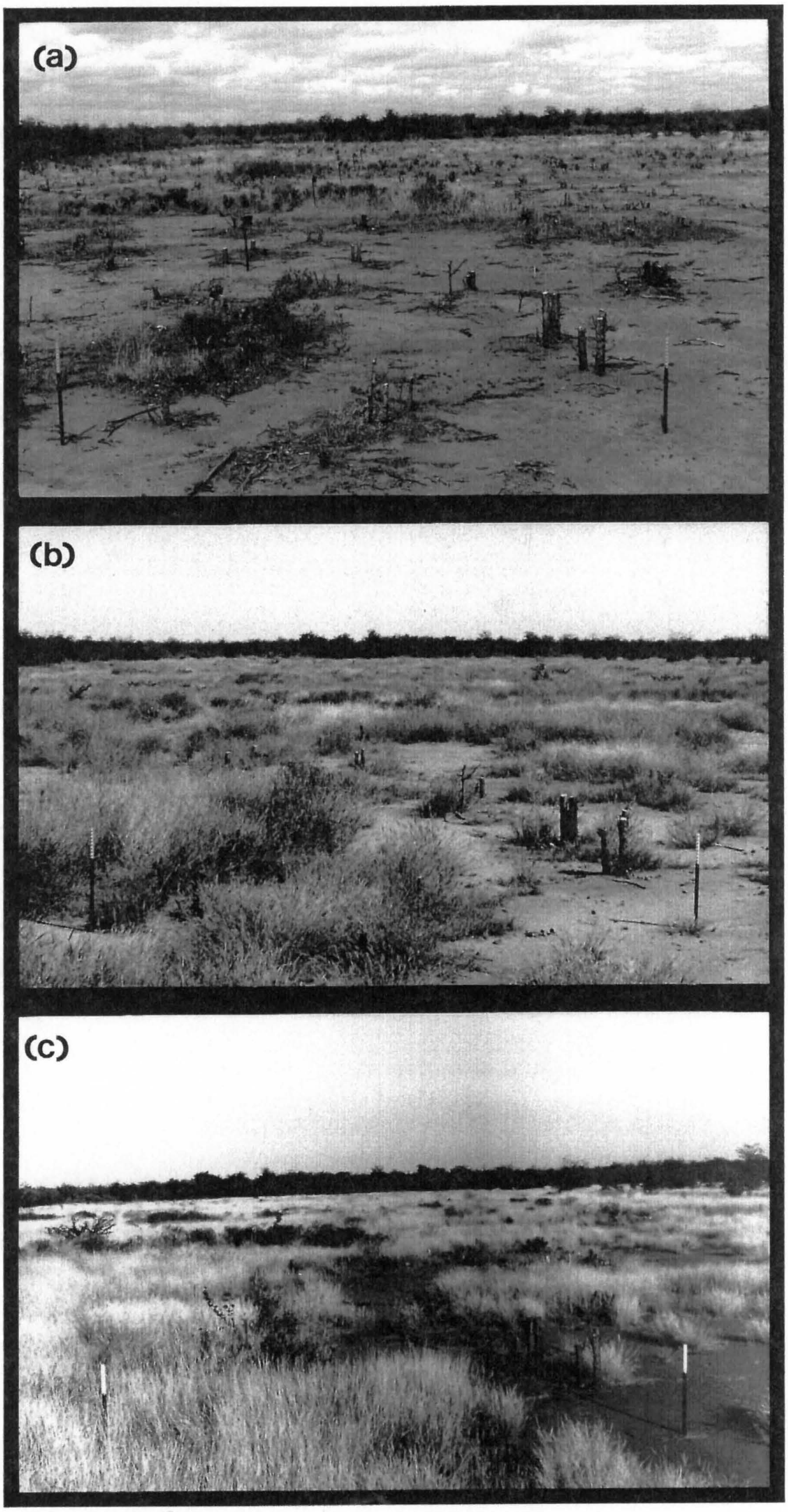


Figure 8.6 Fixed point photographs of the 0 % plot taken at the end of each successive season: (a) 1989/90, (b) 1990/91, and (c) 1991/92.

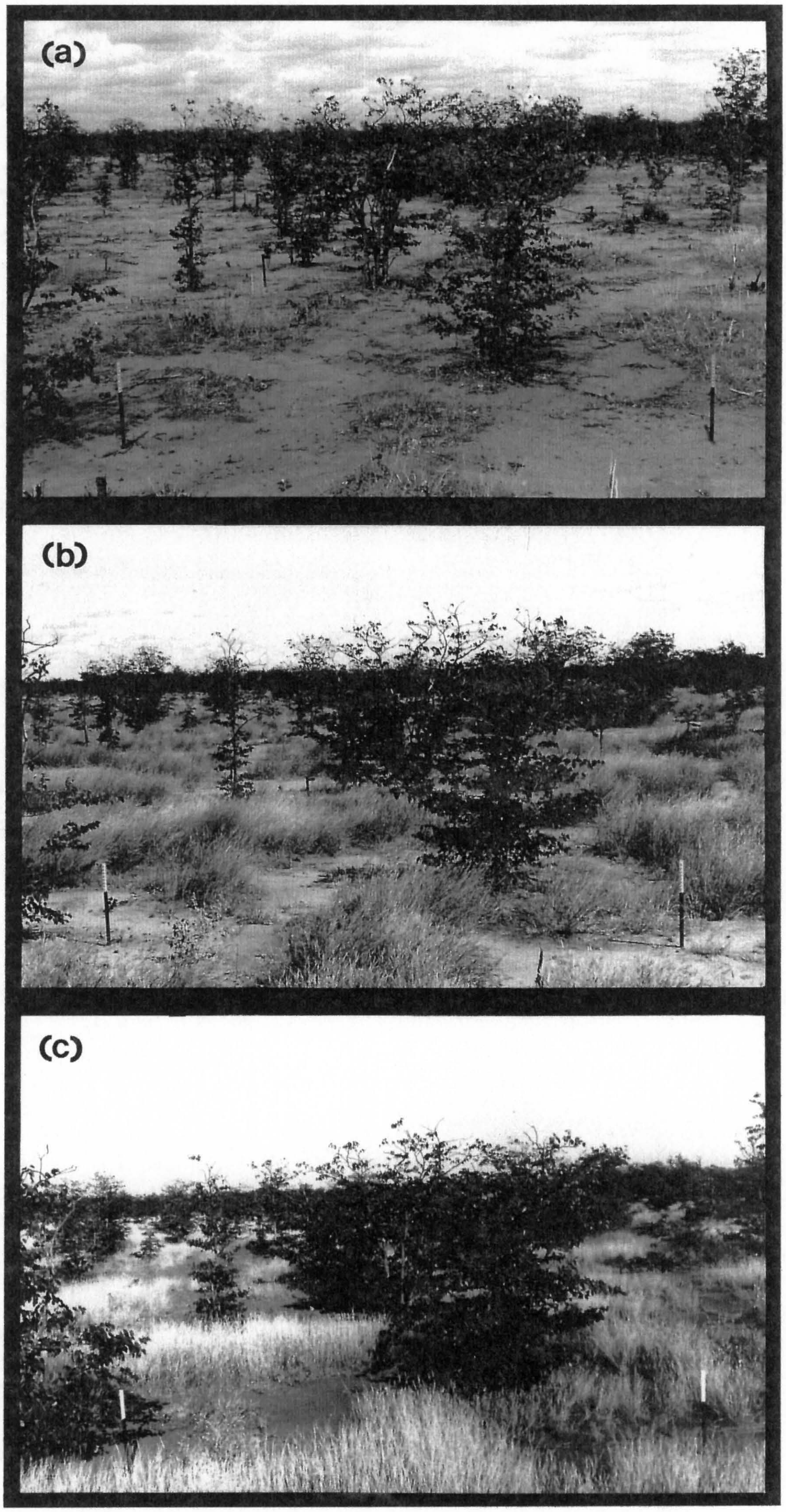


Figure 8.7 Fixed point photographs of the 10 % plot taken at the end of each successive season: (a) 1989/90, (b) 1990/91, and (c) 1991/92.

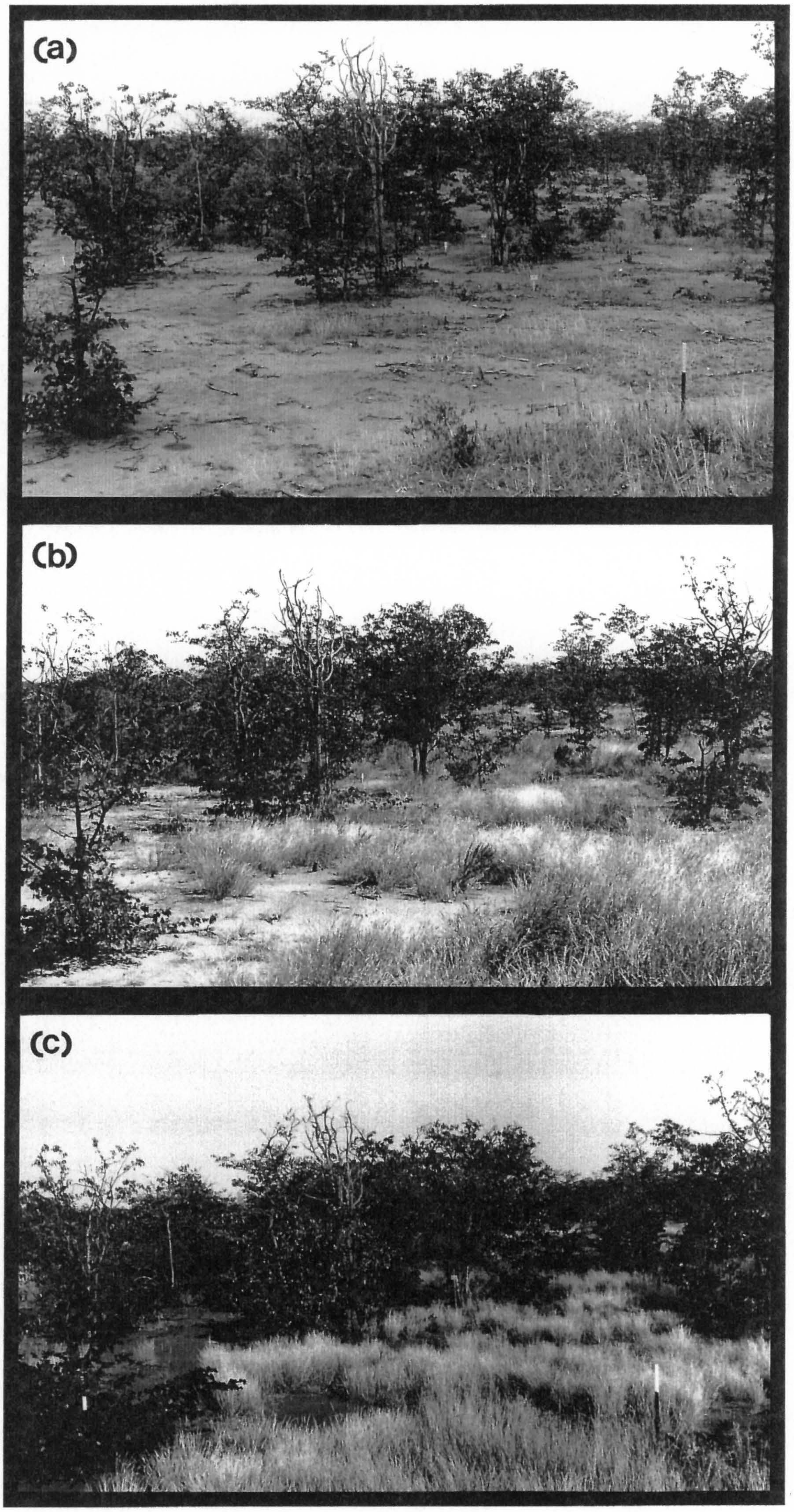


Figure 8.8 Fixed point photographs of the 20 % plot taken at the end of each successive season: (a) 1989/90, (b) 1990/91, and (c) 1991/92.

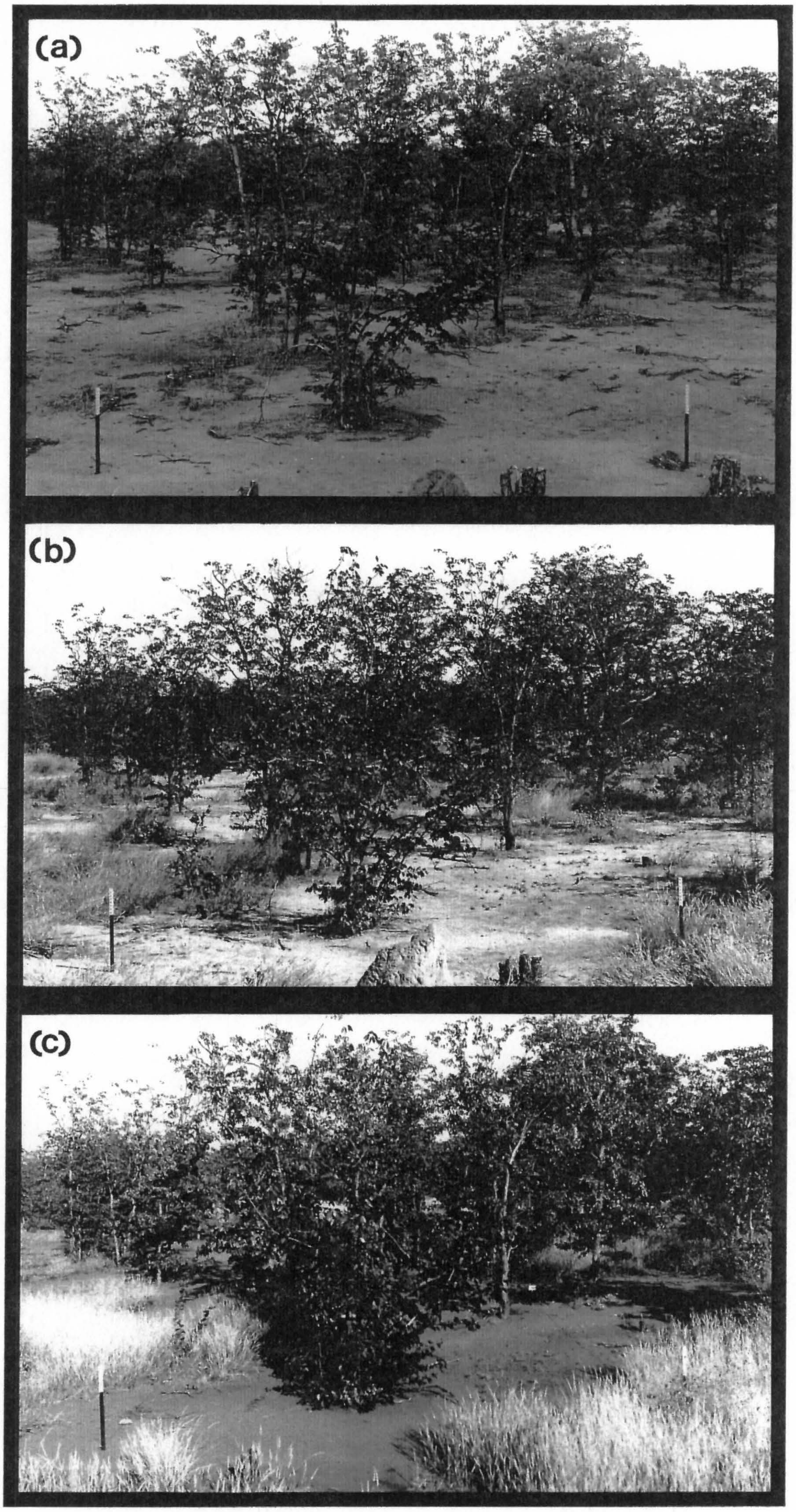


Figure 8.9 Fixed point photographs of the 35 % plot taken at the end of each successive season: (a) 1989/90, (b) 1990/91, and (c) 1991/92.

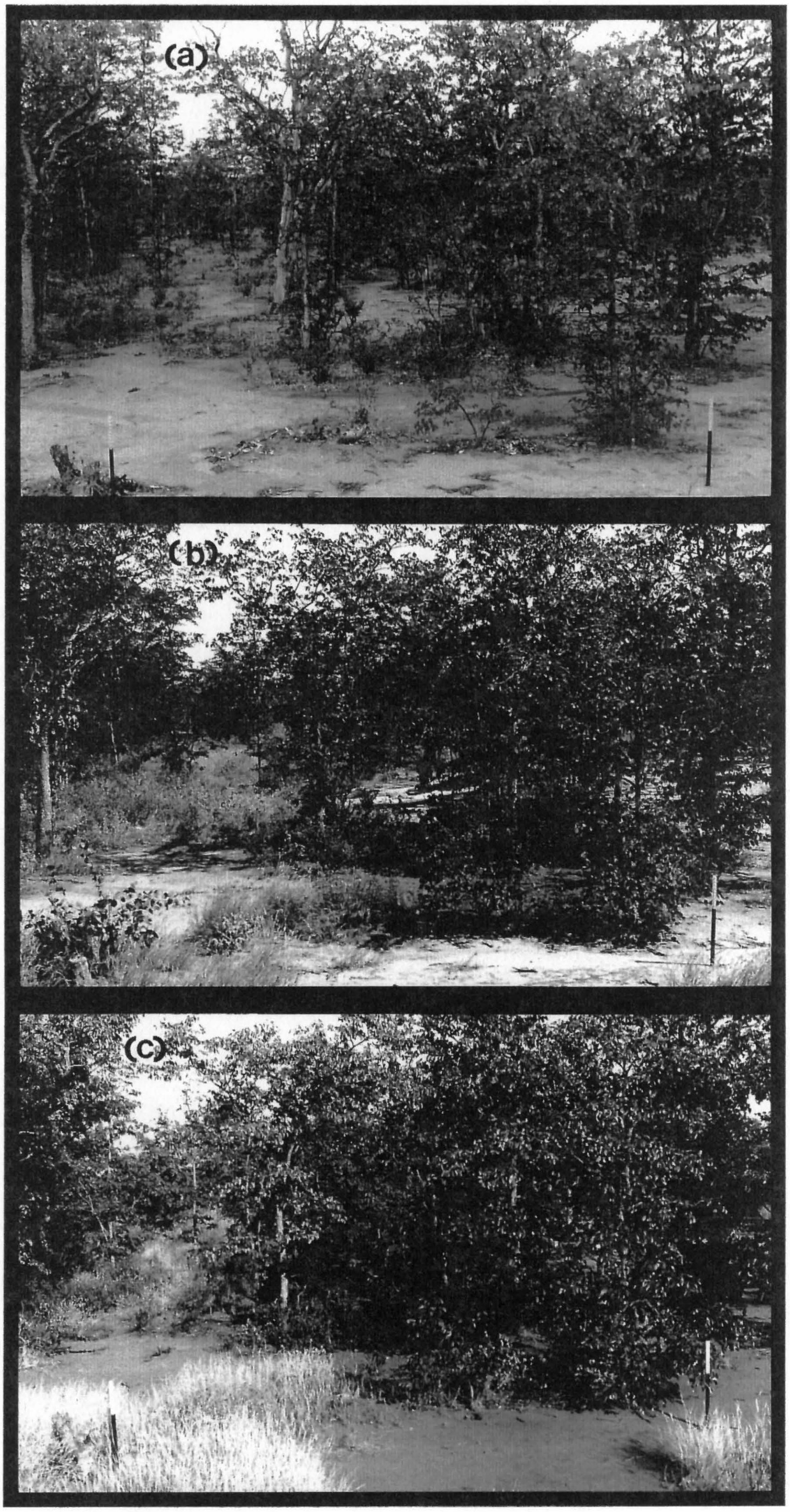


Figure 8.10 Fixed point photographs of the 50 % plot taken at the end of each successive season: (a) 1989/90, (b) 1990/91, and (c) 1991/92.

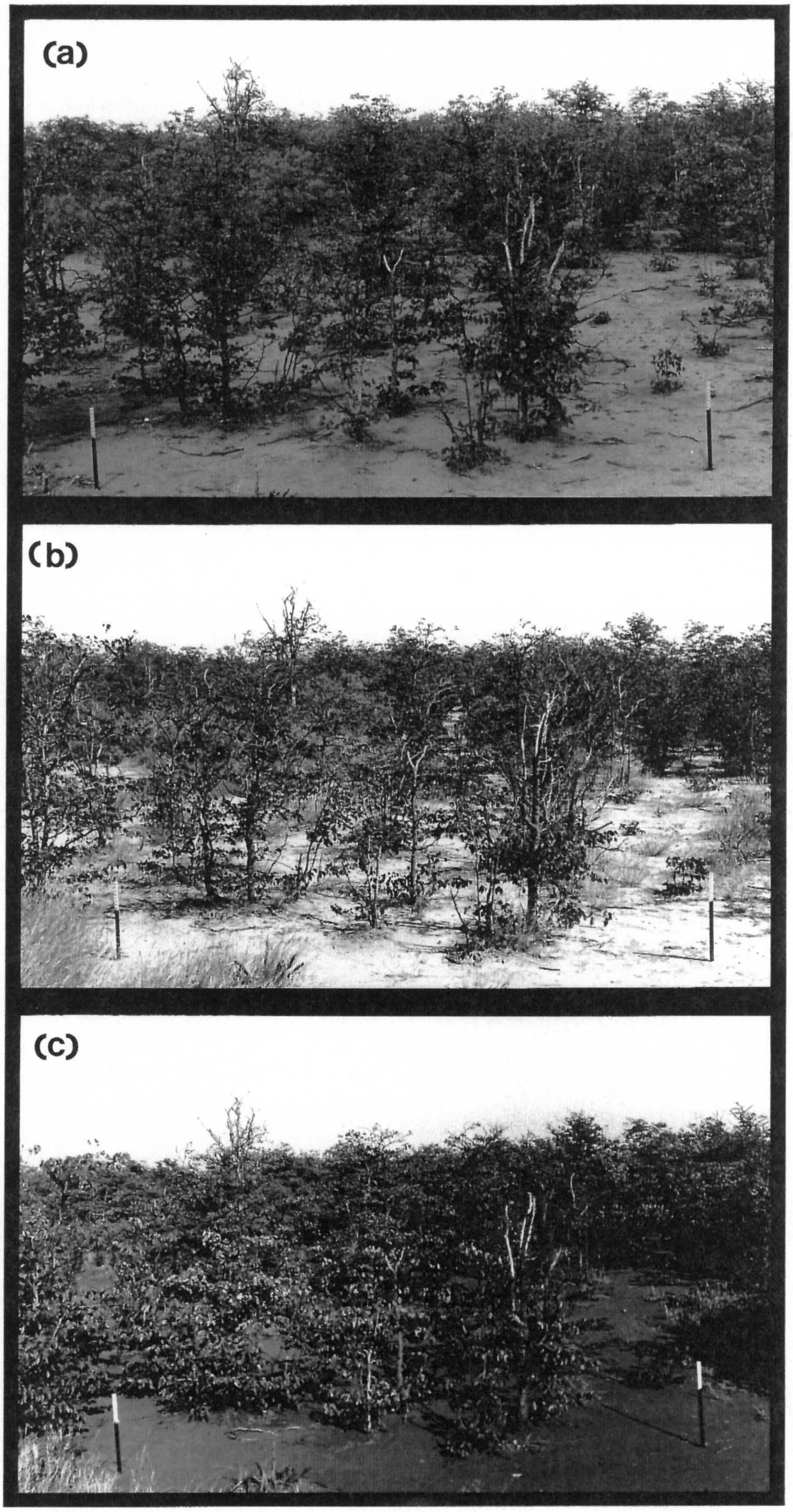


Figure 8.11 Fixed point photographs of the 75 % plot taken at the end of each successive season: (a) 1989/90, (b) 1990/91, and (c) 1991/92.

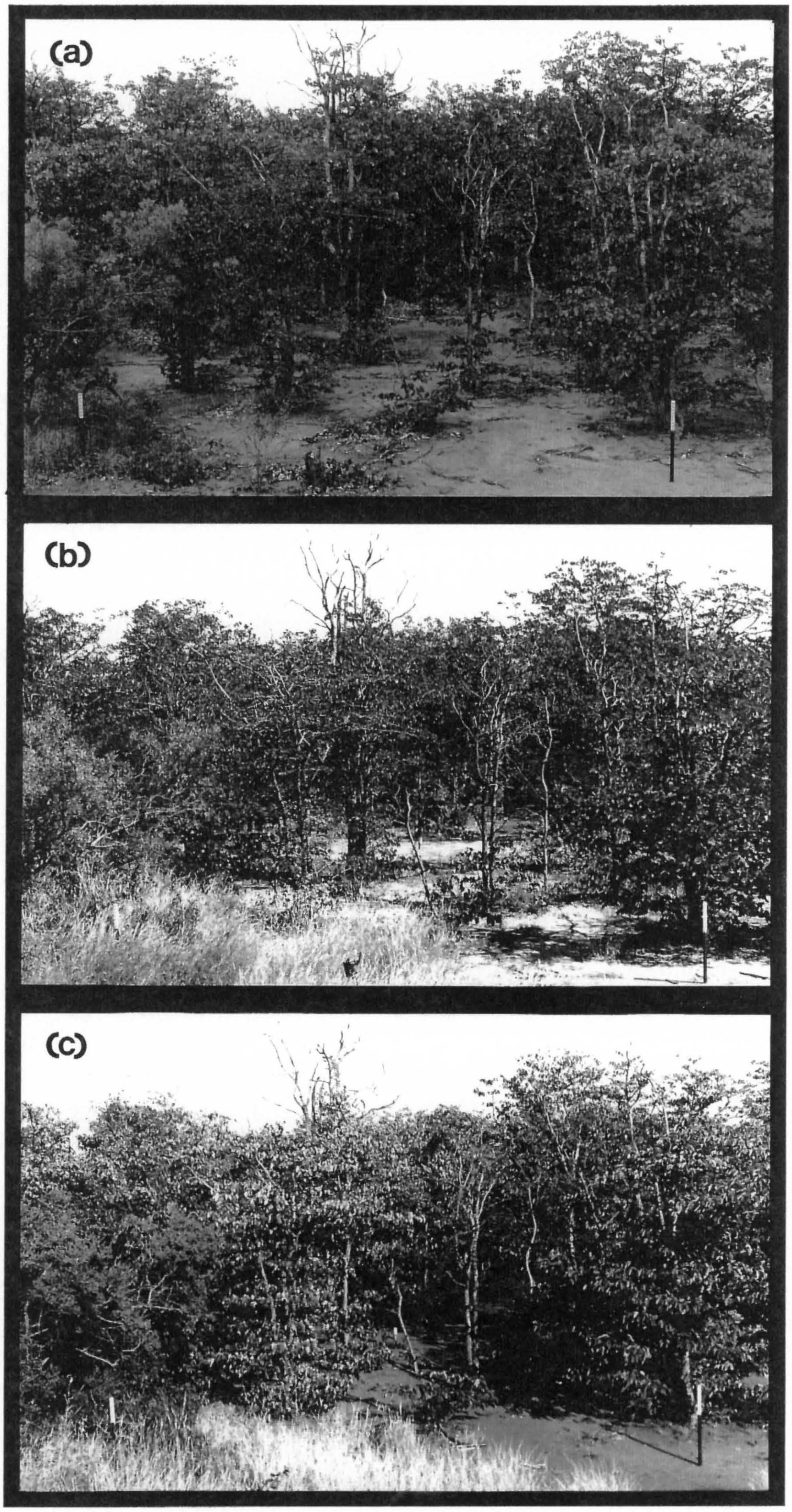


Figure 8.12 Fixed point photographs of the 100 % plot taken at the end of each successive season: (a) 1989/90, (b) 1990/91, and (c) 1991/92.

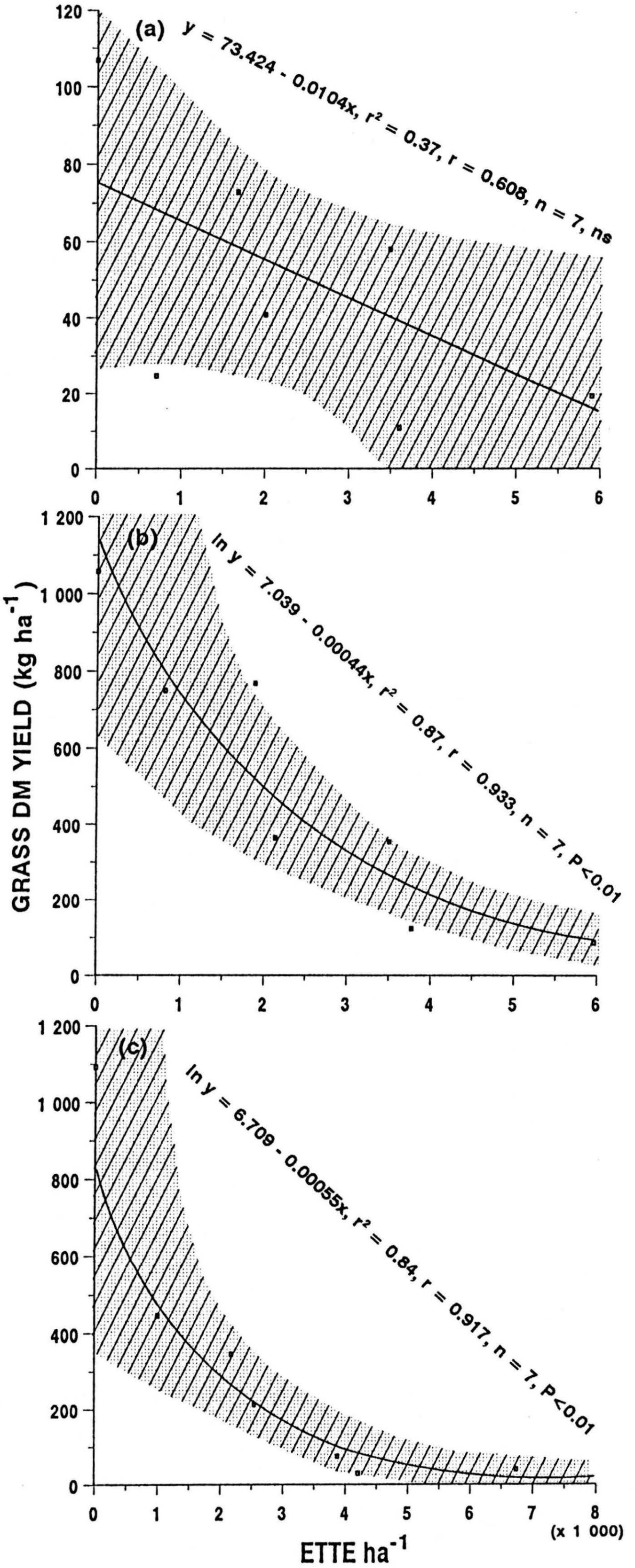


Figure 8.13 Results of the regression analyses of the relations between the grass DM yield of the *Colophospermum mopane*-habitat (subhabitats combined) and the Evapotranspiration Tree Equivalents (ETTE) ha^{-1} (shaded area shows the 95 % confidence limits): (a) 1989/90 season, (b) 1990/91 season, and (c) 1991/92 season.

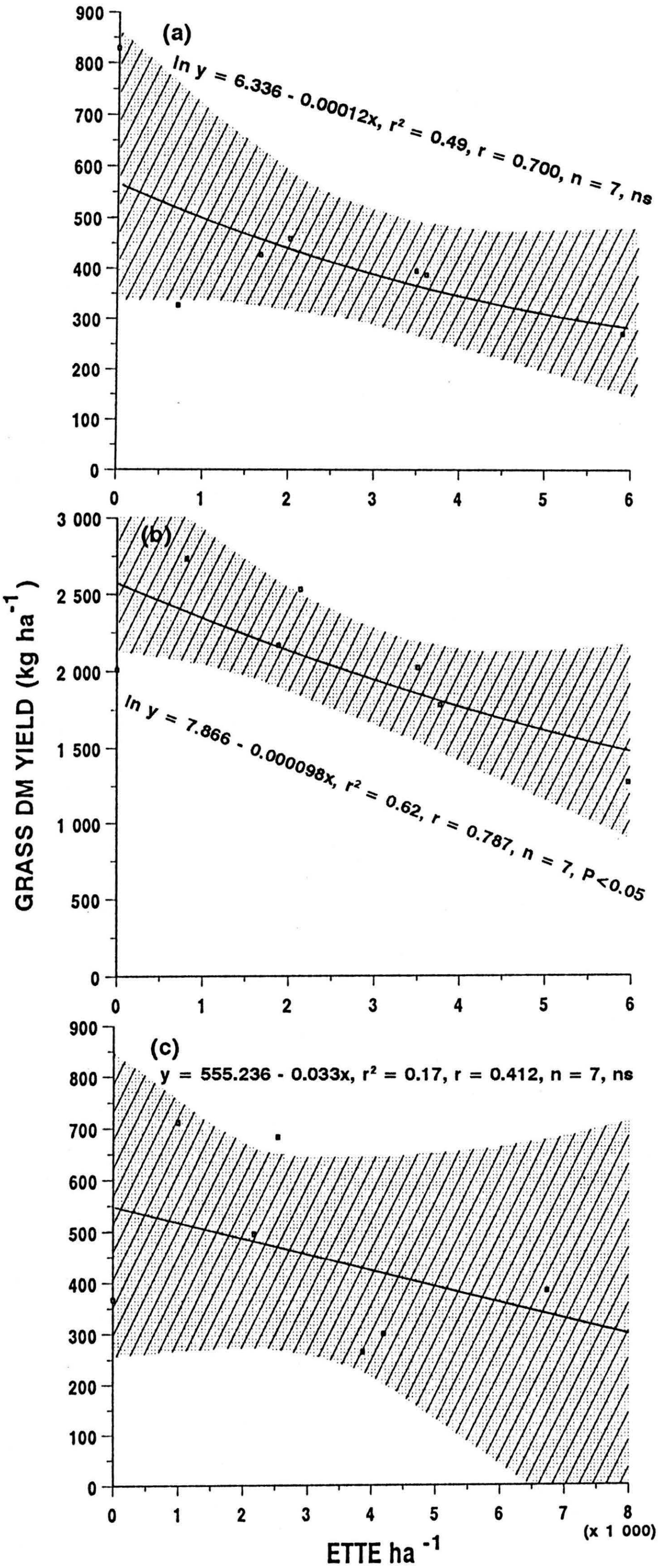


Figure 8.14 Results of the regression analyses of the relations between the grass DM yield of the *Salvadora angustifolia*-habitat and the Evapotranspiration Tree Equivalents (ETTE) ha^{-1} (shaded area shows the 95 % confidence limits): (a) 1989/90 season, (b) 1990/91 season, and (c) 1991/92 season.

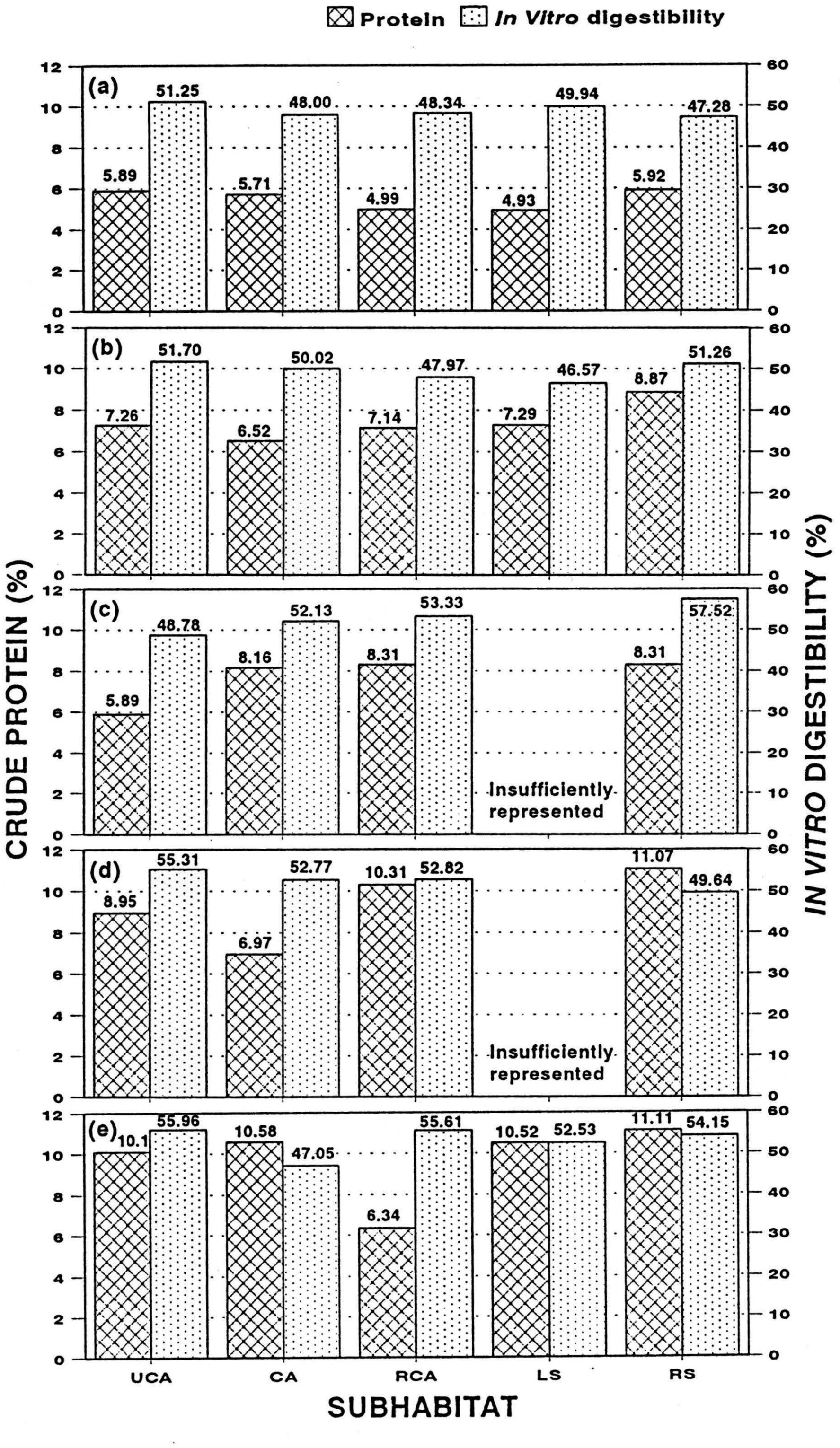


Figure 8.15 Crude protein content and *in vitro* digestibility of some grass species from each habitat and subhabitat (UCA - uncanopied, CA - canopied, RCA - removed canopy, LS - live *Salvadora*, RS - removed *Salvadora*): (a) *Aristida* species, (b) *Enneapogon cenchroides*, (c) *Digitaria eriantha*, (d) *Sporobolus ioclados*, (e) *Cenchrus ciliaris*.

Table 9.1 Results of the analyses of variance indicating the probabilities of differences between soils from the various subhabitats as tested by the following contrasts: (i) between tree canopies (UCA) versus under *Colophospermum mopane* tree canopies (CA) + where *C. mopane* trees were removed (RCA), (ii) CA + RCA versus live *Salvadora angustifolia* (LS) + dead *S. angustifolia* (DS), (iii) CA versus RCA, and (iv) LS versus DS.

Soil variable	Probability of differences			
	UCA vs (CA+RCA)	(CA+RCA) vs (LS+DS)	CA vs RCA	LS vs DS
% total N	<0.001 ***	<0.001 ***	0.106 ns	<0.001 ***
% organic C	<0.001 ***	<0.001 ***	0.090 ns	<0.001 ***
P	0.001 ***	0.065 ns	0.453 ns	0.028 *
Na	<0.001 ***	<0.001 ***	0.794 ns	0.769 ns
K	<0.001 ***	<0.001 ***	0.014 *	0.981 ns
Mg	<0.001 ***	<0.001 ***	0.201 ns	0.184 ns
Ca	0.161 ns	<0.001 ***	0.753 ns	0.230 ns
pH (H_2O)	<0.001 ***	<0.001 ***	0.633 ns	0.050 *
Electrical resistance	0.096 ns	<0.001 ***	<0.001 ***	0.328 ns

* = significant ($P \leq 0.05$); ** = highly significant ($P \leq 0.01$); *** = highly significant ($P \leq 0.001$)

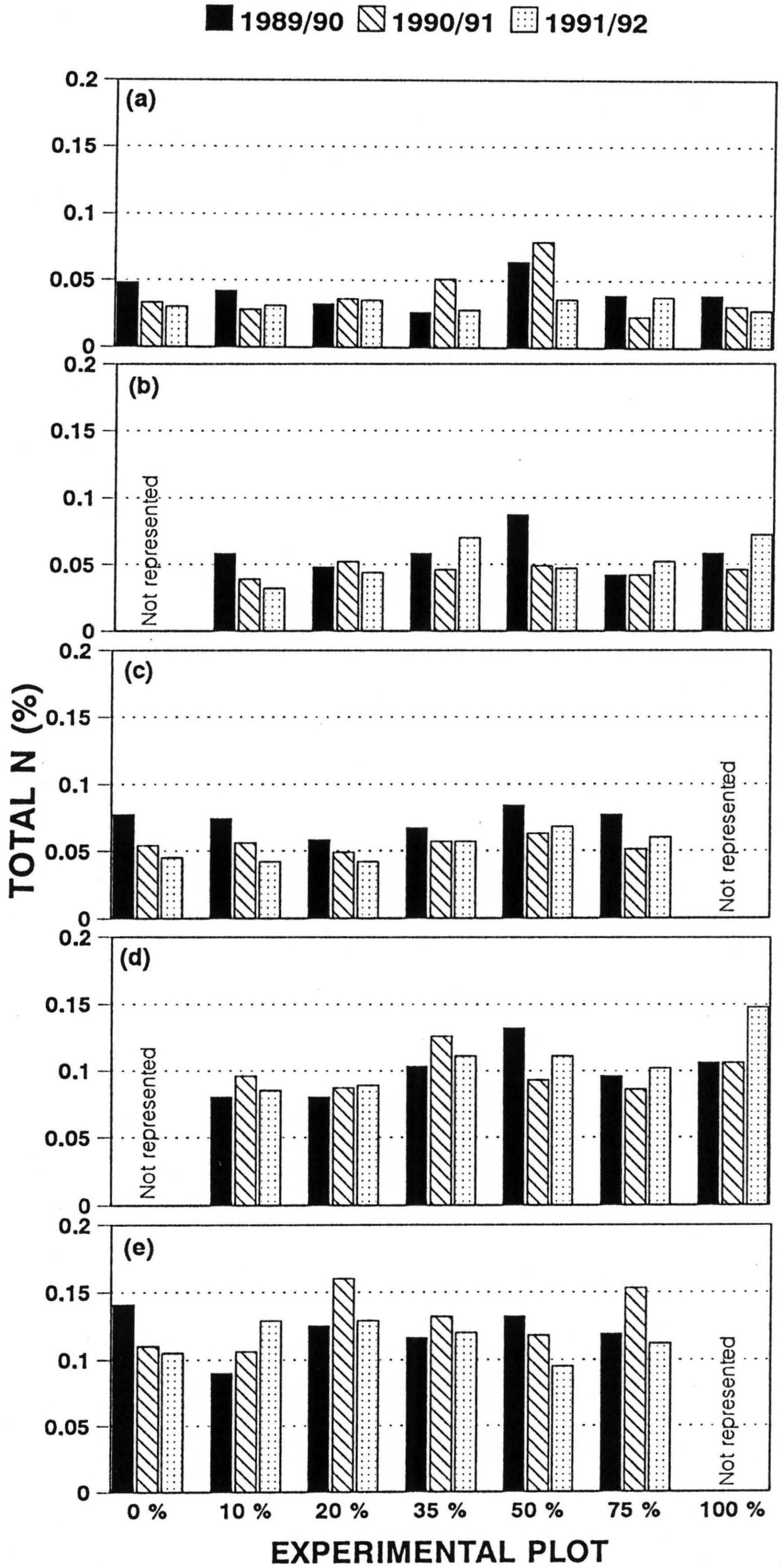


Figure 9.1 The percentage total nitrogen (N) of topsoil sampled at the end of each of the three seasons (1989/90, 1990/91, 1991/92) within 5 subhabitats in each experimental plot: (a) between tree canopies (UCA), (b) under *Colophospermum mopane* trees (CA), (c) where *C. mopane* trees have been removed (RCA), (d) live *Salvadora angustifolia* (LS) and (e) where *S. angustifolia* have been removed (DS).

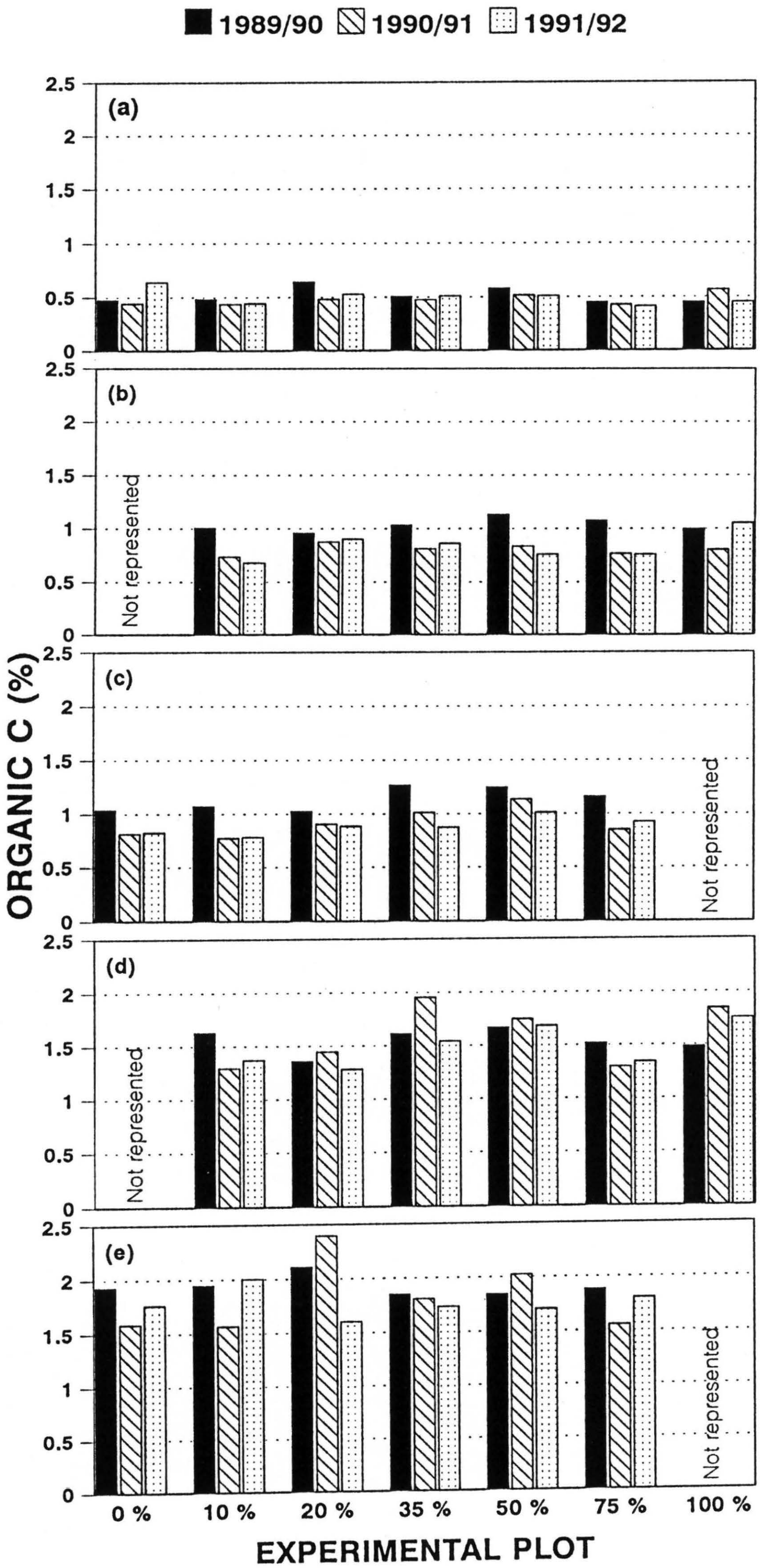


Figure 9.2 The percentage organic C of topsoil sampled at the end of each of the three seasons (1989/90, 1990/91, 1991/92) within 5 subhabitats in each experimental plot: (a) between tree canopies (UCA), (b) under *Colophospermum mopane* trees (CA), (c) where *C. mopane* trees have been removed (RCA), (d) live *Salvadora angustifolia* (LS) and (e) where *S. angustifolia* have been removed (DS).

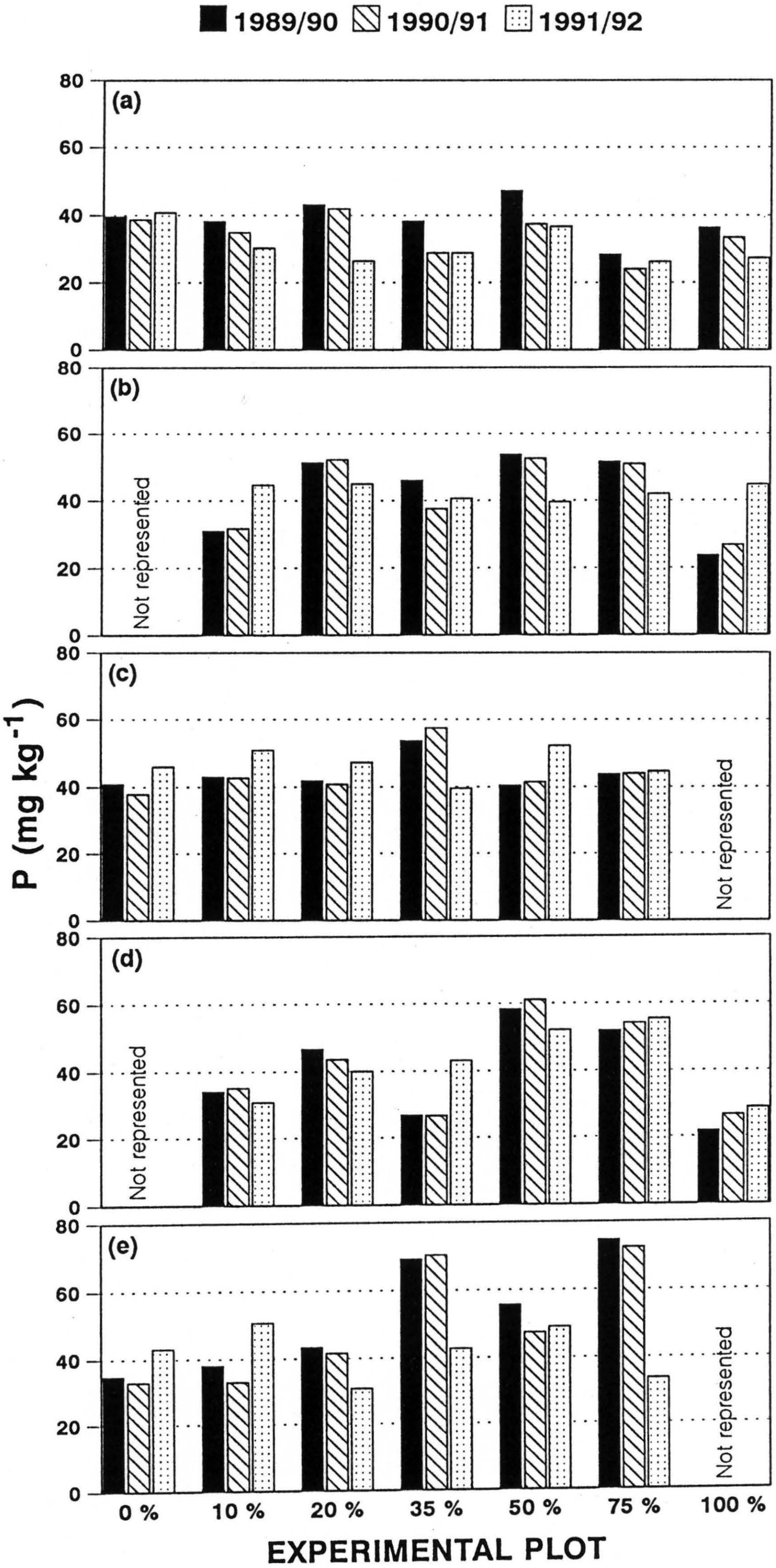


Figure 9.3 The phosphorus (P) content of topsoil sampled at the end of each of the three seasons (1989/90, 1990/91, 1991/92) within 5 subhabitats in each experimental plot: (a) between tree canopies (UCA), (b) under *Colophospermum mopane* trees (CA), (c) where *C. mopane* trees have been removed (RCA), (d) live *Salvadora angustifolia* (LS) and (e) where *S. angustifolia* have been removed (DS).

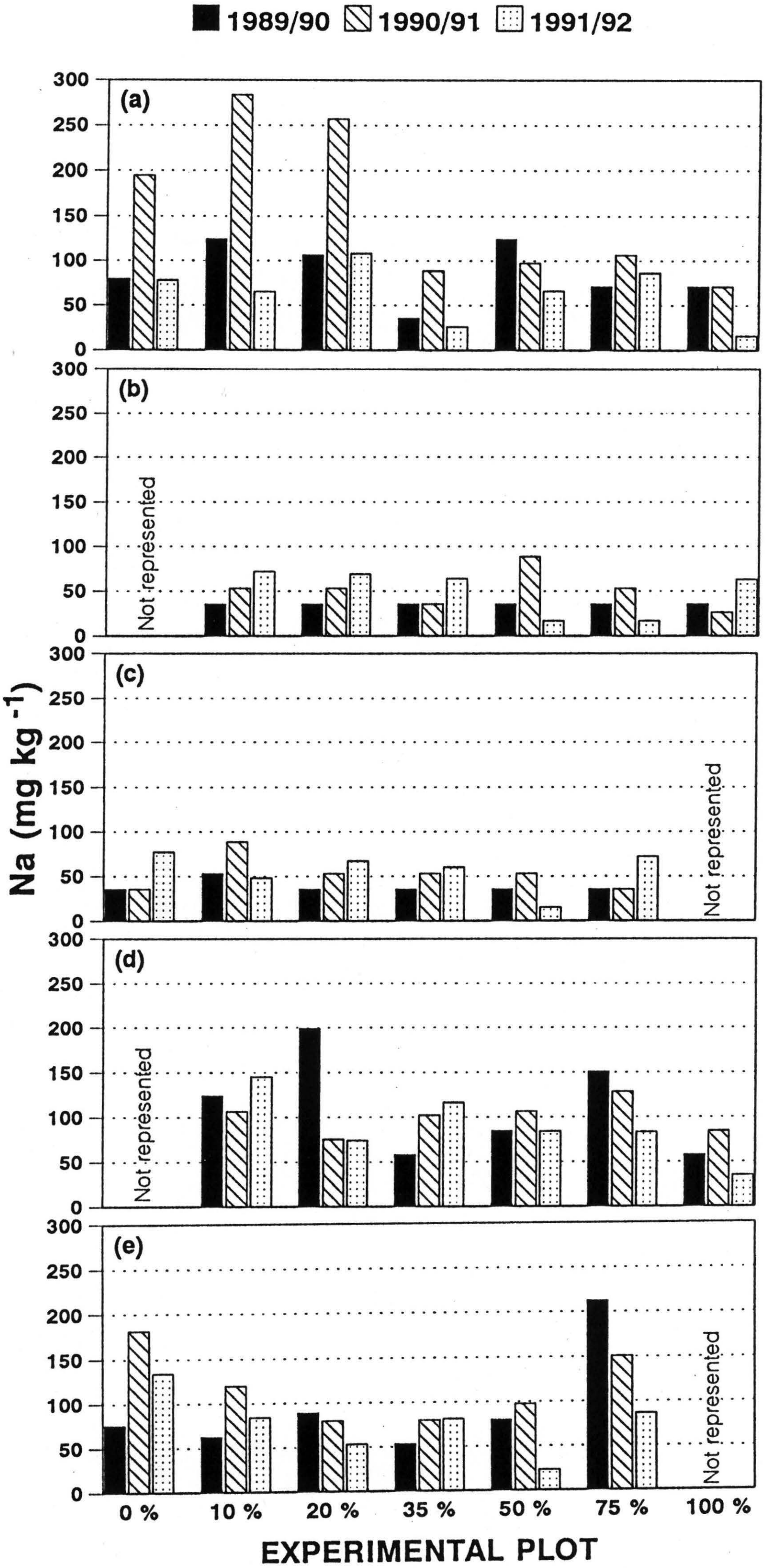


Figure 9.4 The sodium (Na) content of topsoil sampled at the end of each of he three seasons (1989/90, 1990/91, 1991/92) within 5 subhabitats in each experimental plot: (a) between tree canopies (UCA), (b) under *Colophospermum mopane* trees (CA), (c) where *C. mopane* trees have been removed (RCA), (d) live *Salvadora angustifolia* (LS) and (e) where *S. angustifolia* have been removed (DS).

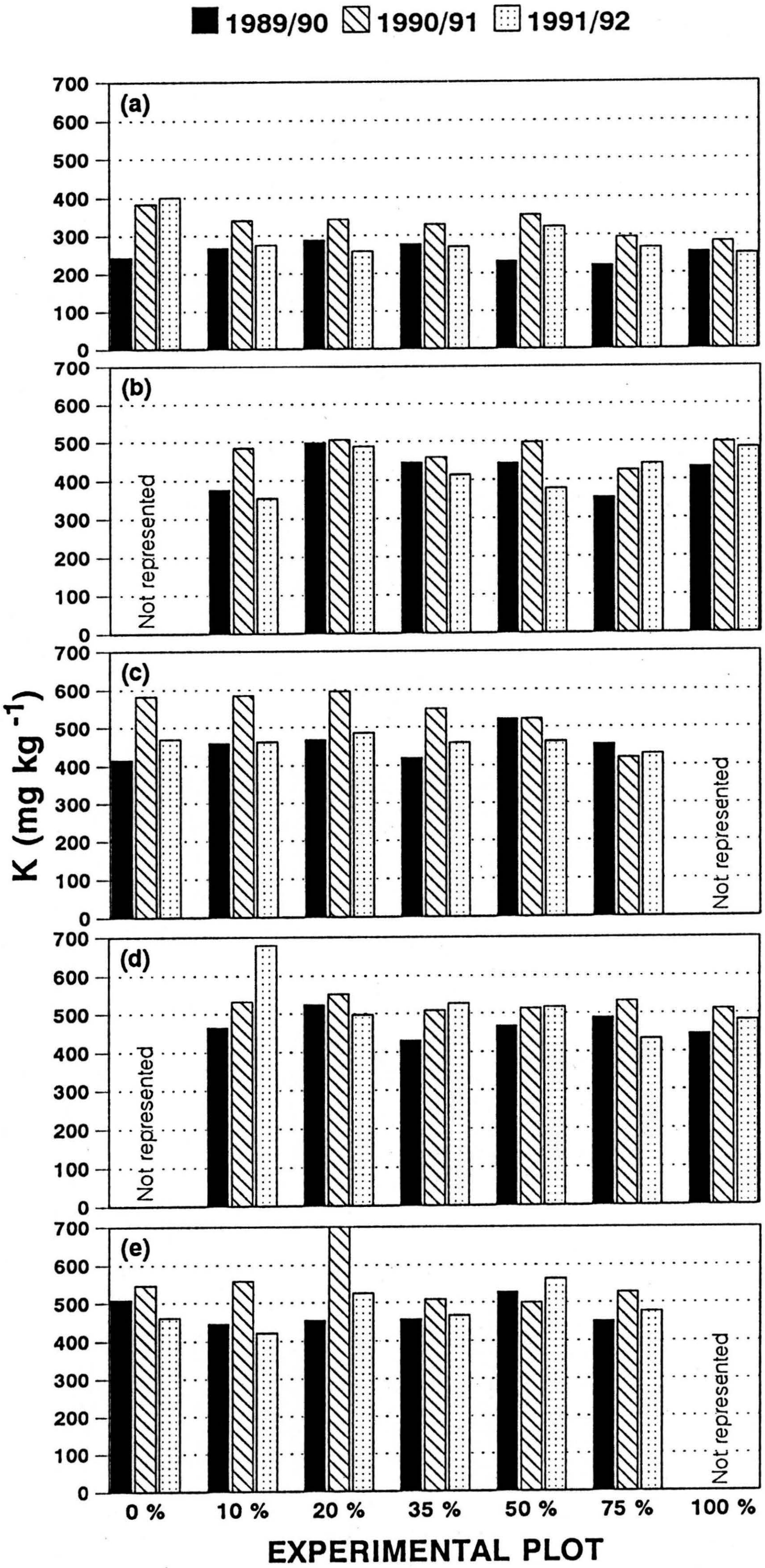


Figure 9.5 The potassium (K) content of topsoil sampled at the end of each of the three seasons (1989/90, 1990/91, 1991/92) within 5 subhabitats in each experimental plot: (a) between tree canopies (UCA), (b) under *Colophospermum mopane* trees (CA), (c) where *C. mopane* trees have been removed (RCA), (d) live *Salvadora angustifolia* (LS) and (e) where *S. angustifolia* have been removed (DS).

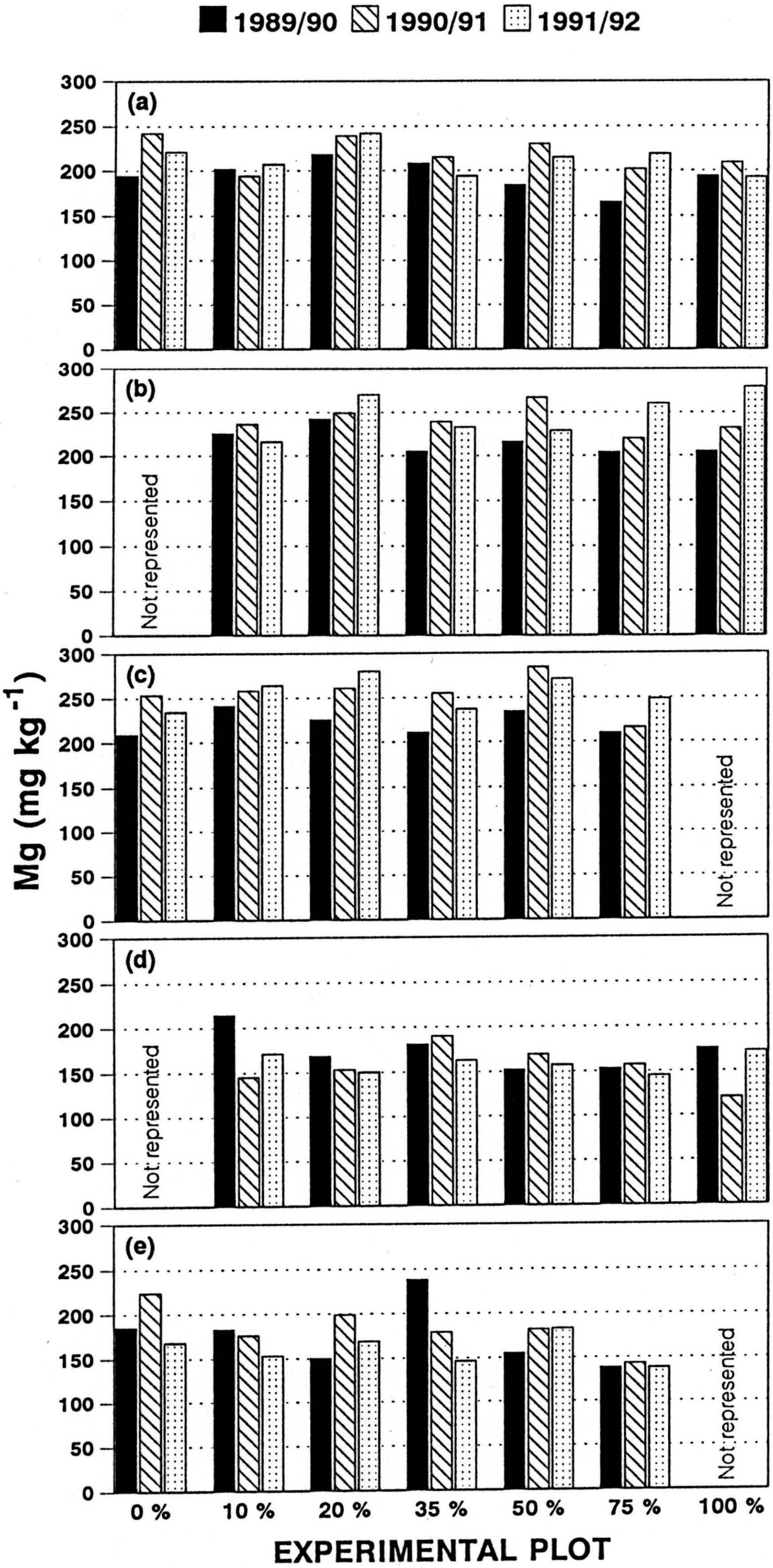


Figure 9.6 The magnesium (Mg) content of topsoil sampled at the end of each of the three seasons (1989/90, 1990/91, 1991/92) within 5 subhabitats in each experimental plot: (a) between tree canopies (UCA), (b) under *Colophospermum mopane* trees (CA), (c) where *C. mopane* trees have been removed (RCA), (d) live *Salvadora angustifolia* (LS) and (e) where *S. angustifolia* have been removed (DS).

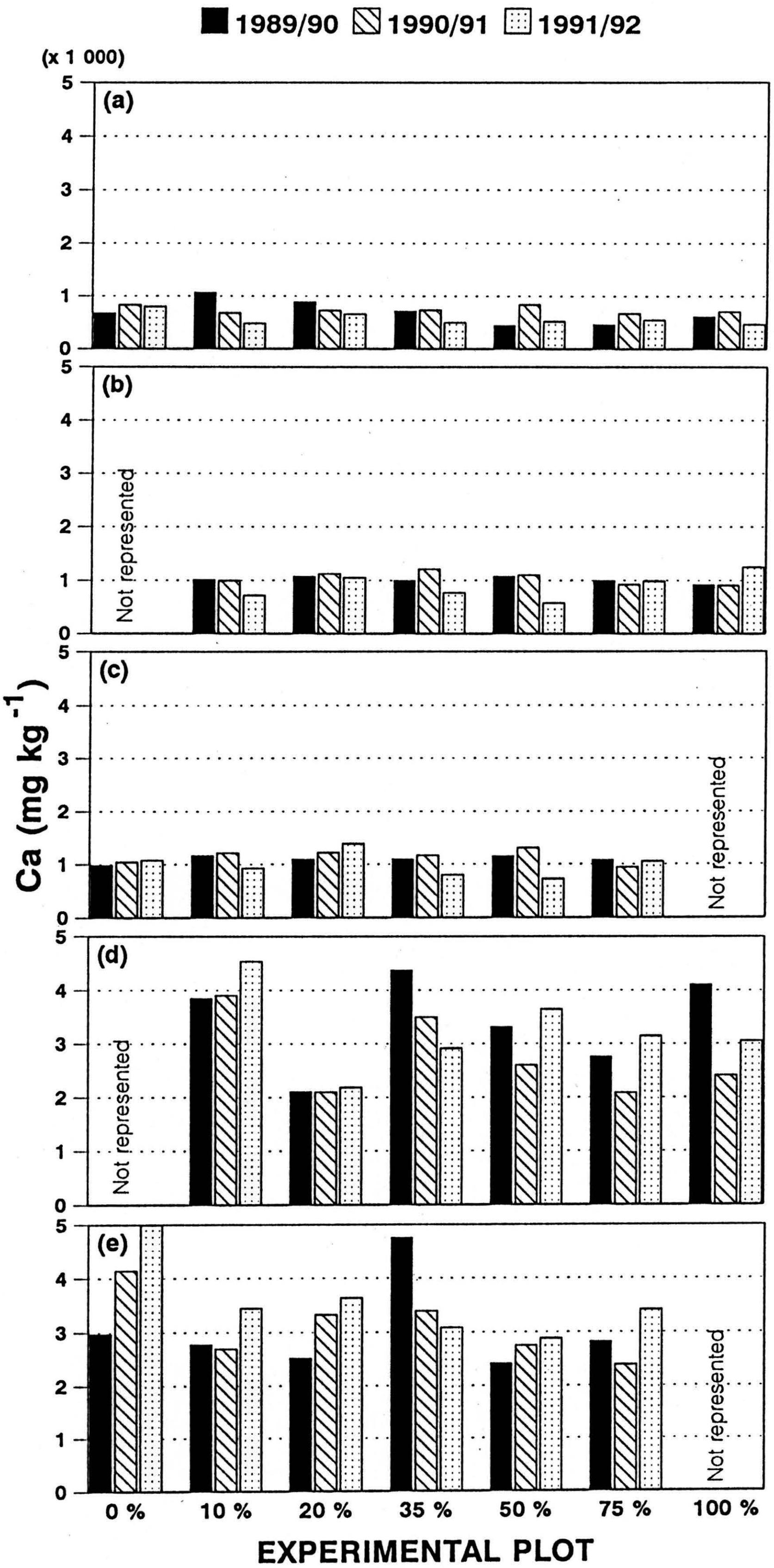


Figure 9.7 The calcium (Ca) content of topsoil sampled at the end of each of the three seasons (1989/90, 1990/91, 1991/92) within 5 subhabitats in each experimental plot: (a) between tree canopies (UCA), (b) under *Colophospermum mopane* trees (CA), (c) where *C. mopane* trees have been removed (RCA), (d) live *Salvadora angustifolia* (LS) and (e) where *S. angustifolia* have been removed (DS).

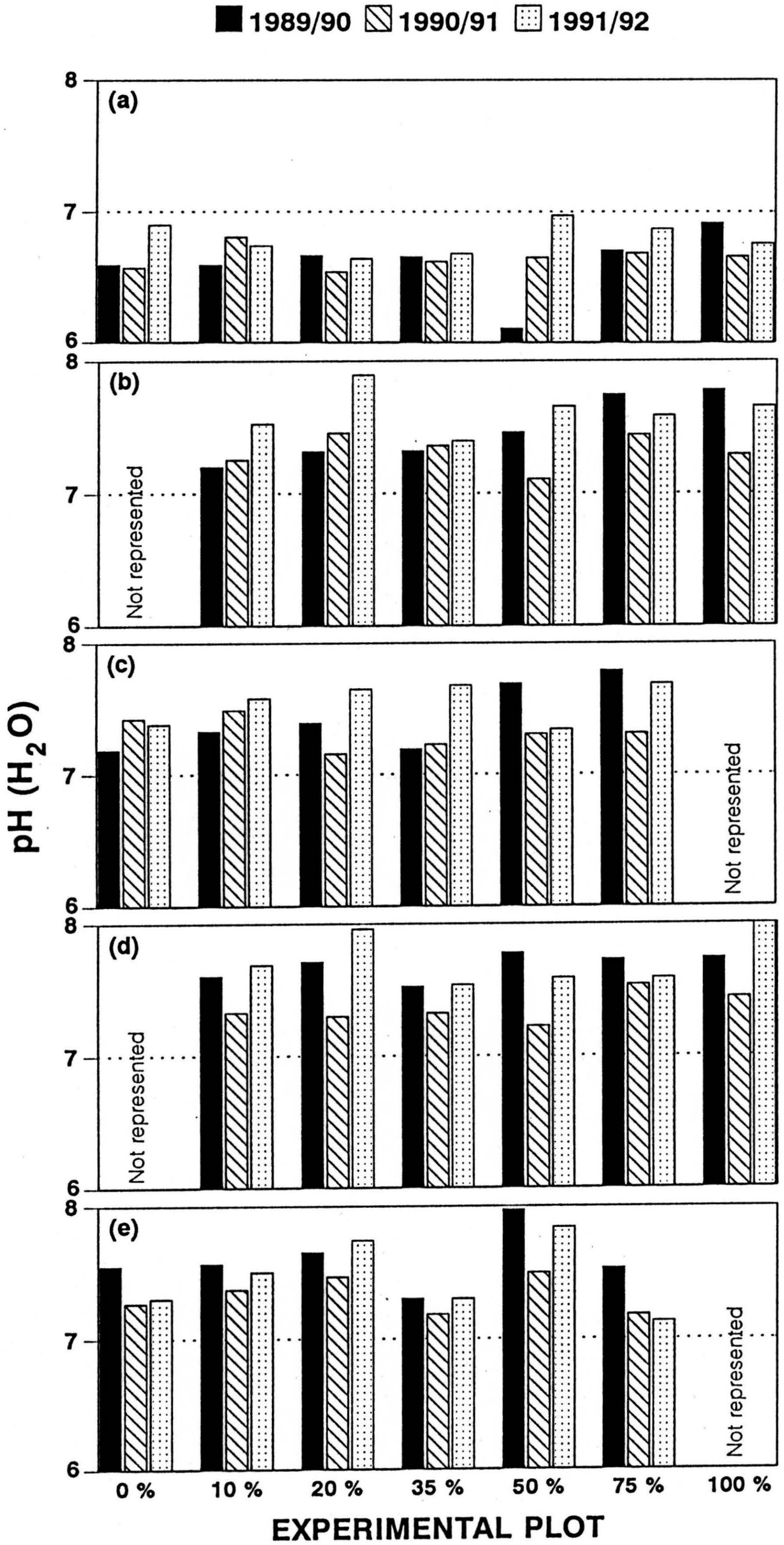


Figure 9.8 The pH (H_2O) of topsoil sampled at the end of each of the three seasons (1989/90, 1990/91, 1991/92) within 5 subhabitats in each experimental plot: (a) between tree canopies (UCA), (b) under *Colophospermum mopane* trees (CA), (c) where *C. mopane* trees have been removed (RCA), (d) live *Salvadora angustifolia* (LS) and (e) where *S. angustifolia* have been removed (DS).

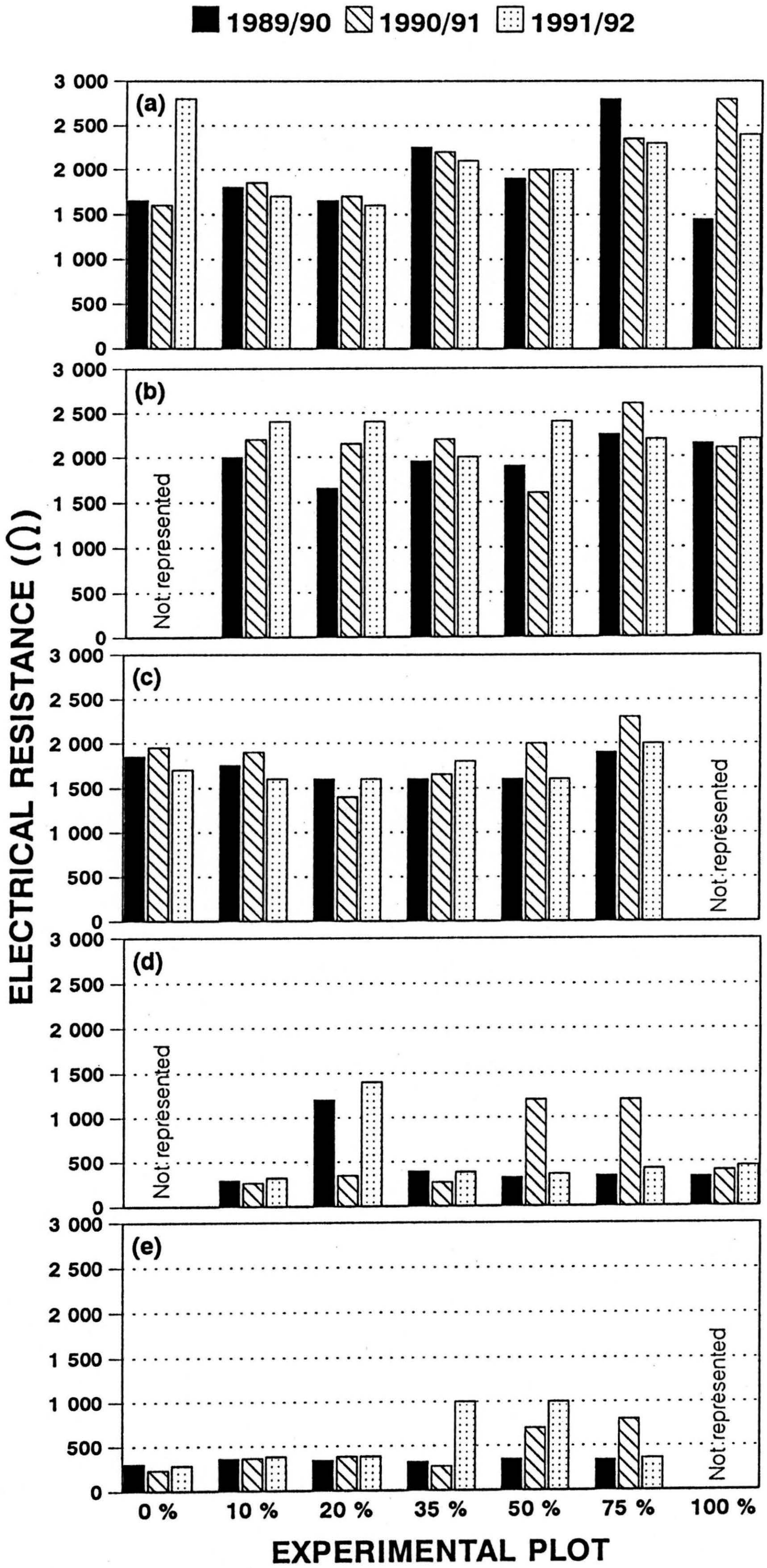


Figure 9.9 The electrical resistance (Ω) of topsoil sampled at the end of each of the three seasons (1989/90, 1990/91, 1991/92) within 5 subhabitats in each experimental plot: (a) between tree canopies (UCA), (b) under *Colophospermum mopane* trees (CA), (c) where *C. mopane* trees have been removed (RCA), (d) live *Salvadora angustifolia* (LS) and (e) where *S. angustifolia* have been removed (DS).

Table 10.1 Regression equations of the relations between the neutron water meter counts (ratio) (independent variable) and the percentage volumetric soil water content (dependent variable) for each of the six soil depth zones.

Soil depth zone (interval) (mm)	Regression equation (linear: y = a +bx)	r	r^2	n	Significance
0-150 (75)	y = -5.79571 + 39.012x	0.975	0.951	14	P<0.001
150-300 (225)	y = -12.3488 + 39.017x	0.949	0.901	14	P<0.001
300-450 (375)	y = -12.3603 + 36.9264x	0.957	0.916	14	P<0.001
450-600 (525)	y = -3.7777 + 23.7243x	0.952	0.906	14	P<0.001
600-750 (675)	y = -5.52243 + 27.7924x	0.965	0.930	14	P<0.001
750-900 (825)	y = -4.4965 + 26.3812x	0.950	0.903	14	P<0.001

Table 10.2 Regression equations of the relations between neutron water meter counts (ratio) obtained with steel tubes (independent variable) and counts obtained with aluminium tubes (dependent variable) for each of the six soil depth zones.

Soil depth zone (interval) (mm)	Regression equation (linear: y = a +bx)	r	r^2	n	Significance
0-150 (75)	y = 0.03369 + 0.77778x	0.926	0.857	805	P<0.001
150-300 (225)	y = 0.14563 + 0.62156x	0.844	0.713	805	P<0.001
300-450 (375)	y = 0.18264 + 0.62917x	0.841	0.707	805	P<0.001
450-600 (525)	y = 0.23192 + 0.58374x	0.846	0.716	805	P<0.001
600-750 (675)	y = 0.24297 + 0.56667x	0.870	0.757	805	P<0.001
750-900 (825)	y = 0.32917 + 0.45024x	0.844	0.713	805	P<0.001

Table 10.3 Daily rainfall records (as measured at 7.00 am) for the duration of the soil water study, with indication of the days when measurements were taken with the neutron water meter (NWM).

Date	Rain (mm)	NWM	Date	Rain (mm)	NWM	Date	Rain (mm)	NWM
23/11/90	1.0	–	27/02/91	–	√	17/11/91	–	√
24/11/90	25.0	–	12/03/91	9.5	–	18/11/91	–	√
26/11/90	–	√	14/03/91	–	√	19/11/91	–	√
27/11/90	–	√	15/03/91	24.0	–	20/11/91	–	√
28/11/90	–	√	16/03/91	3.0	–	21/11/91	–	√
29/11/90	–	√	17/03/91	12.0	–	22/11/91	17.8	√
30/11/90	–	√	19/03/91	38.1	√	23/11/91	–	√
01/12/90	–	√	20/03/91	–	√	24/11/91	–	√
03/12/90	0.3	√	21/03/91	–	√	25/11/91	–	√
04/12/90	7.8	√	22/03/91	10.1	√	26/11/91	–	√
05/12/90	–	√	23/03/91	–	√	27/11/91	–	√
06/12/90	17.4	√	24/03/91	–	√	28/11/91	–	√
07/12/90	18.4	√	25/03/91	8.0	√	29/11/91	–	√
09/12/90	2.6	–	26/03/91	10.0	√	30/11/91	–	√
10/12/90	–	√	25/04/91	–	√	01/12/91	–	√
11/12/90	–	√	07/05/91	37.0	–	02/12/91	–	√
12/12/90	–	√	13/05/91	21.0	–	03/12/91	–	√
13/12/90	–	√	14/05/91	–	√	04/12/91	–	√
14/12/90	–	√	15/05/91	–	√	05/12/91	–	√
17/12/90	–	√	16/05/91	–	√	06/12/91	–	√
18/12/90	9.1	√	17/05/91	–	√	08/12/91	7.5	–
19/12/90	2.2	√	21/05/91	–	√	10/12/91	–	√
20/12/90	9.8	√	22/05/91	–	√	11/12/91	–	√
21/12/90	–	√	23/05/91	–	√	12/12/91	–	√
27/12/90	–	√	24/05/91	–	√	09/01/92	–	√
01/01/91	7.0	–	12/06/91	–	√	17/01/92	16.0	–
08/01/91	–	√	02/07/91	–	√	20/01/92	5.0	–
10/01/91	34.0	–	16/07/91	–	√	23/01/92	2.5	–
12/01/91	–	√	01/08/91	–	√	03/02/92	46.0	–
13/01/91	–	√	15/08/91	–	√	05/02/92	–	√
14/01/91	1.7	√	04/09/91	–	√	06/02/92	–	√
15/01/91	2.5	√	18/09/91	–	√	07/02/92	–	√
17/01/91	–	√	01/10/91	25.9	–	08/02/92	–	√
20/01/91	33.0	–	02/10/91	–	√	09/02/92	–	√
22/01/91	–	√	03/10/91	–	√	10/02/92	–	√
23/01/91	–	√	04/10/91	–	√	11/02/92	–	√
24/01/91	24.1	√	05/10/91	–	√	20/02/92	–	√
25/01/91	–	√	06/10/91	–	√	02/03/92	3.5	–
31/01/91	14.1	√	07/10/91	–	√	03/03/92	–	√
01/02/91	–	√	08/10/91	–	√	15/03/92	20.0	–
14/02/91	–	√	17/10/91	–	√	25/03/92	–	√
18/02/91	30.9	–	24/10/91	–	√	14/04/92	–	√
19/02/91	7.1	√	07/11/91	–	√	07/05/92	–	√
20/02/91	–	√	14/11/91	20.3	–	20/05/92	–	√
21/02/91	–	√	15/11/91	49.5	√			
22/02/91	–	√	16/11/91	–	√			

Table 10.4 Water use efficiency (WUE) (based on total seasonal rainfall and not actual evapotranspiration) expressed in terms of leaf dry mass production of the *Colophospermum mopane* trees, grass dry mass production and combined leaf and grass dry mass production in the various experimental plots for the 1990/91 and 1991/92 seasons.

Season (rainfall)	Exp. plot	Dry mass production (kg ha^{-1})			WUE (kg ha^{-1} mm^{-1})		
		Leaves	Grass	Combined	Leaves	Grass	Combined
1990/91	0 %	0	1 106	1 106	0	2.51	2.51
(440 mm)	10 %	209	842	1 051	0.48	1.91	2.39
"	20 %	486	849	1 335	1.10	1.93	3.03
"	35 %	551	442	993	1.25	1.00	2.26
"	50 %	903	410	1 313	2.05	0.93	2.98
"	75 %	972	176	1 148	2.21	0.40	2.61
"	100 %	1 537	125	1 662	3.49	0.28	3.78
1991/92	0 %	0	1 055	1 055	0	4.73	4.73
(223 mm)	10 %	257	459	716	1.15	2.06	3.21
"	20 %	560	355	915	2.51	1.59	4.10
"	35 %	655	230	885	2.94	1.03	3.97
"	50 %	998	81	1 079	4.48	0.36	4.84
"	75 %	1 082	38	1 120	4.85	0.17	5.02
"	100 %	1 736	50	1 786	7.78	0.22	8.01

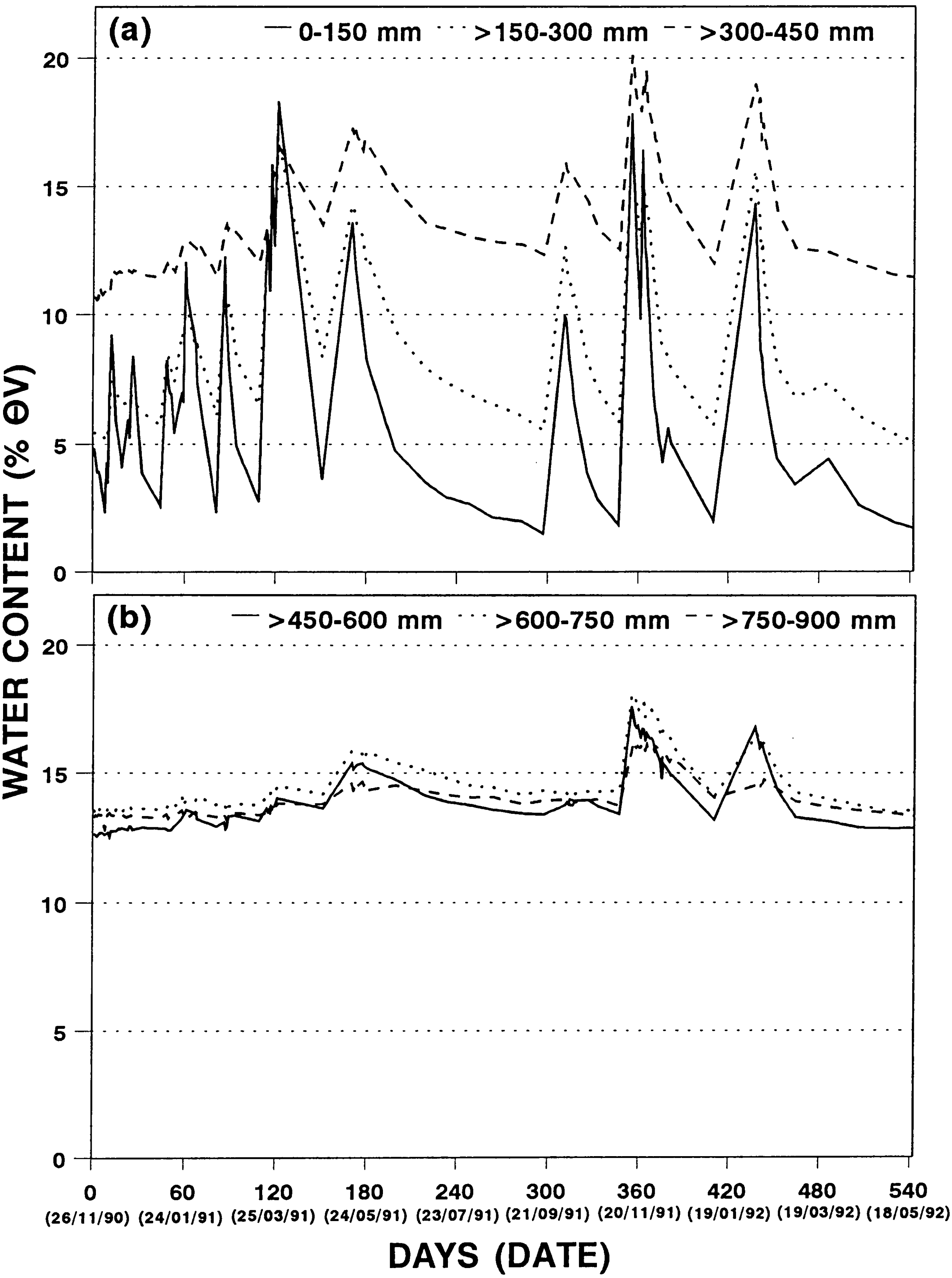


Figure 10.1 Soil water redistribution in the soil profile of the 0 % plot: (a) soil depth zones 0-450 mm, and (b) soil depth zones >450-900 mm.

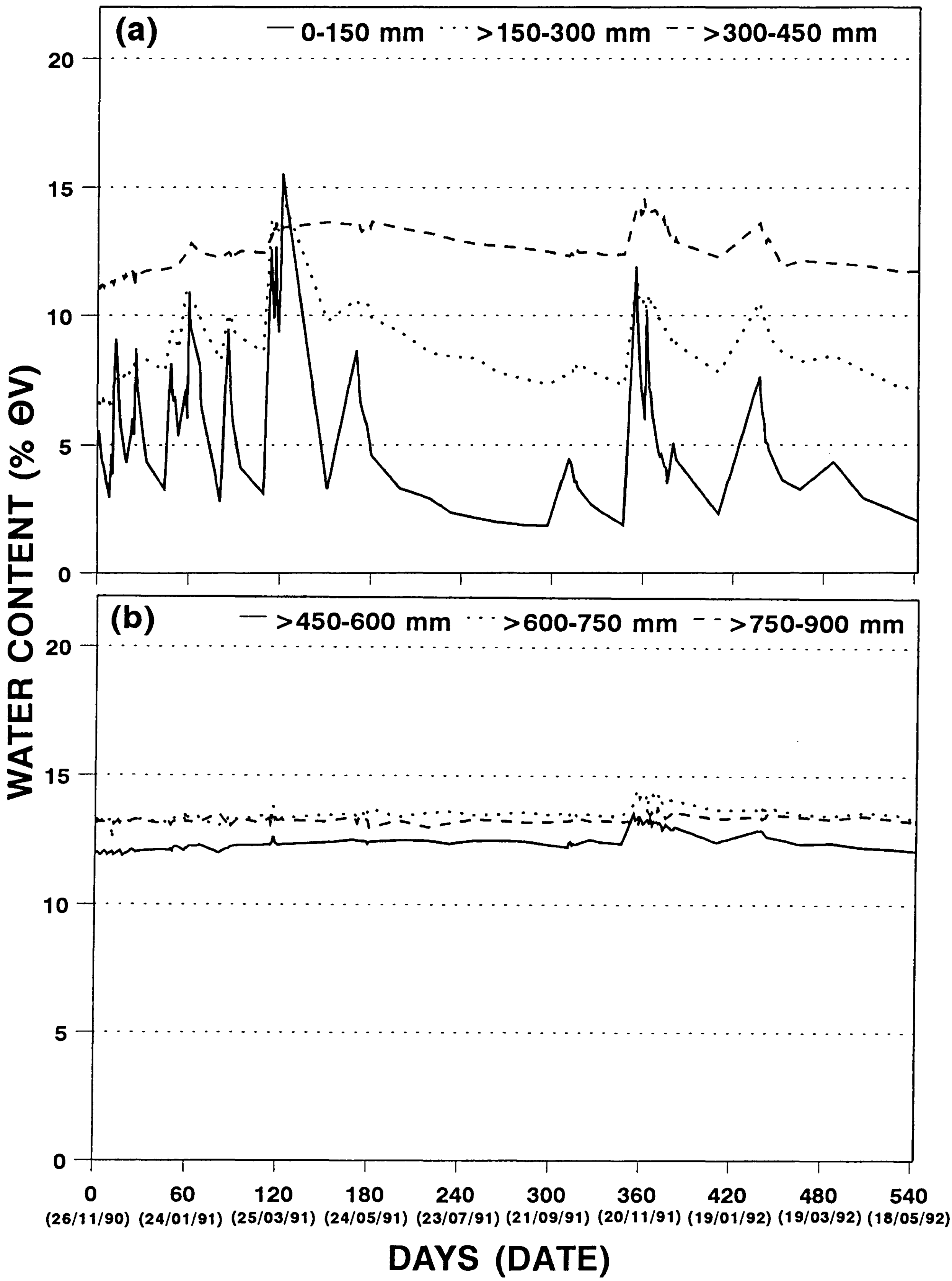


Figure 10.2 Soil water redistribution in the soil profile of the 10 % plot: (a) soil depth zones 0-450 mm, and (b) soil depth zones >450-900 mm.

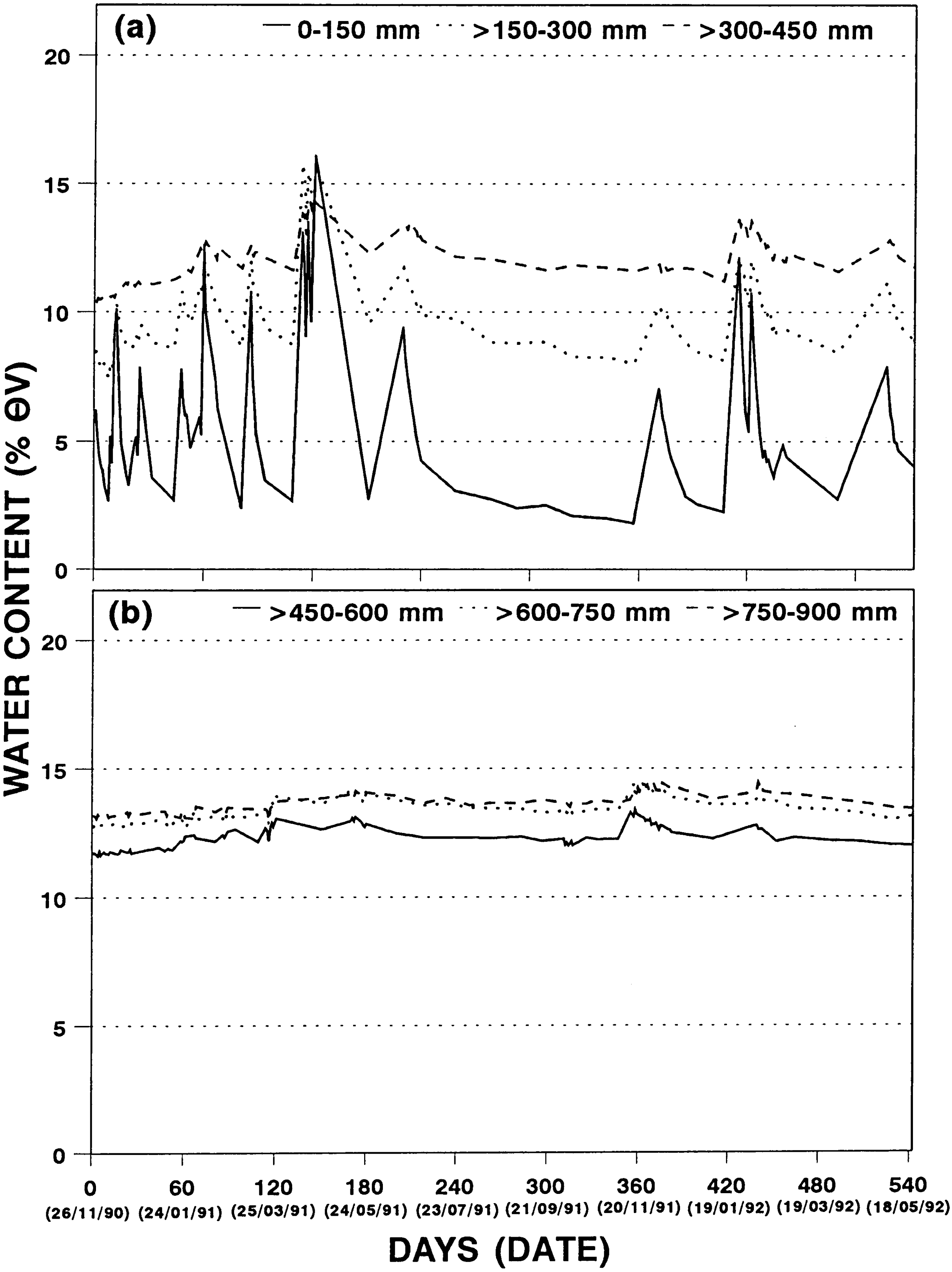


Figure 10.3 Soil water redistribution in the soil profile of the 20 % plot: (a) soil depth zones 0-450 mm, and (b) soil depth zones >450-900 mm.

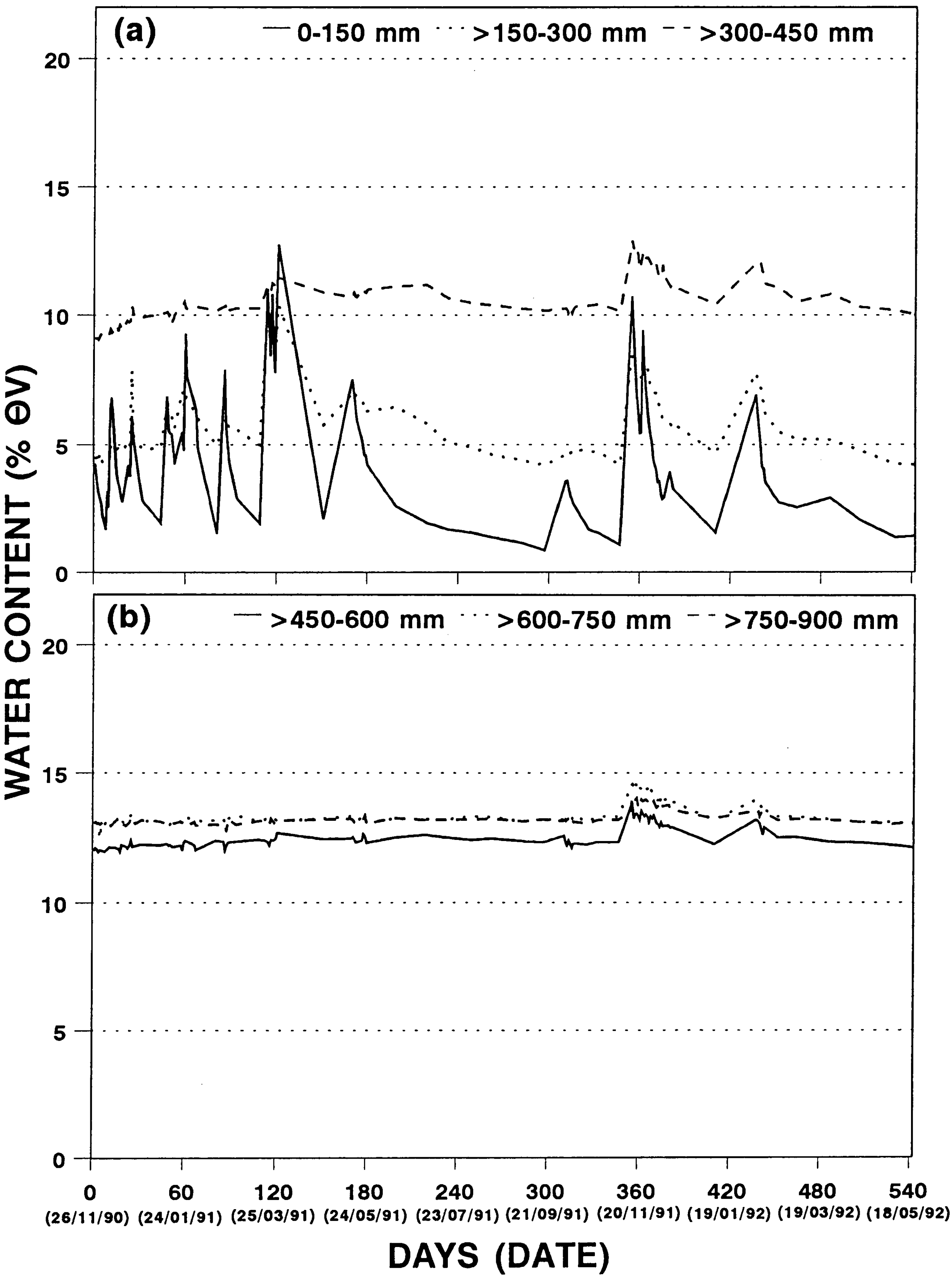


Figure 10.4 Soil water redistribution in the soil profile of the 35 % plot: (a) soil depth zones 0-450 mm, and (b) soil depth zones >450-900 mm.

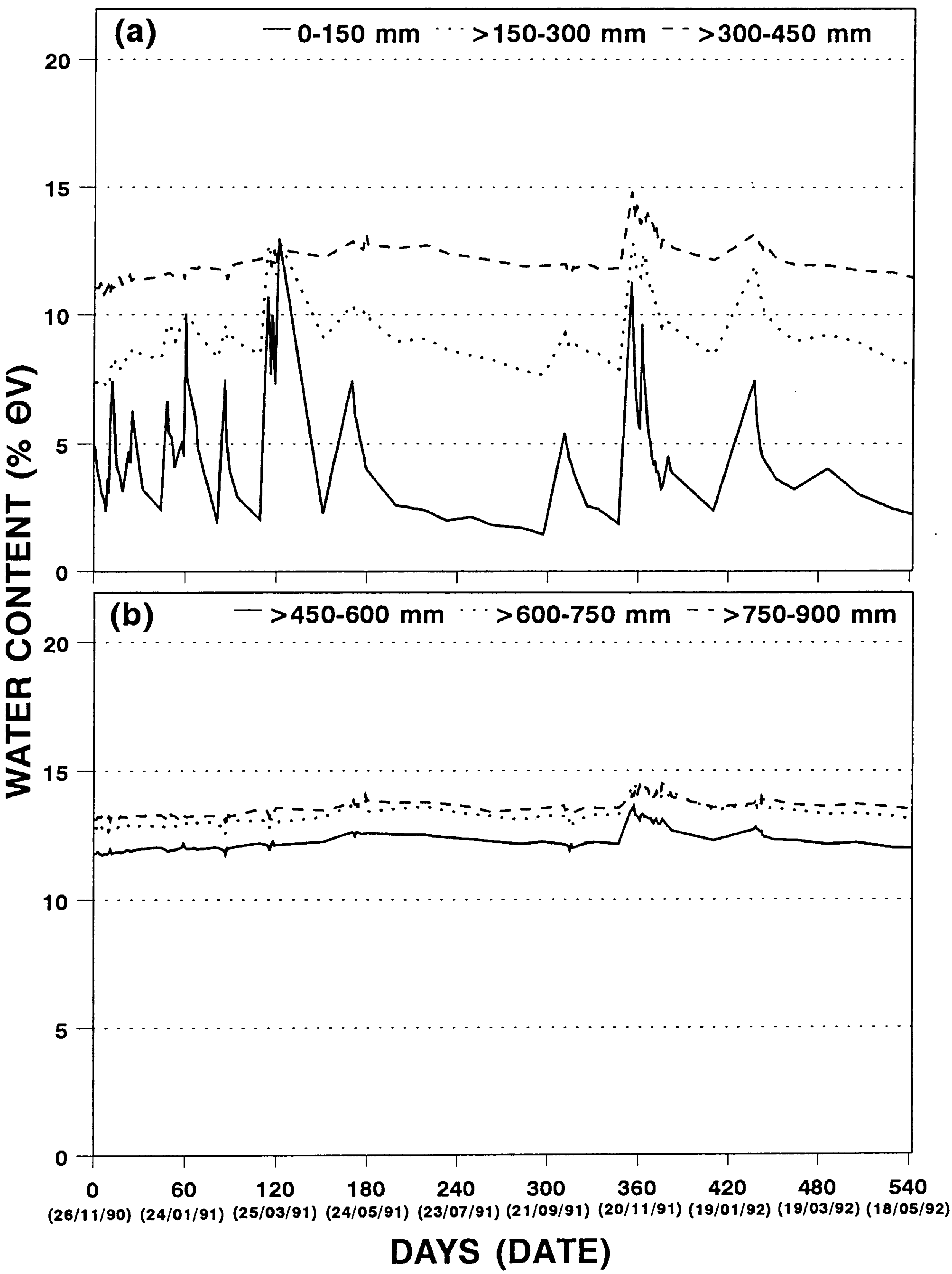


Figure 10.5 Soil water redistribution in the soil profile of the 50 % plot: (a) soil depth zones 0-450 mm, and (b) soil depth zones >450-900 mm.

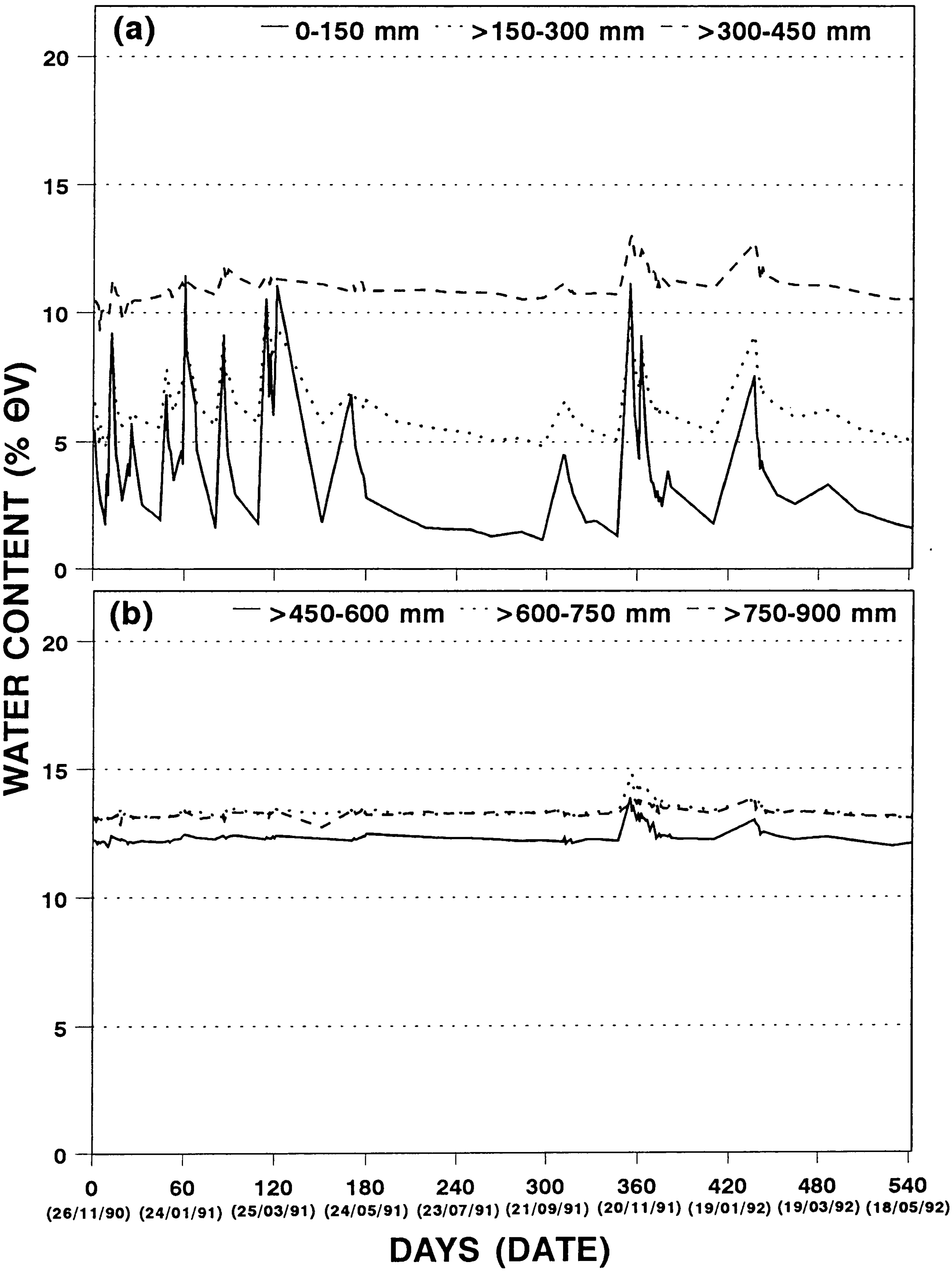


Figure 10.6 Soil water redistribution in the soil profile of the 75 % plot: (a) soil depth zones 0-450 mm, and (b) soil depth zones >450-900 mm.

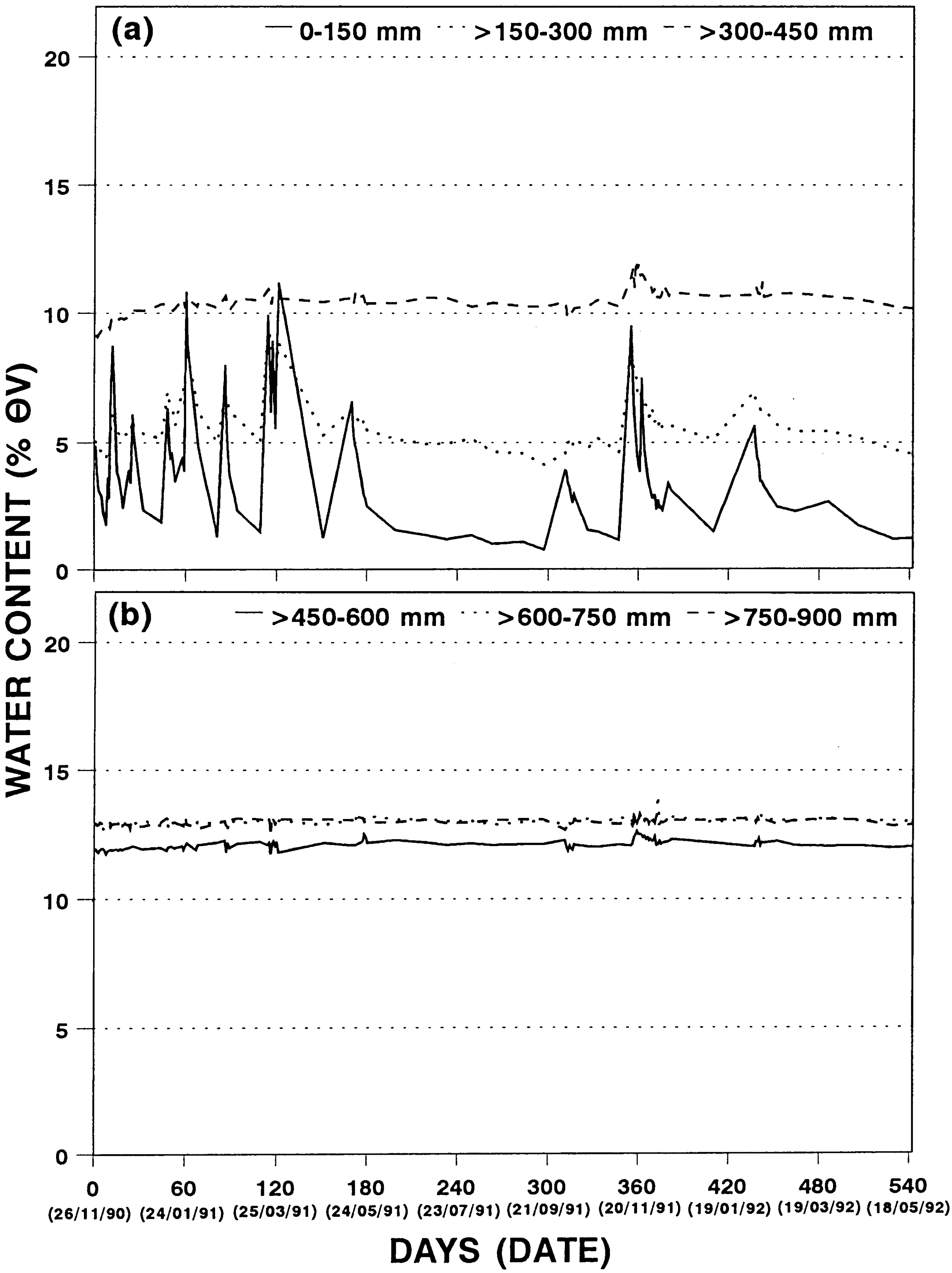


Figure 10.7 Soil water redistribution in the soil profile of the 100 % plot: (a) soil depth zones 0-450 mm, and (b) soil depth zones >450-900 mm.

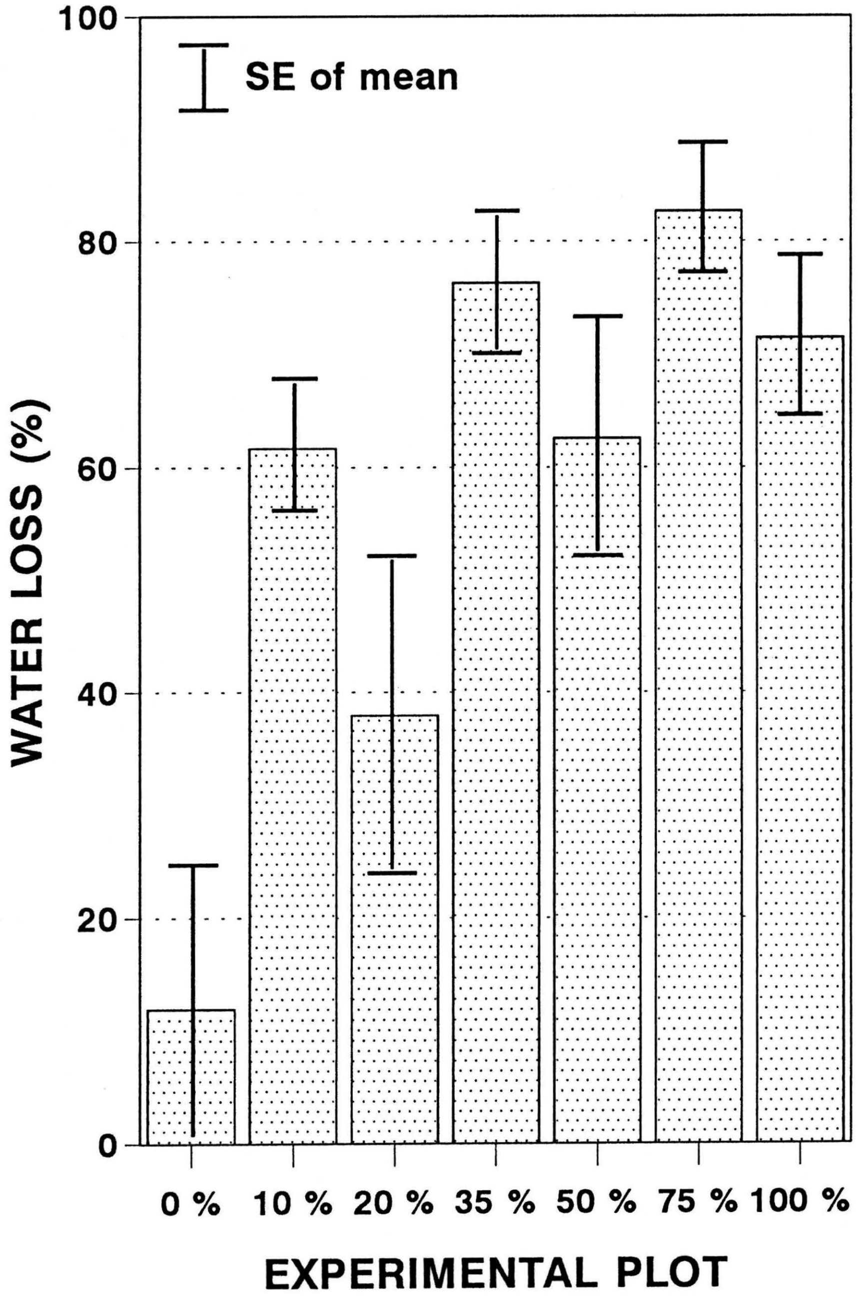


Figure 10.8 Estimates of the mean percentage incidental water losses (interception and runoff) of five rain showers >10.0 mm in the various experimetal plots during the 1990/91 and 1991/92 seasons, with indication of the standard errors (SE) of the mean.

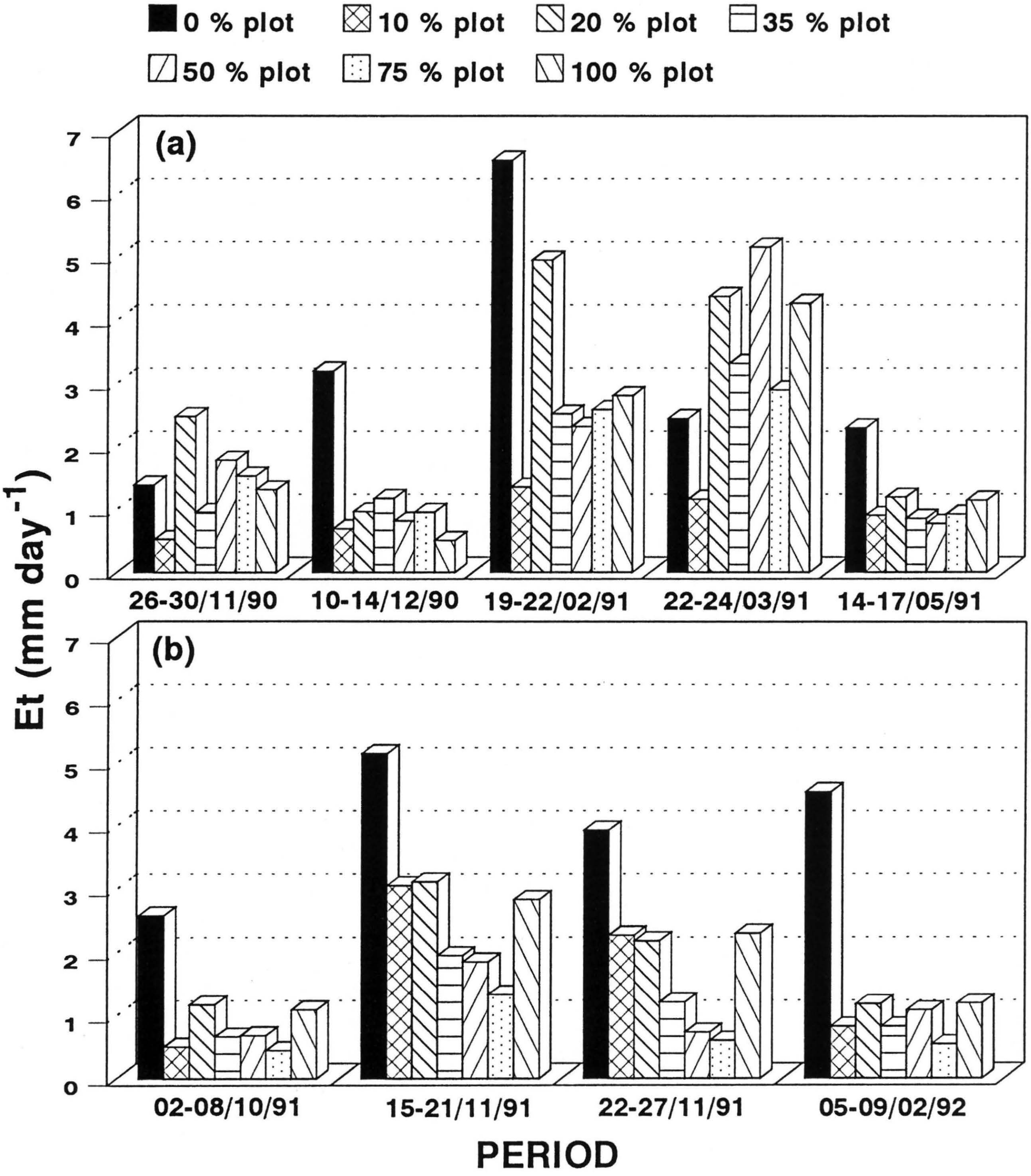


Figure 10.9 Mean evapotranspiration (Et) water losses from the soil profiles of the various experimental plots during specific periods of (a) the 1990/91 season, and (b) the 1991/92 season.

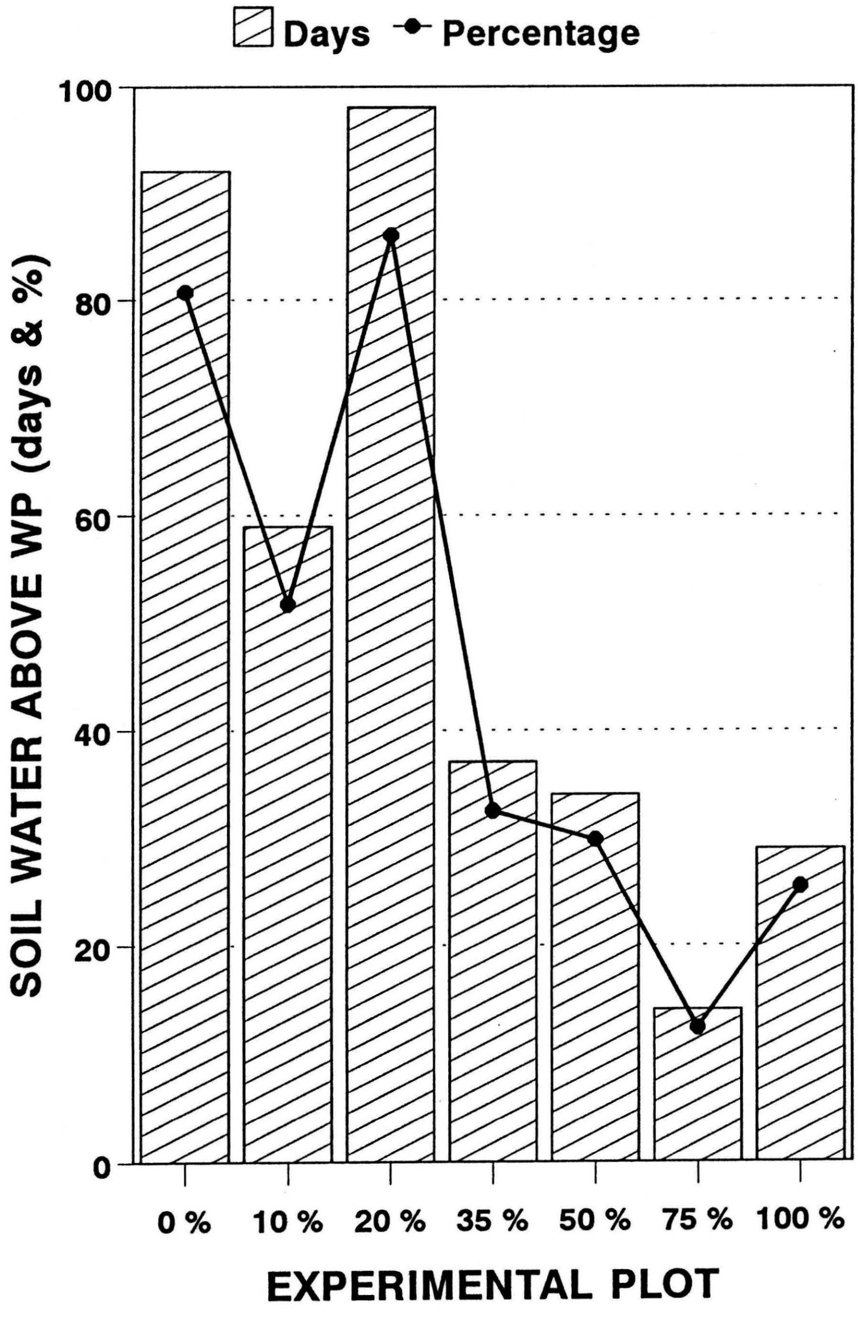


Figure 10.10 Number and percentage of days (of a total of 114 days during which soil water measurements were taken) that the soil water content of the 0-450 mm soil zone exceeded the estimated wilting point (WP = 0.09 mm H_2O mm^{-1}).

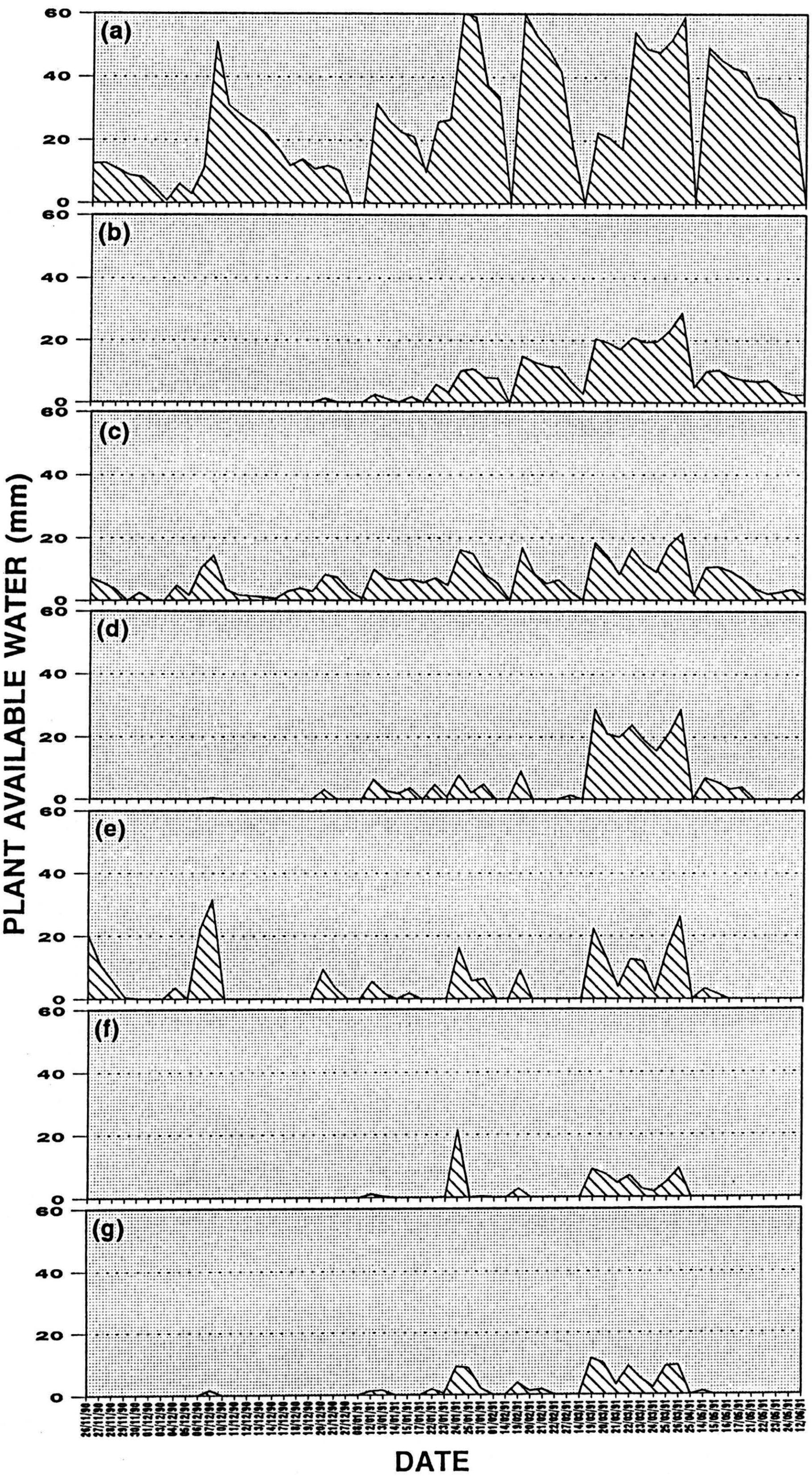


Figure 10.11 Comparative estimates of the amount of plant available water (WP = 0.09 mm H_2O mm^{-1}) within the 0-450 mm soil zone during the 1990/91 season (59 non-continues days): (a) 0 % plot, (b) 10 % plot, (c) 20 % plot, (d) 35 % plot, (e) 50 % plot, (f) 75 % plot, and (g) 100 % plot.

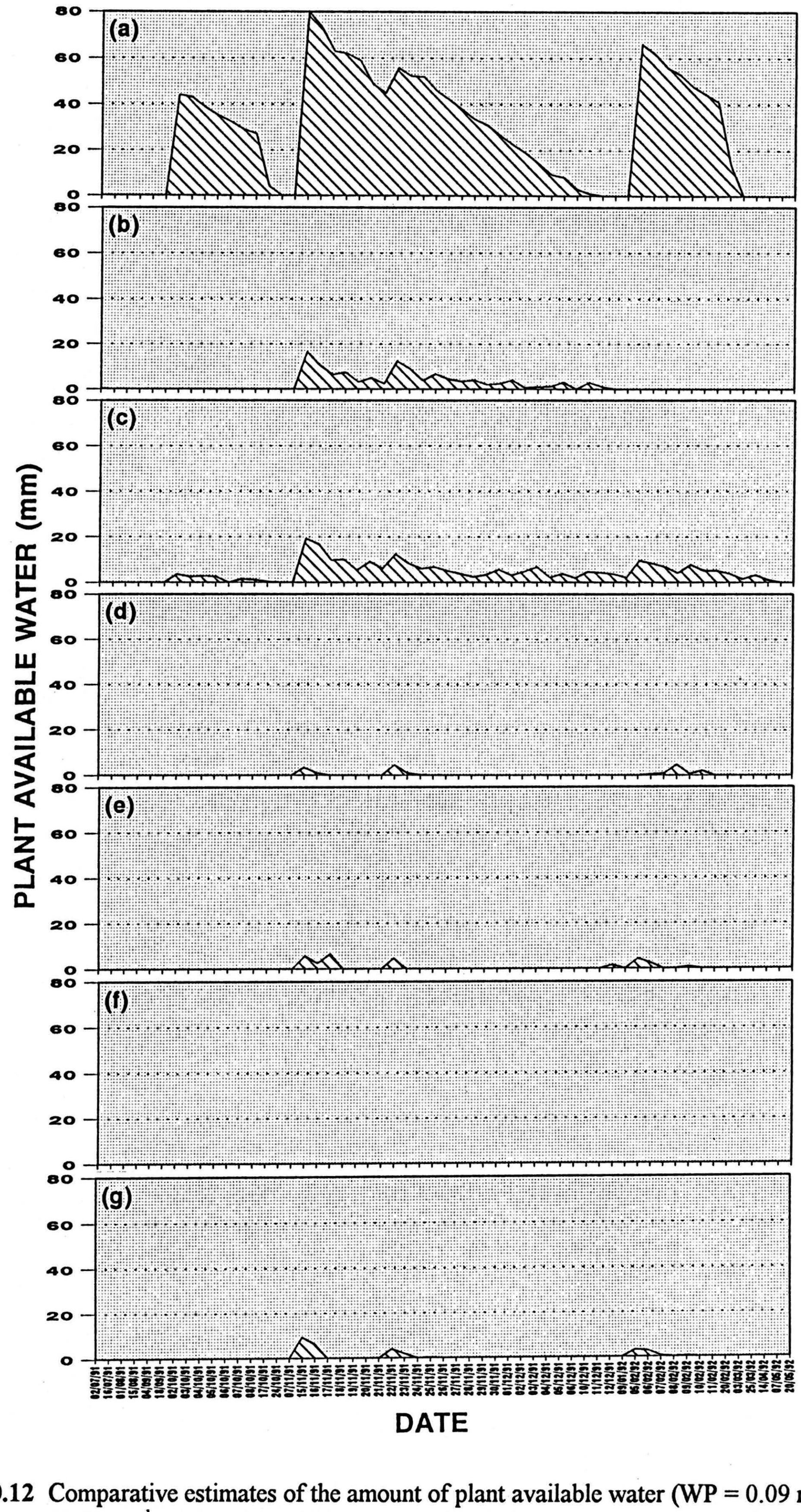


Figure 10.12 Comparative estimates of the amount of plant available water (WP = 0.09 mm H_2O mm^{-1}) within the 0-450 mm soil zone during the 1991/92 season (55 non-continues days): (a) 0 % plot, (b) 10 % plot, (c) 20 % plot, (d) 35 % plot, (e) 50 % plot, (f) 75 % plot, and (g) 100 % plot.

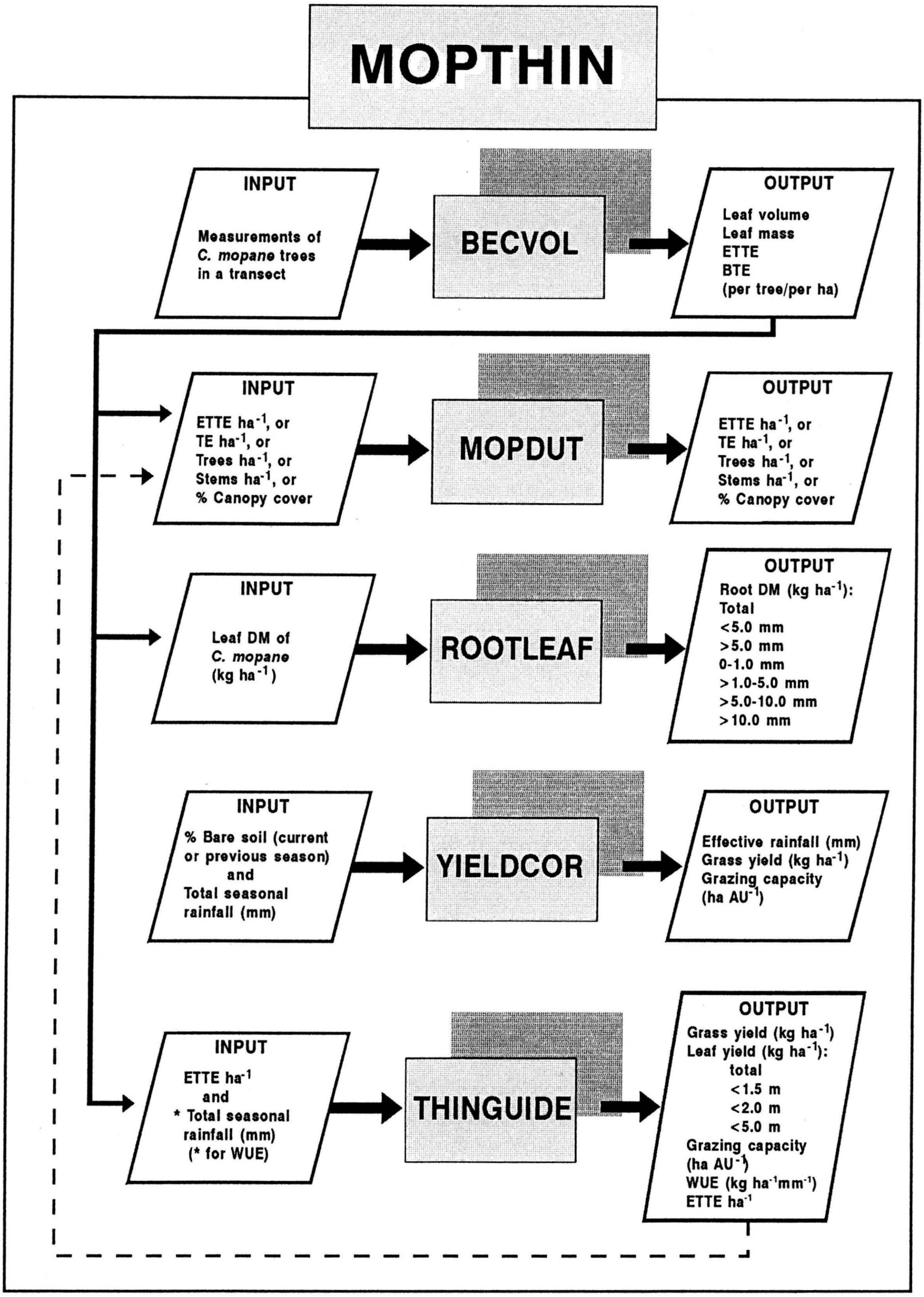


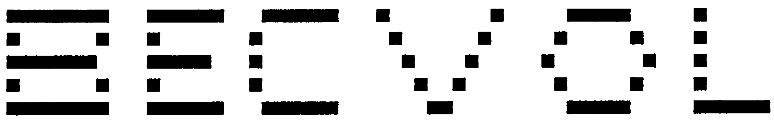
Figure 11.1 Schematized summary of the input and output of the various models within the MOPTHIN framework (Shell), and how they relate to each other.

APPENDICES

Appendix 1: Printout of the dBASE IV computer program of the BECVOL-model, incorporating the calculations of leaf volume and leaf dry mass from tree canopy measurements as described in Chapter 3 (see also Chapter 11). The program provides for stratified leaf DM estimates to heights of 1.5 m, 2.0 m and 5.0 m. A printout of the structure of the standard dBASE data file (BECV_STD.dbf), showing the field names used by the program, is also provided.

Program: BECVOL.prg

```
SET ECHO OFF
SET TALK OFF
SET CONFIRM ON
SET BELL OFF
SET STATUS OFF
SET COLOR TO GR+/BG
CLEAR
SET COLOR TO W+/B
DEFINE WINDOW MAIN3 FROM 1,0 TO 24,79
CLEAR
SET COLOR TO R+/B
TEXT
```



```
                          Version 1.3 (1994)
ENDTEXT
SET COLOR TO W+/B
@ 11,16 SAY "      :  iomass  stimates from  anopy    ume"
SET COLOR TO R+*/B
@ 11,16 SAY "BECVOL"
@ 11,24 SAY "B"
@ 11,32 SAY "E"
@ 11,47 SAY "C"
@ 11,54 SAY "VOL"
SET COLOR TO W+/B
@ 14,13 TO 22,62
@ 15,15 TO 21,60
@ 16,17 SAY "Program compiled by:  G.N. Smit"
@ 17,17 SAY "                      Towoomba ADC"
@ 18,17 SAY "                      Private Bag X1615"
@ 19,17 SAY "                      Warmbaths 0480"
@ 20,17 SAY "                      Tel. (014) 736-2250"
@ 24,25 SAY "Press any key to continue ...."
READ
DO WHILE .T.
CLEAR
SET COLOR TO G+/B
@ 1,15 TO 3,62 PANEL
SET COLOR TO W/B
@ 2,17 SAY "      :  iomass  stimates from  anopy    ume"
SET COLOR TO W+/B
@ 2,17 SAY "BECVOL"
@ 2,25 SAY "B"
@ 2,33 SAY "E"
@ 2,48 SAY "C"
@ 2,55 SAY "VOL"
SET COLOR TO W+/B
@ 5,19 TO 16,59 DOUBLE
SET COLOR TO R+/B
@ 6,34 SAY "MAIN MENU"
SET COLOR TO W+/B
```

```
@ 8,21 SAY "(0) Quit application              - 0"
@ 9,21 SAY "(1) Data input [(T)est]           - 1"
@ 10,21 SAY "(2) View data files               - 2"
@ 11,21 SAY "(3) Print data files              - 3"
@ 12,21 SAY "(4) Execute calculations          - 4"
@ 14,34 SAY "Option:"
@ 15,21 SAY "(Press ENTER for general information)"
B1=SPACE(1)
@ 14,42 GET B1
READ
DO CASE
 CASE B1="0"
 CLOSE DATA
 SET STATUS ON
 CLEAR
 RETURN
 CASE B1=" "
 ACTIVATE WINDOW MAIN3
 TEXT
  For a complete description on the functioning of the BECVOL-model, consult
  Chapter 3, as well as Chapter 11.

  Data input:            Data is stored in files which are created from a
                         standard file.  You must specify if you want the
                         data input to be stored in a new file or an existing
                         file.  You may create an unlimited number of files.
                         Data consists of measurements (m) taken of C. mopane.
                         These measurements are described in Chapter 3, and
                         this program uses the same symbols (e.g. A = tree
                         height, D = canopy diameter).  Note that provision
                         was made for two measurements of both D and E.  Two
                         measurements are needed when the tree crown is not
                         circular (program calculates the mean).
  View data files:       Displays the content of data files on the screen.
  Print data files:      Prints data files onto paper via a printer.  Various
                         options of printing are provided whereby complete
                         files or specific fields of files can be printed.
                         Refer to Appendix 1 (page A-7) for field names and
                         the information they contain.
  Execute calculations: Calculates an estimated leaf volume and leaf DM for
                         each tree, as well as ETTE, BTE and DM per ha.
 ENDTEXT
 READ
 DEACTIVATE WINDOW MAIN3
 CASE B1="1".OR.B1="T".OR.B1="t"
 IF B1="T".OR.B1="t"
 @ 0,10 SAY "TEST"
 ENDIF
 @ 18,0 CLEAR TO 24,79
 @ 18,0 TO 23,79
 @ 19,30 SAY "BECVOL: DATA INPUT"
 FIL=SPACE(1)
 @ 21,3 SAY "(E)xisting or (N)ew data file:      (Press 'Q' to return to previous menu)"
 @ 21,34 GET FIL
 READ
 IF UPPER(FIL)="Q"
 CLOSE DATA
 CLEAR
 LOOP
 ENDIF
 IF UPPER(FIL)="E"
 @ 20,1 CLEAR TO 22,78
 @ 21,22 SAY "Name of existing file:"
 FIL2=SPACE(8)
 @ 21,45 GET FIL2
 READ
 ENDIF
 IF UPPER(FIL)="N"
 @ 20,1 CLEAR TO 22,78
 @ 21,27 SAY "Name of new file:"
 FIL2=SPACE(8)
 @ 21,45 GET FIL2
 READ
 USE BECV_STD
 COPY TO &FIL2
 CLOSE DATA
 ENDIF
 USE &FIL2
 IN1=SPACE(8)
 IN2=SPACE(3)
```

```
IN22="0"
DO WHILE .T.
CLEAR
@ 2,30 SAY "BECVOL: DATA INPUT"
SELECT 1
@ 6,12 SAY "DATE:            (Press 'Q' to terminate data input)"
@ 6,18 GET IN1
READ
IF IN1="Q".OR.IN1="q"
CLOSE DATA
CLEAR
EXIT
ENDIF
@ 8,12 SAY "PLOT:"
@ 8,18 GET IN2
READ
COUNT ALL FOR PLOT=VAL(IN2) TO IN6
@ 12,10 TO 24,64
DO WHILE .T.
@ 13,11 CLEAR TO 22,63
SP1="Y"
MD=SPACE(1)
A=SPACE(5)
B=SPACE(5)
C=SPACE(5)
D1=SPACE(5)
D2=SPACE(5)
E1=SPACE(5)
E2=SPACE(5)
@ 13,12 SAY "Continue (Y/N):"
@ 13,28 GET SP1
READ
IF UPPER(SP1)="N"
EXIT
ENDIF
@ 13,12 CLEAR TO 13,60
@ 13,12 SAY "Model:    (1 = Normal C. mopane trees)"
@ 14,12 SAY "          (2 = Coppicing C. mopane trees)"
@ 13,19 GET MD
@ 16,12 SAY "(A):"
@ 16,18 GET A
@ 17,12 SAY "(B):"
@ 17,18 GET B
@ 18,12 SAY "(C):"
@ 18,18 GET C
@ 19,12 SAY "(D1):"
@ 19,18 GET D1
@ 20,12 SAY "(D2):       (If D2=D1 just press ENTER)"
@ 20,18 GET D2
@ 21,12 SAY "(E1):"
@ 21,18 GET E1
@ 22,12 SAY "(E2):       (If E2=E1 just press ENTER)"
@ 22,18 GET E2
READ
IF A="     ".AND.B="     ".AND.C="     ".AND.D1="     ".AND.D2="     ".AND.E1="
".AND.E2="     "
EXIT
ENDIF
IF D2="     ".OR.D2="0    "
D2=D1
ENDIF
IF E2="     ".OR.E2="0    "
E2=E1
ENDIF
IF B1="T".OR.B1="t"
LOOP
ENDIF
SELECT 1
APPE BLANK
IN6=IN6+1
REPLACE NO WITH IN6
REPLACE SPECIES WITH "C. mopane"
REPLACE DATE WITH IN1
REPLACE PLOT WITH VAL(IN2)
REPLACE MOD WITH VAL(MD)
REPLACE L_A WITH VAL(A)
REPLACE L_B WITH VAL(B)
REPLACE L_C WITH VAL(C)
REPLACE L_D1 WITH VAL(D1)
REPLACE L_D2 WITH VAL(D2)
```

```
REPLACE L_E1 WITH VAL(E1)
REPLACE L_E2 WITH VAL(E2)
ENDDO
ENDDO
CASE B1="2"
@ 18,0 CLEAR TO 24,79
@ 18,0 TO 23,79
@ 19,28 SAY "BECVOL: VIEW DATA FILES"
FIL=SPACE(8)
@ 21,8 SAY "Name of file:          (Press 'Q' to return to previous menu)"
@ 21,22 GET FIL
READ
IF UPPER(FIL)="Q"
CLEAR
LOOP
ENDIF
USE &FIL
SET STATUS ON
BROW
SET STATUS OFF
CLOSE DATA
CASE B1="3"
@ 17,0 CLEAR TO 24,79
@ 17,0 TO 24,79
@ 18,28 SAY "BECVOL: PRINT DATA FILES"
FIL=SPACE(8)
@ 20,8 SAY "Name of file:          (Press 'Q' to return to previous menu)"
@ 20,22 GET FIL
READ
IF UPPER(FIL)="Q"
CLEAR
LOOP
ENDIF
@ 19,2 CLEAR TO 23,77
@ 20,3 SAY "OPTIONS: 1 = All data fields"
@ 21,3 SAY "         2 = Input data only ($)"
@ 22,3 SAY "         3 = Calculated leaf volumes and ETTE values only (#)"
@ 23,3 SAY "         4 = Calculated leaf DM and BTE values only (#)"
@ 22,68 SAY "Option:"
OPT=SPACE(1)
@ 22,76 GET OPT
READ
@ 19,2 CLEAR TO 23,77
SET COLOR TO R+*/B
@ 22,5 SAY "Make sure printer is switched on.    Press any key to continue ..."
READ
SET COLOR TO W+/B
USE &FIL
DO CASE
 CASE OPT="1"
 LIST TO PRINT OFF
 CASE OPT="2"
 LIST TO PRINT OFF FIELDS NO,DATE,PLOT,L_A,L_B,L_C,L_D1,L_D2,L_E1,L_E2,MOD
 CASE OPT="3"
 LIST TO PRINT OFF FIELDS NO,CANVOL,LVOL,ETTE
 CASE OPT="4"
 LIST TO PRINT OFF FIELDS NO,LMAS,LM_15,LM_20,LM_50,BTE,BTE_15,BTE_20,BTE_50
ENDCASE
CASE B1="4"
@ 18,0 CLEAR TO 24,79
@ 18,0 TO 24,79
@ 19,24 SAY "BECVOL: EXECUTING CALCULATIONS"
FIL=SPACE(8)
@ 21,8 SAY "Name of file:          (Press 'Q' to return to previous menu)"
@ 21,22 GET FIL
READ
IF UPPER(FIL)="Q"
CLEAR
LOOP
ENDIF
AR=SPACE(3)
@ 23,6 SAY "Transect/sampling area (m^2):        (Needed to calculte ETTE/ha)"
@ 23,36 GET AR
READ
USE &FIL
@ 17,0 CLEAR TO 24,79
@ 21,26 SAY "Executing calculations ...."
REPLACE ALL CAL WITH " "
SCAN FOR CAL=" "
MAS21=1
```

```
 MAS22=1
 MAS23=1
 A=L_A
 B=L_B
 C=L_C
 D=(L_D1+L_D2)/2
 E=(L_E1+L_E2)/2
 F=A-B
 G=B-C
 IF A>B
 V1=((22/7)*D^2*F)/6
 ELSE
 V1=0
 ENDIF
 IF B>C
 DO CASE
  CASE E=D
  V2=(22/7)*(D/2)^2*G
  CASE E=0
  V2=(1/3)*(22/7)*(D/2)^2*G
  CASE E>0.AND.E<D
  V2=(1/3)*(22/7)*G*((D/2)^2+(D/2)*(E/2)+(E/2)^2)
 ENDCASE
 ELSE
 V2=0
 ENDIF
 V3=V1+V2
 V33=V3
 V3=V3*1000000
TWE=0
DO WHILE TWE<3
DO CASE
 CASE TWE=0
 WH=1.501
 CASE TWE=1
 WH=2.001
 CASE TWE=2
 WH=5.001
ENDCASE
DO CASE
 CASE C>=WH
 DO CASE
  CASE TWE=0
  MAS21=0
  CASE TWE=1
  MAS22=0
  CASE TWE=2
  MAS23=0
 ENDCASE
 CASE C<WH.AND.B>=WH
 L=WH-C
 M=(D-E)/G
 N=M*L
 K=N+E
 DO CASE
  CASE E=D
  V4=(22/7)*(K/2)^2*L
  CASE E=0
  V4=(1/3)*(22/7)*(K/2)^2*L
  CASE E>0.AND.E<D
  V4=(1/3)*(22/7)*L*((K/2)^2+(K/2)*(E/2)+(E/2)^2)
 ENDCASE
 V4=V4*1000000
 CASE B<WH.AND.A>=WH
 J=WH-B
 I=A-WH
 H2=(D^2*(F^2-J^2))/F^2
 VBO=((22/7)*H2*I)/6
 V4=V2+(V1-VBO)
 V4=V4*1000000
 CASE A<=WH
 V4=V3
ENDCASE
DO CASE
 CASE TWE=0
 IF MAS21=1
 PERS1=(V4/V3)
 ENDIF
 CASE TWE=1
 IF MAS22=1
```

```
  PERS2=(V4/V3)
  ENDIF
  CASE TWE=2
  IF MAS23=1
  PERS3=(V4/V3)
  ENDIF
 ENDCASE
 TWE=TWE+1
 ENDDO
V3=LOG(V3)
DO CASE
 CASE MOD=1
 VOL=-3.68235+(0.722215*V3)
 MAS=-4.31191+(0.72008*V3)
 CASE MOD=2
 VOL=-3.19629+(0.727767*V3)
 MAS=-3.81457+(0.728971*V3)
ENDCASE
VOL=EXP(VOL)
MAS=EXP(MAS)
IF MAS21=1
MAS21=MAS*PERS1
ENDIF
IF MAS22=1
MAS22=MAS*PERS2
ENDIF
IF MAS23=1
MAS23=MAS*PERS3
ENDIF
REPLACE CAL WITH "*"
REPLACE CANVOL WITH V33
REPLACE LVOL WITH VOL
REPLACE ETTE WITH VOL/500
REPLACE LMAS WITH MAS
REPLACE BTE WITH MAS/250
REPLACE LM_15 WITH MAS21
MAS21=LM_15
IF MAS21>0
REPLACE BTE_15 WITH MAS21/250
ENDIF
IF MAS21=0
REPLACE BTE_15 WITH 0
ENDIF
REPLACE LM_20 WITH MAS22
MAS22=LM_20
IF MAS22>0
REPLACE BTE_20 WITH MAS22/250
ENDIF
IF MAS22=0
REPLACE BTE_20 WITH 0
ENDIF
REPLACE LM_50 WITH MAS23
MAS23=LM_50
IF MAS23>0
REPLACE BTE_50 WITH MAS23/250
ENDIF
IF MAS23=0
REPLACE BTE_50 WITH 0
ENDIF
ENDSCAN
SUM ALL LVOL TO HA01
SUM ALL ETTE TO HA02
SUM ALL LMAS TO HA03
SUM ALL LM_15 TO HA04
SUM ALL LM_20 TO HA05
SUM ALL LM_50 TO HA06
SUM ALL BTE TO HA07
SUM ALL BTE_15 TO HA08
SUM ALL BTE_20 TO HA09
SUM ALL BTE_50 TO HA10
APPEND BLANK
REPLACE SPECIES WITH "ETTE,BTE,kg/ha"
HA="HA01HA02HA03HA04HA05HA06HA07HA08HA09HA10"
H1=1
H2=0
DO WHILE H2<10
H3=SUBSTR(HA,H1,4)
H3=(10000/VAL(AR))*&H3
H1=H1+4
DO CASE
```

```
CASE H2=1
 REPLACE ETTE WITH H3
 CASE H2=2
 REPLACE LMAS WITH H3/1000
 CASE H2=3
 REPLACE LM_15 WITH H3/1000
 CASE H2=4
 REPLACE LM_20 WITH H3/1000
 CASE H2=5
 REPLACE LM_50 WITH H3/1000
 CASE H2=6
 REPLACE BTE WITH H3
 CASE H2=7
 REPLACE BTE_15 WITH H3
 CASE H2=8
 REPLACE BTE_20 WITH H3
 CASE H2=9
 REPLACE BTE_50 WITH H3
ENDCASE
H2=H2+1
ENDDO
GOTO 1
SET STATUS ON
BROW
SET STATUS OFF
ENDCASE
ENDDO
```

Standard data file: BECV_STD.dbf

Field	Field name	Type	Width	Dec
1	CAL	Character	1	
2	DATE	Character	8	
3	PLOT	Numeric	3	0
4	SPECIES	Character	12	
5	L_A	Numeric	5	2
6	L_B	Numeric	5	2
7	L_C	Numeric	5	2
8	L_D1	Numeric	5	2
9	L_D2	Numeric	5	2
10	L_E1	Numeric	5	2
11	L_E2	Numeric	5	2
12	MOD	Numeric	1	0
13	CANVOL	Numeric	6	3
14	LVOL	Numeric	6	0
15	ETTE	Numeric	6	3
16	LMAS	Numeric	6	0
17	LM_15	Numeric	6	0
18	LM_20	Numeric	6	0
19	LM_50	Numeric	6	0
20	BTE	Numeric	6	3
21	BTE_15	Numeric	6	3
22	BTE_20	Numeric	6	3
23	BTE_50	Numeric	6	3

* CAL - Non-data field used by program
$ DATE - Date of survey
$ PLOT - Experimental/survey plot
$ SPECIES - Tree species (*C. mopane* in this case)
$ L_A - Tree height (m)
$ L_B - Height of maximum canopy diameter (m)
$ L_C - Height of first leaves (m)
$ L_D1 - Maximum canopy diameter - first measurement (m)
$ L_D2 - Maximum canopy diameter - second measurement (m)
$ L_E1 - Base diameter of foliage at height C - first measurement (m)

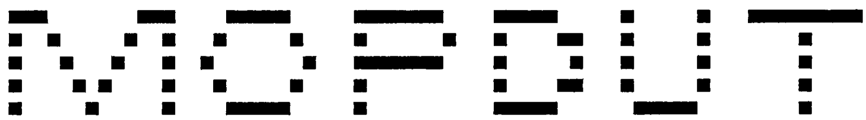
$ L_E2 - Base diameter of foliage at height C - second measurement (m)
$ MOD - Model 1 (normal *C. mopane* trees) or model 2 (*C. mopane* regrowth)
# CANVOL - Canopy volume (cm^3)
# LVOL - Estimated total leaf volume (cm^3)
# ETTE - Total Evapotranspiration Tree Equivalents (leaf volume/500)
# LMAS - Estimated total leaf dry mass (g)
# LM_15 - Estimated leaf dry mass below 1.5 m (g)
# LM_20 - Estimated leaf dry mass below 2.0 m (g)
# LM_50 - Estimated leaf dry mass below 5.0 m (g)
# BTE - Total Browse Tree Equivalents (leaf dry mass/250)
# BTE_15 - Browse Tree Equivalents below 1.5 m
# BTE_20 - Browse Tree Equivalents below 2.0 m
# BTE_50 - Browse Tree Equivalents below 5.0 m

* - Program orientation symbols
$ - Values from data input
# - Values calculated by program

Appendix 2: Printout of the dBASE IV computer program of the MOPDUT-model, for the transformation of tree descriptive units as described in Chapter 4 (see also Chapter 11). A printout of the structure of the standard dBASE data file (MDUT_STD.dbf), showing the field names used by the program, is also provided.

Program: MOPDUT.prg

```
SET ECHO OFF
SET TALK OFF
SET CONFIRM ON
SET BELL OFF
SET STATUS OFF
SET COLOR TO GR+/BG
DEFINE WINDOW MAIN3 FROM 1,0 TO 24,79
CLEAR
SET COLOR TO R+/B
TEXT
```



```
                           Version 1.0 (1994)
ENDTEXT
SET COLOR TO W+/B
@ 11,14 SAY "      :    ani  escriptive  nit  ransformations"
SET COLOR TO R+*/B
@ 11,14 SAY "MOPDUT"
@ 11,22 SAY "MOP"
@ 11,29 SAY "D"
@ 11,41 SAY "U"
@ 11,46 SAY "T"
SET COLOR TO W+/B
@ 14,13 TO 22,62
@ 15,15 TO 21,60
@ 16,17 SAY "Program compiled by:  G.N. Smit"
@ 17,17 SAY "                      Towoomba ADC"
@ 18,17 SAY "                      Private Bag X1615"
@ 19,17 SAY "                      Warmbaths 0480"
@ 20,17 SAY "                      Tel. (014) 736-2250"
@ 24,25 SAY "Press any key to continue ...."
READ
DO WHILE .T.
CLEAR
SET COLOR TO G+/B
@ 1,14 TO 3,64 PANEL
SET COLOR TO W/B
@ 2,16 SAY "      :    ani  escriptive  nit  ransformations"
SET COLOR TO W+/B
@ 2,16 SAY "MOPDUT"
@ 2,24 SAY "MOP"
@ 2,31 SAY "D"
@ 2,43 SAY "U"
@ 2,48 SAY "T"
SET COLOR TO W+/B
@ 5,17 TO 14,61 DOUBLE
SET COLOR TO R+/B
@ 6,34 SAY "MAIN MENU"
SET COLOR TO W+/B
@ 8,19 SAY "(0) Quit application                 - 0"
@ 9,19 SAY "(1) Transformations using data files  - 1"
@ 10,19 SAY "(2) On-screen transformations         - 2"
@ 12,34 SAY "Option:"
@ 13,21 SAY "(Press ENTER for general information)"
MN1=SPACE(1)
@ 12,42 GET MN1
READ
DO CASE
 CASE MN1="0"
```

```
CLOSE DATA
SET STATUS ON
CLEAR
RETURN
CASE MN1=" "
ACTIVATE WINDOW MAIN3
TEXT
For a more information on the MOPDUT-model, consult Chapters 4 and 11.

                        Transformations using data files:

Data input: Data is stored in files which are created from a standard file.
            You must specify if you want the data input to be stored in a
            new file or an existing file.  Data consists of a known value of
            any of the following desriptive units: ETTE/ha, TE/ha, trees/ha,
            stems/ha, % canopy cover. There is a restriction on the range of
            values that can be entered. A warning of this is given and the
            program will not allow you to enter a value outside the range.
View data files:  Displays data files of the given names on the screen.
Print data files: Prints data files onto paper via a printer.  Refer to Ap-
                  pendix 2 (page A-16) for information on field names.
Execute transformations: Calculates estimated values for all the descriptive
                         units from a known value of any of the descriptive
                         units and stores them in the appropriate file.

                            On-screen transformations:

The data input is the same as for transformations using data files. Estimated
values are displayed immediately on screen (numerically and graphically).
ENDTEXT
READ
DEACTIVATE WINDOW MAIN3
CASE MN1="1"
DO WHILE .T.
@ 4,0 CLEAR TO 24,79
SET COLOR TO W+/B
@ 5,19 TO 15,59 DOUBLE
SET COLOR TO R+/B
@ 6,31 SAY "FILE OPERATIONS"
SET COLOR TO W+/B
@ 8,21 SAY "(0) Return to previous menu       - 0"
@ 9,21 SAY "(1) Data input [(T)est]           - 1"
@ 10,21 SAY "(2) View data files               - 2"
@ 11,21 SAY "(3) Print data files              - 3"
@ 12,21 SAY "(4) Execute transformations       - 4"
@ 14,34 SAY "Option:"
M1=SPACE(1)
@ 14,42 GET M1
READ
DO CASE
 CASE M1="0"
 CLOSE DATA
 CLEAR
 EXIT
 CASE M1="1".OR.M1="T".OR.M1="t"
 IF M1="T".OR.M1="t"
 @ 0,10 SAY "TEST"
 ENDIF
 @ 18,0 CLEAR TO 24,79
 @ 18,0 TO 23,79
 @ 19,28 SAY "MOPDUT: FILE DATA INPUT"
 FIL=SPACE(1)
 @ 21,3 SAY "(E)xisting or (N)ew data file:      (Press 'Q' to return to previous menu)"
 @ 21,34 GET FIL
 READ
 IF UPPER(FIL)="Q"
 CLOSE DATA
 @ 4,0 CLEAR TO 24,79
 LOOP
 ENDIF
 IF UPPER(FIL)="E"
 @ 20,1 CLEAR TO 22,78
 @ 21,22 SAY "Name of existing file:"
 FIL2=SPACE(8)
 @ 21,45 GET FIL2
 READ
 ENDIF
 IF UPPER(FIL)="N"
 @ 20,1 CLEAR TO 22,78
 @ 21,27 SAY "Name of new file:"
```

```
FIL2=SPACE(8)
@ 21,45 GET FIL2
READ
USE MDUT_STD
COPY TO &FIL2
CLOSE DATA
ENDIF
USE &FIL2
IN1=SPACE(8)
DO WHILE .T.
@ 4,0 CLEAR TO 24,79
@ 6,27 SAY "MOPDUT: FILE DATA INPUT"
@ 8,12 SAY "DATE:             (Press 'Q' to terminate data input)"
@ 8,18 GET IN1
READ
IF IN1="Q".OR.IN1="q"
CLOSE DATA
CLEAR
EXIT
ENDIF
@ 12,13 TO 21,61
DO WHILE .T.
@ 13,14 CLEAR TO 20,60
CO="Y"
D1=SPACE(5)
D2=SPACE(5)
D3=SPACE(5)
D4=SPACE(5)
D5=SPACE(5)
@ 13,18 SAY "Continue (Y/N):"
@ 13,34 GET CO
READ
IF UPPER(CO)="N"
EXIT
ENDIF
DO WHILE .T.
@ 13,14 CLEAR TO 13,60
SET COLOR TO R+/B
@ 13,20 SAY "<< Enter any one of the values >>"
SET COLOR TO GR+/B
@ 15,15 SAY "ETTE/ha:         (Range: 600 - 6 750 ETTE/ha)"
@ 15,26 GET D1
@ 16,15 SAY "TE/ha:           (Range: 800 - 8 500 TE/ha)"
@ 16,26 GET D2
@ 17,15 SAY "TREES/ha:        (Range: 300 - 2 750 trees/ha)"
@ 17,26 GET D3
@ 18,15 SAY "STEMS/ha:        (Range: 600 - 6 000 stems/ha)"
@ 18,26 GET D4
@ 19,15 SAY "Cover (%):       (Range: 2.5 - 54.0 %)"
@ 19,26 GET D5
READ
IF D1="     ".AND.D2="     ".AND.D3="     ".AND.D4="     ".AND.D5="     "
EXIT
ENDIF
WARN="N"
DO CASE
 CASE VAL(D1)>0
 IF VAL(D1)<600.OR.VAL(D1)>6750
 WARN="Y"
 ENDIF
 CASE VAL(D2)>0
 IF VAL(D2)<800.OR.VAL(D2)>8500
 WARN="Y"
 ENDIF
 CASE VAL(D3)>0
 IF VAL(D3)<300.OR.VAL(D3)>2750
 WARN="Y"
 ENDIF
 CASE VAL(D4)>0
 IF VAL(D4)<600.OR.VAL(D4)>6000
 WARN="Y"
 ENDIF
 CASE VAL(D5)>0
 IF VAL(D5)<2.5.OR.VAL(D5)>54
 WARN="Y"
 ENDIF
ENDCASE
IF WARN="Y"
SET COLOR TO GR+*/B
@ 23,10 SAY "Value outside estimation range.  Press any key to continue ..."
```

```
READ
SET COLOR TO W+/B
@ 22,0 CLEAR TO 24,79
LOOP
ENDIF
IF M1="T".OR.M1="t"
LOOP
ELSE
EXIT
ENDIF
ENDDO
APPE BLANK
REPLACE DATE WITH IN1
REPLACE ETTE_HA WITH VAL(D1)
REPLACE TE_HA WITH VAL(D2)
REPLACE TREES_HA WITH VAL(D3)
REPLACE STEMS_HA WITH VAL(D4)
REPLACE COVER WITH VAL(D5)
ENDDO
ENDDO
CASE M1="2"
@ 18,0 CLEAR TO 24,79
@ 18,0 TO 23,79
@ 19,28 SAY "MOPDUT: VIEW DATA FILES"
FIL=SPACE(8)
@ 21,8 SAY "Name of file:           (Press 'Q' to return to previous menu)"
@ 21,22 GET FIL
READ
IF UPPER(FIL)="Q"
@ 4,0 CLEAR TO 24,79
LOOP
ENDIF
USE &FIL
SET STATUS ON
BROW
SET STATUS OFF
CLOSE DATA
CASE M1="3"
@ 17,0 CLEAR TO 24,79
@ 17,0 TO 24,79
@ 18,28 SAY "MOPDUT: PRINT DATA FILES"
FIL=SPACE(8)
@ 20,8 SAY "Name of file:           (Press 'Q' to return to previous menu)"
@ 20,22 GET FIL
READ
IF UPPER(FIL)="Q"
@ 4,0 CLEAR TO 24,79
LOOP
ENDIF
@ 21,2 CLEAR TO 23,77
SET COLOR TO R+*/B
@ 22,5 SAY "Make sure printer is switched on.    Press any key to continue ..."
READ
SET COLOR TO W+/B
USE &FIL
LIST TO PRINT OFF
CASE M1="4"
@ 18,0 CLEAR TO 24,79
@ 18,0 TO 23,79
@ 19,15 SAY "MOPDUT: EXECUTING TRANSFORMATIONS IN DATA FILES"
FIL=SPACE(8)
@ 21,8 SAY "Name of file:           (Press 'Q' to return to previous menu)"
@ 21,22 GET FIL
READ
IF UPPER(FIL)="Q"
@ 4,0 CLEAR TO 24,79
LOOP
ENDIF
USE &FIL
@ 17,0 CLEAR TO 24,79
@ 21,25 SAY "Executing transformations ...."
SCAN FOR CAL=" "
D1=ETTE_HA
D2=TE_HA
D3=TREES_HA
D4=STEMS_HA
D5=COVER
DO CASE
 CASE D1#0
 DD2=-223.377+(1.30519*D1)
```

```
  DD3=-143.901+(0.449703*D1)
  DD4=-250.971+(0.952131*D1)
  DD5=-0.472471+(0.00986*D1)
  CASE D2#0
  DD1=366.337+(0.713108*D2)
  DD3=-74.654+(0.346648*D2)
  DD4=-87.7148+(0.729415*D2)
  DD5=1.6984+(0.00671*D2)
  CASE D3#0
  DD1=606.433+(1.98508*D3)
  DD2=316.339+(2.80065*D3)
  DD4=86.6899+(2.08977*D3)
  DD5=2.94022+(0.019535*D3)
  CASE D4#0
  DD1=507.974+(0.956113*D4)
  DD2=199.012+(1.34062*D4)
  DD3=-33.3752+(0.475399*D4)
  DD5=2.39488+(0.00924*D4)
  CASE D5#0
  DD1=439.842+(96.7198*D5)
  DD2=188.321+(132.242*D5)
  DD3=-56.6397+(47.6324*D5)
  DD4=-20.0496+(99.1001*D5)
 ENDCASE
 IF ETTE_HA=0
 REPLACE ETTE_HA WITH DD1
 ENDIF
 IF TE_HA=0
 REPLACE TE_HA WITH DD2
 ENDIF
 IF TREES_HA=0
 REPLACE TREES_HA WITH DD3
 ENDIF
 IF STEMS_HA=0
 REPLACE STEMS_HA WITH DD4
 ENDIF
 IF COVER=0
 REPLACE COVER WITH DD5
 ENDIF
 REPLACE CAL WITH "*"
ENDSCAN
GOTO 1
BROWSE
ENDCASE
ENDDO
CASE MN1="2"
DO WHILE .T.
@ 4,0 CLEAR TO 24,79
@ 5,16 TO 7,63 DOUBLE
@ 6,18 SAY "MOPDUT: EXECUTING TRANSFORMATIONS ON-SCREEN"
SET COLOR TO R+/B
@ 8,16 SAY "Mark the input unit with a 'x' (NB: MARK ONLY ONE)"
@ 9,19 SAY "(press ESC to return to previous menu"
SET COLOR TO W+/B
@ 12,28 SAY "ETTE/ha:"
@ 14,28 SAY "TE/ha:"
@ 16,28 SAY "Trees/ha:"
@ 18,28 SAY "Stems/ha:"
@ 20,28 SAY "Cover (%):"
D1=SPACE(1)
D2=SPACE(1)
D3=SPACE(1)
D4=SPACE(1)
D5=SPACE(1)
@ 12,39 GET D1
@ 14,39 GET D2
@ 16,39 GET D3
@ 18,39 GET D4
@ 20,39 GET D5
READ
IF D1=" ".AND.D2=" ".AND.D3=" ".AND.D4=" ".AND.D5=" "
EXIT
ENDIF
DO WHILE .T.
@ 21,0 CLEAR TO 24,79
INP=SPACE(5)
WARN="N"
DO CASE
 CASE UPPER(D1)="X"
 @ 22,23 SAY "Type the ETTE/ha-value:"
```

```
 SET COLOR TO R+*/B
 @ 24,12 SAY "Transformations for ETTE between 600 and 6 750 ETTE/ha"
 SET COLOR TO W+/B
 @ 22,47 GET INP
 READ
 IF VAL(INP)<600.OR.VAL(INP)>6750
 WARN="Y"
 ENDIF
 NR=1
 CASE UPPER(D2)="X"
 @ 22,24 SAY "Type the TE/ha-value:"
 SET COLOR TO R+*/B
 @ 24,14 SAY "Transformations for TE between 800 and 8 500 TE/ha"
 SET COLOR TO W+/B
 @ 22,46 GET INP
 READ
 IF VAL(INP)<800.OR.VAL(INP)>8500
 WARN="Y"
 ENDIF
 NR=2
 CASE UPPER(D3)="X"
 @ 22,23 SAY "Type the Trees/ha-value:"
 SET COLOR TO R+*/B
 @ 24,11 SAY "Transformations for Trees between 300 and 2 750 trees/ha"
 SET COLOR TO W+/B
 @ 22,48 GET INP
 READ
 IF VAL(INP)<300.OR.VAL(INP)>2750
 WARN="Y"
 ENDIF
 NR=3
 CASE UPPER(D4)="X"
 @ 22,23 SAY "Type the Stems/ha-value:"
 SET COLOR TO R+*/B
 @ 24,11 SAY "Transformations for Stems between 600 and 6 000 stems/ha"
 SET COLOR TO W+/B
 @ 22,48 GET INP
 READ
 IF VAL(INP)<600.OR.VAL(INP)>6000
 WARN="Y"
 ENDIF
 NR=4
 CASE UPPER(D5)="X"
 @ 22,22 SAY "Type the % Canopy cover:"
 SET COLOR TO R+*/B
 @ 24,10 SAY "Transformations for % Canopy cover between 2.5 and 54.0 %"
 SET COLOR TO W+/B
 @ 22,47 GET INP
 READ
 IF VAL(INP)<2.5.OR.VAL(INP)>54
 WARN="Y"
 ENDIF
 NR=5
ENDCASE
INP=VAL(INP)
IF WARN="Y"
SET COLOR TO GR+*/B
@ 24,10 SAY "Value outside estimation range.  Press any key to continue ..."
READ
LOOP
ELSE
EXIT
ENDIF
ENDDO
DO CASE
 CASE UPPER(D1)="X"
 DD1=INP
 DD2=-223.377+(1.30519*INP)
 DD3=-143.901+(0.449703*INP)
 DD4=-250.971+(0.952131*INP)
 DD5=-0.472471+(0.00986*INP)
 UN="ETTE/ha"
 CASE UPPER(D2)="X"
 DD1=366.337+(0.713108*INP)
 DD2=INP
 DD3=-74.654+(0.346648*INP)
 DD4=-87.7148+(0.729415*INP)
 DD5=1.6984+(0.00671*INP)
 UN="TE/ha"
 CASE UPPER(D3)="X"
```

```
 DD1=606.433+(1.98508*INP)
 DD2=316.339+(2.80065*INP)
 DD3=INP
 DD4=86.6899+(2.08977*INP)
 DD5=2.94022+(0.019535*INP)
 UN="Trees/ha"
 CASE UPPER(D4)="X"
 DD1=507.974+(0.956113*INP)
 DD2=199.012+(1.34062*INP)
 DD3=-33.3752+(0.475399*INP)
 DD4=INP
 DD5=2.39488+(0.00924*INP)
 UN="Stems/ha"
 CASE UPPER(D5)="X"
 DD1=439.842+(96.7198*INP)
 DD2=188.321+(132.242*INP)
 DD3=-56.6397+(47.6324*INP)
 DD4=-20.0496+(99.1001*INP)
 DD5=INP
 UN="% Cover"
ENDCASE
SET DISPLAY TO VGA43
@ 1,27 TO 3,50 DOUBLE
SET COLOR TO R+*/B
@ 2,29 SAY "Input unit:"
@ 2,41 SAY UN
SET COLOR TO W+/B
@ 4,59 TO 42,59 DOUBLE
@ 4,0 TO 42,79 DOUBLE
@ 7,1 TO 7,78 DOUBLE
@ 5,35 SAY "NUMBER/ha"
@ 5,63 SAY "CANOPY COVER"
@ 6,4 SAY "      ETTE          TE          Trees          Stems                   (%)"
IF DD1>=DD2
SC=DD1
ELSE
SC=DD2
ENDIF
IF DD3>=SC
SC=DD3
ENDIF
IF DD4>=SC
SC=DD4
ENDIF
SCL1=32/SC
DD1S=DD1*SCL1
DD2S=DD2*SCL1
DD3S=DD3*SCL1
DD4S=DD4*SCL1
SCL2=32/100
DD5S=DD5*SCL2
DD1=STR(DD1,6,1)
DD2=STR(DD2,6,1)
DD3=STR(DD3,6,1)
DD4=STR(DD4,6,1)
DD5=STR(DD5,6,1)
S1="1224364869"
S2=1
S3=0
W1="DD1DD2DD3DD4DD5"
W2=1
V1="DD1SDD2SDD3SDD4SDD5S"
V2=1
DO WHILE S3<5
S4=SUBSTR(S1,S2,2)
W3=SUBSTR(W1,W2,3)
V3=SUBSTR(V1,V2,4)
S5=0
S6=40
DO CASE
 CASE S3<4
 @ 41,VAL(S4)-2 SAY &W3
 CASE S3=4
 @ 41,VAL(S4)-3 SAY &W3
ENDCASE
SET COLOR TO G+/B
SYM="███"
IF S3+1=NR
SET COLOR TO R+/B
SYM="███"
```

```
ENDIF
DO WHILE S5<32
S6=S6-1
@ S6,VAL(S4) SAY "|"
S5=S5+1
ENDDO
S6=40
S5=0
DO WHILE S5<&V3
S6=S6-1
@ S6,VAL(S4)-1 SAY SYM
S5=S5+1
ENDDO
SET COLOR TO W+/B
S3=S3+1
S2=S2+2
W2=W2+3
V2=V2+4
ENDDO
READ
SET DISPLAY TO VGA25
ENDDO
ENDCASE
ENDDO
```

Standard data file: MDUT_STD.dbf

Field	Field name	Type	Width	Dec
1	CAL	Character	1	
2	DATE	Character	8	
3	ETTE_HA	Numeric	5	0
4	TE_HA	Numeric	5	0
5	TREES_HA	Numeric	5	0
6	STEMS_HA	Numeric	5	0
7	COVER	Numeric	5	2

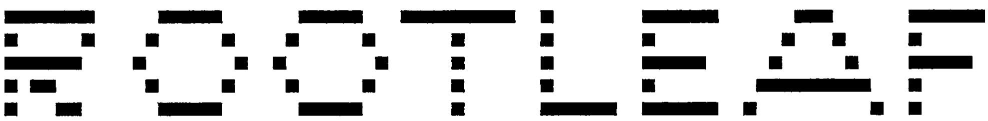
* CAL - Non-data field used by program
$ DATE - Date of survey
$/# ETTE_HA - Evapotranspiration Tree Equivalents ha^{-1}
$/# TE_HA - Tree Equivalents ha^{-1}
$/# TREES_HA - Trees ha^{-1}
$/# STEMS_HA - Stems ha^{-1}
$/# COVER - Tree canopy cover (%)

* - Program orientation symbols $ - Values from data input   # - Values calculated by program

Appendix 3: Printout of the dBASE IV computer program of the ROOTLEAF-model, for the estimation of root dry mass ha^{-1} of *Colophospermum mopane* from the leaf dry mass ha^{-1} (see Chapters 5 and 11). A printout of the structure of the standard dBASE data file (RL_STD.dbf), showing the field names used by the program, is also provided.

Program: ROOTLEAF.prg

```
SET ECHO OFF
SET TALK OFF
SET CONFIRM ON
SET BELL OFF
SET STATUS OFF
SET COLOR TO W+/B
DEFINE WINDOW MAIN3 FROM 1,0 TO 24,79
CLEAR
SET COLOR TO R+/B
TEXT
```



```
                         Version 1.0 (1994)
ENDTEXT
SET COLOR TO W+/B
@ 11,19 SAY "        :      biomass from      biomass"
SET COLOR TO R+*/B
@ 11,19 SAY "ROOTLEAF"
@ 11,29 SAY "ROOT"
@ 11,47 SAY "LEAF"
SET COLOR TO W+/B
@ 14,13 TO 22,62
@ 15,15 TO 21,60
@ 16,17 SAY "Program compiled by:  G.N. Smit"
@ 17,17 SAY "                      Towoomba ADC"
@ 18,17 SAY "                      Private Bag X1615"
@ 19,17 SAY "                      Warmbaths 0480"
@ 20,17 SAY "                      Tel. (014) 736-2250"
@ 24,25 SAY "Press any key to continue ...."
READ
DO WHILE .T.
CLEAR
SET COLOR TO G+/B
@ 1,17 TO 3,60 PANEL
SET COLOR TO W/B
@ 2,19 SAY "        :      biomass from      biomass"
SET COLOR TO W+/B
@ 2,19 SAY "ROOTLEAF"
@ 2,29 SAY "ROOT"
@ 2,47 SAY "LEAF"
SET COLOR TO W+/B
@ 5,17 TO 14,61 DOUBLE
SET COLOR TO R+/B
@ 6,34 SAY "MAIN MENU"
SET COLOR TO W+/B
@ 8,19 SAY "(0) Quit application                  - 0"
@ 9,19 SAY "(1) Estimations using data files      - 1"
@ 10,19 SAY "(2) On-screen estimations             - 2"
@ 12,34 SAY "Option:"
@ 13,21 SAY "(Press ENTER for general information)"
MN1=SPACE(1)
@ 12,42 GET MN1
READ
DO CASE
 CASE MN1="0"
 CLOSE DATA
 SET STATUS ON
 CLEAR
 RETURN
```

```
 CASE MN1=" "
 ACTIVATE WINDOW MAIN3
 TEXT
For a more information on the ROOTLEAF-model, consult Chapters 5 and 11.
                           ESTIMATIONS USING DATA FILES:

 Data input: Data is stored in files which are created from a standard file.
             You must specify if you want the data input to be stored in a
             new file or an existing file.  Data input consists of a value of
             the leaf DM (kg/ha).  There is a restriction on the range of
             values that can be entered, and values should be between 550 and
             1700 kg/ha. A warning of this is given and the program will not
             allow you to enter a value outside this range.
 View data files:  Displays data files of the given names on the screen.
 Print data files: Prints data files onto paper via a printer.  Refer to Ap-
                   pendix 3 (page A-21) for information on field names.
 Execute estimations: Estimates the root DM/ha (0-1 m soil depth) from the
                      given leaf DM/ha.   Estimates consists of total root
                      DM with subdivision into diameter classes (Chapter 5).
                      These estimates are stored in the appropriate file.

                               ON-SCREEN ESTIMATIONS:

The data input is the same as for estimates using data files. Predicted values
are displayed immediately on screen (numerically and graphically).
 ENDTEXT
 READ
 DEACTIVATE WINDOW MAIN3
 CASE MN1="1"
 DO WHILE .T.
 @ 4,0 CLEAR TO 24,79
 SET COLOR TO W+/B
 @ 5,19 TO 15,59 DOUBLE
 SET COLOR TO R+/B
 @ 6,31 SAY "FILE OPERATIONS"
 SET COLOR TO W+/B
 @ 8,21 SAY "(0) Return to previous menu       - 0"
 @ 9,21 SAY "(1) Data input [(T)est]           - 1"
 @ 10,21 SAY "(2) View data files               - 2"
 @ 11,21 SAY "(3) Print data files              - 3"
 @ 12,21 SAY "(4) Execute estimations           - 4"
 @ 14,34 SAY "Option:"
 M1=SPACE(1)
 @ 14,42 GET M1
 READ
 DO CASE
  CASE M1="0"
  CLOSE DATA
  CLEAR
  EXIT
  CASE M1="1".OR.M1="T".OR.M1="t"
  IF M1="T".OR.M1="t"
  @ 0,10 SAY "TEST"
  ENDIF
  @ 18,0 CLEAR TO 24,79
  @ 18,0 TO 23,79
  @ 19,27 SAY "ROOTLEAF: FILE DATA INPUT"
  FIL=SPACE(1)
  @ 21,3 SAY "(E)xisting or (N)ew data file:      (Press 'Q' to return to previous menu)"
  @ 21,34 GET FIL
  READ
  IF UPPER(FIL)="Q"
  CLOSE DATA
  @ 4,0 CLEAR TO 24,79
  LOOP
  ENDIF
  IF UPPER(FIL)="E"
  @ 20,1 CLEAR TO 22,78
  @ 21,22 SAY "Name of existing file:"
  FIL2=SPACE(8)
  @ 21,45 GET FIL2
  READ
  ENDIF
  IF UPPER(FIL)="N"
  @ 20,1 CLEAR TO 22,78
  @ 21,27 SAY "Name of new file:"
  FIL2=SPACE(8)
  @ 21,45 GET FIL2
  READ
  USE RL_STD
```

```
COPY TO &FIL2
CLOSE DATA
ENDIF
USE &FIL2
IN1=SPACE(8)
DO WHILE .T.
@ 4,0 CLEAR TO 24,79
@ 6,26 SAY "ROOTLEAF: FILE DATA INPUT"
@ 6,12 SAY "DATE:            (Press 'Q' to terminate data input)"
@ 6,18 GET IN1
READ
IF IN1="Q".OR.IN1="q"
CLOSE DATA
CLEAR
EXIT
ENDIF
@ 12,11 TO 19,63
DO WHILE .T.
@ 13,12 CLEAR TO 18,62
@ 21,0 CLEAR TO 23,79
LM=SPACE(4)
@ 14,17 SAY "Leaf dry mass/ha:         (No decimals !)"
@ 14,35 GET LM
SET COLOR TO R+/B
@ 16,28 SAY "<< Press 'Q' to exit >>"
SET COLOR TO R+*/B
@ 18,13 SAY "Estimates for leaf DM between 550 and 1 700 kg/ha"
SET COLOR TO W+/B
READ
IF UPPER(LM)="Q"
CLOSE DATA
EXIT
ENDIF
IF VAL(LM)<550.OR.VAL(LM)>1700
SET COLOR TO R+*/B
@ 22,9 SAY "Value outside prediction range.  Press any key to continue ..."
SET COLOR TO W+/B
READ
LOOP
ENDIF
IF M1="T".OR.M1="t"
LOOP
ENDIF
APPE BLANK
REPLACE DATE WITH IN1
REPLACE LM_TOTAL WITH VAL(LM)
ENDDO
ENDDO
CASE M1="2"
@ 18,0 CLEAR TO 24,79
@ 18,0 TO 23,79
@ 19,28 SAY "ROOTLEAF: VIEW DATA FILES"
FIL=SPACE(8)
@ 21,8 SAY "Name of file:          (Press 'Q' to return to previous menu)"
@ 21,22 GET FIL
READ
IF UPPER(FIL)="Q"
@ 4,0 CLEAR TO 24,79
LOOP
ENDIF
USE &FIL
SET STATUS ON
BROW
SET STATUS OFF
CLOSE DATA
CASE M1="3"
@ 17,0 CLEAR TO 24,79
@ 17,0 TO 24,79
@ 18,28 SAY "ROOTLEAF: PRINT DATA FILES"
FIL=SPACE(8)
@ 20,8 SAY "Name of file:          (Press 'Q' to return to previous menu)"
@ 20,22 GET FIL
READ
IF UPPER(FIL)="Q"
@ 4,0 CLEAR TO 24,79
LOOP
ENDIF
@ 21,2 CLEAR TO 23,77
SET COLOR TO R+*/B
@ 22,5 SAY "Make sure printer is switched on.    Press any key to continue ..."
```

```
 READ
 SET COLOR TO W+/B
 USE &FIL
 LIST TO PRINT OFF
 CASE M1="4"
 @ 18,0 CLEAR TO 24,79
 @ 18,0 TO 23,79
 @ 19,17 SAY "ROOTLEAF: EXECUTING ESTIMATIONS IN DATA FILES"
 FIL=SPACE(8)
 @ 21,8 SAY "Name of file:          (Press 'Q' to return to previous menu)"
 @ 21,22 GET FIL
 READ
 IF UPPER(FIL)="Q"
 @ 4,0 CLEAR TO 24,79
 LOOP
 ENDIF
 USE &FIL
 @ 17,0 CLEAR TO 24,79
 @ 21,25 SAY "Executing estimations ...."
 REPLACE ALL CAL WITH " "
 SCAN FOR CAL=" "
 LM=LM_TOTAL
 RMT=6325.08+(10.192*LM)
 RMF=2192.21+(4.278*LM)
 RMC=4132.87+(5.913*LM)
 RM1=567.64+(2.529*LM)
 RM2=1624.58+(1.750*LM)
 RM3=1098.98+(1.580*LM)
 RM4=3033.89+(4.333*LM)
 REPLACE RM_TOTAL WITH RMT
 REPLACE RM_FINE WITH RMF
 REPLACE RM_COARSE WITH RMC
 REPLACE RM0_1 WITH RM1
 REPLACE RM1_5 WITH RM2
 REPLACE RM5_10 WITH RM3
 REPLACE RM10 WITH RM4
 REPLACE CAL WITH "*"
ENDSCAN
GOTO 1
SET STATUS ON
BROWSE
SET STATUS OFF
ENDCASE
ENDDO
CASE MN1="2"
DO WHILE .T.
@ 4,0 CLEAR TO 24,79
@ 5,16 TO 7,62 DOUBLE
@ 6,19 SAY "ROOTLEAF: EXECUTING ESTIMATIONS ON-SCREEN"
DO WHILE .T.
INP=SPACE(5)
@ 10,19 SAY "Type the leaf dry mass (kg/ha):"
@ 12,19 SAY "(Press 'Q' to return to previous menu)"
SET COLOR TO R+*/B
@ 13,0 CLEAR TO 24,79
@ 14,14 SAY "Estimates for leaf DM between 550 and 1 700 kg/ha"
SET COLOR TO W+/B
@ 10,51 GET INP
READ
IF UPPER(INP)="Q".OR.VAL(INP)>549.AND.VAL(INP)<1701
EXIT
ENDIF
IF VAL(INP)<550.OR.VAL(INP)>1700
SET COLOR TO R+*/B
@ 19,9 SAY "Value outside prediction range.  Press any key to continue ..."
SET COLOR TO W+/B
READ
LOOP
ENDIF
ENDDO
IF UPPER(INP)="Q"
EXIT
ENDIF
UN=RTRIM(INP)+" kg/ha"
INP=VAL(INP)
RMT=6325.08+(10.192*INP)
RMF=2192.21+(4.278*INP)
RMC=4132.87+(5.913*INP)
RM1=567.64+(2.529*INP)
RM2=1624.58+(1.750*INP)
```

```
RM3=1098.98+(1.580*INP)
RM4=3033.89+(4.333*INP)
SET DISPLAY TO VGA43
@ 1,27 TO 3,51 DOUBLE
SET COLOR TO R+*/B
@ 2,29 SAY "Leaf mass:"
@ 2,40 SAY UN
SET COLOR TO W+/B
@ 4,0 TO 42,79 DOUBLE
@ 7,1 TO 7,78 DOUBLE
@ 5,29 SAY "ROOT DRY MASS (kg/ha)"
@ 6,4 SAY "Total     (< 5 mm)    (> 5 mm)    (0-1 mm)    (1-5 mm)   (5-10 mm)    (> 10 mm)"
SCL1=32/RMT
RMTS=RMT*SCL1
RMFS=RMF*SCL1
RMCS=RMC*SCL1
RM1S=RM1*SCL1
RM2S=RM2*SCL1
RM3S=RM3*SCL1
RM4S=RM4*SCL1
RMT=STR(RMT,6,1)
RMF=STR(RMF,6,1)
RMC=STR(RMC,6,1)
RM1=STR(RM1,6,1)
RM2=STR(RM2,6,1)
RM3=STR(RM3,6,1)
RM4=STR(RM4,6,1)
S1="06172839506172"
S2=1
S3=0
W1="RMTRMFRMCRM1RM2RM3RM4"
W2=1
V1="RMTSRMFSRMCSRM1SRM2SRM3SRM4S"
V2=1
DO WHILE S3<7
S4=SUBSTR(S1,S2,2)
W3=SUBSTR(W1,W2,3)
V3=SUBSTR(V1,V2,4)
S5=0
S6=40
@ 41,VAL(S4)-2 SAY &W3
SET COLOR TO G+/B
SYM="█"
DO WHILE S5<32
S6=S6-1
@ S6,VAL(S4) SAY "|"
S5=S5+1
ENDDO
S6=40
S5=0
DO WHILE S5<&V3
S6=S6-1
@ S6,VAL(S4)-1 SAY SYM
S5=S5+1
ENDDO
SET COLOR TO W+/B
S3=S3+1
S2=S2+2
W2=W2+3
V2=V2+4
ENDDO
READ
SET DISPLAY TO VGA25
ENDDO
ENDCASE
ENDDO
```

Standard data file: LR_STD.dbf

Field	Field name	Type	Width	Dec
1	CAL	Character	1	
2	DATE	Character	8	
3	PLOT	Numeric	3	0
4	LM_TOTAL	Numeric	4	0
5	RM_TOTAL	Numeric	5	0

6	RM_FINE	Numeric	5	0
7	RM_COARSE	Numeric	5	0
8	RM0_1	Numeric	5	0
9	RM1_5	Numeric	5	0
10	RM5_10	Numeric	5	0
11	RM10	Numeric	5	0

* CAL - Non-data field used by program
$ DATE - Date of survey
$ PLOT - Experimental/survey plot
$ LM_TOTAL - Total leaf dry mass ha^{-1}
# RM_TOTAL - Total root dry mass ha^{-1} (to a depth of 1 m)
# RM_FINE - Dry mass ha^{-1} of fine roots (<5.0 mm)
# RM_COARSE - Dry mass ha^{-1} of coarse roots (>5.0 mm)
# RM0_1 - Dry mass ha^{-1} of roots 0-1.0 mm
# RM1_5 - Dry mass ha^{-1} of roots >1.0-5.0 mm
# RM5_10 - Dry mass ha^{-1} of roots >5.0-10.0 mm
# RM10 - Dry mass ha^{-1} of roots >10.0 mm

* - Program orientation symbols
$ - Values from data input
# - Values calculated by program

Appendix 4: Printout of the dBASE IV computer program of the YIELDCOR-model, for the estimation of grass DM yield (kg ha^{-1}) and the grazing capacity (ha AU^{-1}) from the percentage bare soil (areas 60 cm in diameter with no grass plant) and total seasonal rainfall (see Chapter 11).

```
SET ECHO OFF
SET TALK OFF
SET CONFIRM ON
SET BELL OFF
SET STATUS OFF
CLEAR
SET COLOR TO W+/B
@ 0,0 TO 24,79 PANEL
CLEAR
SET COLOR TO R+/B
TEXT
```

```
                              Version 1.0 (1994)
ENDTEXT
SET COLOR TO W+/B
@ 11,8 SAY "        : Estimates of grass       from grass   ver and  ianfall"
SET COLOR TO R+*/B
@ 11,8 SAY "YIELDCOR"
@ 11,37 SAY "YIELD"
@ 11,54 SAY "CO"
@ 11,64 SAY "R"
SET COLOR TO W+/B
@ 14,13 TO 22,62
@ 15,15 TO 21,60
@ 16,17 SAY "Program compiled by:  G.N. Smit"
@ 17,17 SAY "                      Towoomba ADC"
@ 18,17 SAY "                      Private Bag X1615"
@ 19,17 SAY "                      Warmbaths 0480"
@ 20,17 SAY "                      Tel. (014) 736-2250"
@ 24,25 SAY "Press any key to continue ...."
READ
DO WHILE .T.
CLEAR
SET COLOR TO G+/B
@ 1,6 TO 3,73 PANEL
SET COLOR TO W/B
@ 2,8 SAY "        : Estimates of grass       from grass   ver and  ianfall"
SET COLOR TO W+/B
@ 2,8 SAY "YIELDCOR"
@ 2,37 SAY "YIELD"
@ 2,54 SAY "CO"
@ 2,64 SAY "R"
SET COLOR TO W+/B
@ 5,8 TO 14,70 DOUBLE
SET COLOR TO R+/B
@ 6,34 SAY "MAIN MENU"
SET COLOR TO W+/B
@ 8,10 SAY "(0) Quit application                                  - 0"
@ 9,10 SAY "(1) Predictions based on CURRENT season's grass cover  - 1"
@ 10,10 SAY "(2) Predictions based on PREVIOUS season's grass cover  - 2"
@ 12,34 SAY "Option:"
@ 13,21 SAY "(Press ENTER for general information)"
O1=SPACE(1)
@ 12,42 GET O1
READ
DO CASE
 CASE O1="0"
 SET STATUS ON
 CLEAR
 RETURN
 CASE O1=" "
 ACTIVATE WINDOW MAIN3
```

```
TEXT
For a complete description on the functioning of the YIELDCOR-model, consult
Chapter 11.
On-screen data input:  Predictions of grass yield is based on the combined
                       influence of grass cover (either that of the current
                       season or that of the previous season) and total
                       seasonal rainfall.  The grass cover is taken as the
                       percentage of areas, 60 cm in diameter, in which no
                       grass plant occurs (Oropetium capense excluded).  The
                       on-screen data input requires you to supply a percen-
                       tage value for grass cover, as well as the total
                       seasonal rainfall (July-June).  If the values you
                       enter fall outside the model's prediction range, a
                       warning to that effect will be given.

On-screen estimations: Estimate the effective rainfall (mm), grass DM yield
                       (kg/ha) and the grazing capacity (ha/AU) and display
                       it numerically and graphically on the screen.

ENDTEXT
READ
DEACTIVATE WINDOW MAIN3
CASE O1="1".OR.O1="2"
@ 16,0 CLEAR TO 24,79
DO WHILE .T.
@ 15,0 CLEAR TO 24,79
@ 16,0 TO 22,79
DO CASE
 CASE O1="1"
 @ 17,10 SAY "YIELDCOR: PREDICTIONS FROM % BARE SOIL AND RAINFALL (CURRENT)"
 CASE O1="2"
 @ 17,11 SAY "YIELDCOR: PREDICTIONS FROM % BARE SOIL AND RAINFALL (PREVIOUS)"
ENDCASE
ET=SPACE(4)
@ 19,10 SAY "Percentage:        (areas 60 cm in diameter with no grass plant)"
@ 19,22 GET ET
@ 21,24 SAY "(Press 'Q' to return to previous menu)"
READ
ETS=ET
IF UPPER(ET)="Q"
@ 15,1 CLEAR TO 24,79
EXIT
ENDIF
RAI=SPACE(3)
@ 21,1 CLEAR TO 21,78
@ 21,10 SAY "Rainfall:              (Total seasonal rainfall in mm)"
@ 21,20 GET RAI
READ
ETS=ET
ERAI=RAI
ET=VAL(ET)
RAI=VAL(RAI)
EFR=(100-(14.3486+(0.8205*ET)))/100
EFR=RAI*EFR
DO CASE
 CASE O1="1"
 YLD=-132.855+(3.72193*EFR)
 CASE O1="2"
 YLD=-158.747+(4.94594*EFR)
ENDCASE
GCA=365/((YLD*0.35)/10)
IF YLD<0.OR.GCA<0.OR.YLD>2000
SET COLOR TO R+*/B
@ 24,10 SAY "Outside prediction range !    Press any key to continue ..."
READ
SET COLOR TO W+/B
LOOP
ENDIF
CLEAR
SET DISPLAY TO VGA43
@ 1,0 TO 3,79 DOUBLE
SET COLOR TO R+*/B
@ 2,4 SAY "Prediction for:"
DO CASE
 CASE O1="1"
 ETS=RTRIM(ETS)+" % bare soil (cur) AND "
 CASE O1="2"
 ETS=RTRIM(ETS)+" % bare soil (pre) AND "
ENDCASE
ERAI=RTRIM(ERAI)+" mm rainfall (total seasonal)"
```

```
@ 2,20 SAY ETS
@ 2,45 SAY ERAI
SET COLOR TO W+/B
@ 16,2 TO 24,31
@ 18,6 SAY "Effective rainfall (mm)"
@ 20,6 SAY "Grass yield (kg/ha)"
@ 22,6 SAY "Grazing capacity (ha/AU)"
SET COLOR TO G+/B
@ 18,4 SAY "█"
SET COLOR TO GR+/B
@ 20,4 SAY "█"
SET COLOR TO R+/B
@ 22,4 SAY "█"
SET COLOR TO W+/B
@ 4,0 TO 42,79 DOUBLE
DO CASE
 CASE EFR<=150
 DIV1=150
 CASE EFR>150.AND.EFR<=300
 DIV1=300
 CASE EFR>300.AND.EFR<=450
 DIV1=450
 CASE EFR>450.AND.EFR<=600
 DIV1=600
ENDCASE
DO CASE
 CASE YLD<=500
 DIV2=500
 CASE YLD>500.AND.YLD<=1000
 DIV2=1000
 CASE YLD>1000.AND.YLD<=1500
 DIV2=1500
 CASE YLD>1500
 DIV2=2000
ENDCASE
DO CASE
 CASE GCA<=15
 DIV3=15
 CASE GCA>15.AND.GCA<=30
 DIV3=30
 CASE GCA>30.AND.GCA<=60
 DIV3=60
 CASE GCA>60.AND.GCA<=90
 DIV3=90
 CASE GCA>90.AND.GCA<=120
 DIV3=120
 CASE GCA>120
 DIV3=400
ENDCASE
SCL1=34/DIV1
SCL2=34/DIV2
SCL3=34/DIV3
EFRS=EFR*SCL1
YLDS=YLD*SCL2
GCAS=GCA*SCL3
EFR=STR(EFR,6,1)
YLD=STR(YLD,6,1)
GCA=STR(GCA,6,1)
S1="405570"
S2=1
S3=0
W1="EFRYLDGCA"
W2=1
V1="EFRSYLDSGCAS"
V2=1
DO WHILE S3<3
S4=SUBSTR(S1,S2,2)
W3=SUBSTR(W1,W2,3)
V3=SUBSTR(V1,V2,4)
S5=0
S6=40
@ 41,VAL(S4)-2 SAY &W3
 SYM="███"
DO CASE
 CASE S3=0
 SET COLOR TO G+/B
 @ 6,39 SAY "┐"
 @ 6,35 SAY STR(DIV1,3,0)
 CASE S3=1
```

```
  SET COLOR TO GR+/B
  @ 6,54 SAY "┐"
  @ 6,49 SAY STR(DIV2,4,0)
  CASE S3=2
  SET COLOR TO R+/B
  @ 6,69 SAY "┐"
  @ 6,65 SAY STR(DIV3,3,0)
 ENDCASE
 DO WHILE S5<33
 S6=S6-1
 @ S6,VAL(S4) SAY "|"
 S5=S5+1
 ENDDO
 S6=40
 S5=0
 DO WHILE S5<&V3
 S6=S6-1
 @ S6,VAL(S4)-1 SAY SYM
 S5=S5+1
 ENDDO
 SET COLOR TO W+/B
 S3=S3+1
 S2=S2+2
 W2=W2+3
 V2=V2+4
 ENDDO
 READ
 SET DISPLAY TO VGA25
 ENDDO
ENDCASE
ENDDO
```

Appendix 5: Printout of the dBASE IV computer program of the THINGUIDE-model, for the prediction of grass DM yield (for a below and above average rainfall), leaf DM yield of *Colophospermum mopane* (total, <1.5 m, <2.0 m, and <5.0 m), and grazing capacity (for a below and above average rainfall) from the number of Evapotranspiration Tree Equivalents (ETTE) ha^{-1}. The model also provides estimates of the water use efficiency (WUE) of grasses and *C. mopane* leaves, as well as predictions of the seasonal leaf carriage of *C. mopane* (see Chapter 11).

```
SET ECHO OFF
SET TALK OFF
SET CONFIRM ON
SET BELL OFF
SET STATUS OFF
CLEAR
SET COLOR TO W+/B
@ 0,0 TO 24,79 PANEL
CLEAR
SET COLOR TO R+/B
TEXT
```

```
                           Version 1.0 (1994)
ENDTEXT
SET COLOR TO W+/B
@ 11,24 SAY "          : Mopani     ning      "
SET COLOR TO R+*/B
@ 11,24 SAY "THINGUIDE"
@ 11,42 SAY "Thin"
@ 11,51 SAY "Guide"
SET COLOR TO W+/B
@ 14,13 TO 22,62
@ 15,15 TO 21,60
@ 16,17 SAY "Program compiled by:  G.N. Smit"
@ 17,17 SAY "                      Towoomba ADC"
@ 18,17 SAY "                      Private Bag X1615"
@ 19,17 SAY "                      Warmbaths 0480"
@ 20,17 SAY "                      Tel. (014) 736-2250"
@ 24,25 SAY "Press any key to continue ...."
READ
DO WHILE .T.
CLEAR
SET COLOR TO G+/B
@ 1,21 TO 3,56 PANEL
SET COLOR TO W/B
@ 2,23 SAY "         : Mopani     ning      "
SET COLOR TO W+/B
@ 2,23 SAY "THINGUIDE"
@ 2,41 SAY "Thin"
@ 2,50 SAY "Guide"
SET COLOR TO W+/B
@ 5,6 TO 16,71 DOUBLE
SET COLOR TO R+/B
@ 6,34 SAY "MAIN MENU"
SET COLOR TO W+/B
@ 8,8 SAY "(0) Quit application                                          - 0"
@ 9,8 SAY "(1) Yield predictions from ETTE/ha                            - 1"
@ 10,8 SAY "(2) Yield predictions based on gras:leaf proportions          - 2"
@ 11,8 SAY "(3) Predictions of the WUE of grasses and C. mopane leaves - 3"
@ 12,8 SAY "(4) Predictions of seasonal leaf carriage from ETTE/ha       - 4"
@ 14,34 SAY "Option:"
@ 15,21 SAY "(Press ENTER for general information)"
G1=SPACE(1)
@ 14,42 GET G1
READ
DO CASE
 CASE G1="0"
 CLOSE DATA
```

```
SET STATUS ON
CLEAR
RETURN
CASE G1=" "
ACTIVATE WINDOW MAIN3
TEXT
For a complete description on the functioning of the THINGUIDE-model,
 consult Chapter 11.

                         YIELD PREDICTIONS FROM ETTE/ha
Data input consists of ETTE/ha and the model predicts grass DM yield (for
a below and above average rainfall), leaf DM yield (total, <1.5 m, <2.0 m
<5.0 m), and the grazing capacity (for a below and above average rainfall).

                 YIELD PREDICTIONS BASED ON GRASS:LEAF PROPORTIONS
The model estimates at what tree density (ETTE/ha) a specific grass:leaf
ratio will be achieved (e.g. 80 % grass, 20 % leaves).  This estimates can
be based on a below or above average rainfall.

               PREDICTIONS OF THE WUE OF GRASSES AND C. MOPANE LEAVES
Data input consists of ETTE/ha, as well as the expected total seasonal rain-
fall (mm).   The model predicts the water use efficiency (WUE) of both
grasses and the C. mopane leaves (kg/ha/mm).

                PREDICTIONS OF SEASONAL LEAF CARRIAGE FROM ETTE/ha
Data input consists of ETTE/ha and the model predicts the expected leaf
carriage of the C. mopane trees as a % of peak biomass on a monthly basis.
ENDTEXT
READ
DEACTIVATE WINDOW MAIN3
CASE G1="1".OR.G1="2"
DO WHILE .T.
@ 18,0 CLEAR TO 24,79
@ 18,0 TO 24,79
IF G1="1"
@ 19,17 SAY "THINGUIDE: YIELD PREDICTIONS FROM ETTE-VALUES"
ET=SPACE(7)
@ 21,13 SAY "ETTE/ha:              (Press 'Q' to return to previous menu)"
@ 21,22 GET ET
READ
ETS=ET
IF UPPER(ET)="Q"
CLEAR
EXIT
ENDIF
ET=VAL(ET)
GR1=6.709-(0.00055*ET)
GR1=EXP(GR1)
GC1=365/((GR1*0.35)/10)
GR2=7.039-(0.00044*ET)
GR2=EXP(GR2)
GC2=365/((GR2*0.35)/10)
LF1=-0.0396449+(0.257799*ET)
LF2=0.533628+(0.0583879*ET)
LF3=(6.24473+(0.0420903*ET))+LF2
LF4=(-4.30853+(0.153369*ET))+LF3
ENDIF
IF G1="2"
@ 19,18 SAY "THINGUIDE: PREDICTIONS BASED ON PROPORTIONS"
PR1=SPACE(2)
PR2=SPACE(1)
@ 21,2 SAY "% Grasses:    (% Leaves = 100-input) (Press 'Q' to return to previous menu)"
@ 21,13 GET PR1
READ
IF UPPER(PR1)="Q"
CLEAR
EXIT
ENDIF
@ 23,17 SAY "Based on (B)elow or (A)bove average rainfall:"
@ 23,63 GET PR2
READ
@ 23,16 CLEAR TO 23,76
SET COLOR TO GR+*/B
@ 23,21 SAY "Executing estimation, please wait ....."
SET COLOR TO W+/B
PR1=VAL(PR1)
PR3=100-PR1
PR1=PR1/100
PR3=PR3/100
ET=0
```

```
DO WHILE .T.
ET=ET+1
GR1=6.709-(0.00055*ET)
GR1=EXP(GR1)
GC1=365/((GR1*0.35)/10)
GR2=7.039-(0.00044*ET)
GR2=EXP(GR2)
GC2=365/((GR2*0.35)/10)
LF1=-0.0396449+(0.257799*ET)
LF2=0.533628+(0.0583879*ET)
LF3=(6.24473+(0.0420903*ET))+LF2
LF4=(-4.30853+(0.153369*ET))+LF3
DO CASE
 CASE UPPER(PR2)="A"
 IF GR2*PR3>(LF1*PR1)-6.AND.GR2*PR3<(LF1*PR1)+6
 EXIT
 ENDIF
 CASE UPPER(PR2)="B"
 IF GR1*PR3>(LF1*PR1)-6.AND.GR1*PR3<(LF1*PR1)+6
 EXIT
 ENDIF
ENDCASE
ENDDO
ENDIF
CLEAR
SET DISPLAY TO VGA43
@ 1,47 TO 3,78 DOUBLE
SET COLOR TO R+*/B
DO CASE
CASE G1="1"
@ 2,49 SAY "Prediction for:"
ETS=RTRIM(ETS)+" ETTE/ha"
@ 2,65 SAY ETS
CASE G1="2"
@ 2,50 SAY "Estimated on:"
ETS=STR(ET,4,0)+" ETTE/ha"
@ 2,64 SAY ETS
ENDCASE
SET COLOR TO W+/B
@ 2,1 SAY "Grass DM     Leaf DM     Grazing Capacity"
SET COLOR TO G+/B
@ 2,10 SAY "█"
SET COLOR TO GR+/B
@ 2,22 SAY "█"
SET COLOR TO R+/B
@ 2,43 SAY "█"
SET COLOR TO W+/B
@ 4,58 TO 42,58 DOUBLE
@ 4,0 TO 42,79 DOUBLE
@ 7,1 TO 7,78 DOUBLE
@ 5,21 SAY "DM YIELD (kg/ha)"
@ 5,61 SAY "GRAZ CAP (ha/AU)"
@ 6,4 SAY "Rain(-)  Rain(+)  Total    < 1.5    < 2.0    < 5.0       Rain(-)  Rain(+)"
DO CASE
 CASE GR2>=LF1
 SC=GR2
 CASE LF1>GR2
 SC=LF1
ENDCASE
SCL1=32/SC
GR1S=GR1*SCL1
GR2S=GR2*SCL1
LF1S=LF1*SCL1
LF2S=LF2*SCL1
LF3S=LF3*SCL1
LF4S=LF4*SCL1
SCL2=32/GC1
GC1S=GC1*SCL2
GC2S=GC2*SCL2
GR1=STR(GR1,6,1)
GR2=STR(GR2,6,1)
LF1=STR(LF1,6,1)
LF2=STR(LF2,6,1)
LF3=STR(LF3,6,1)
LF4=STR(LF4,6,1)
GC1=STR(GC1,5,1)
GC2=STR(GC2,5,1)
S1="0615243342516472"
S2=1
S3=0
```

```
W1="GR1GR2LF1LF2LF3LF4GC1GC2"
W2=1
V1="GR1SGR2SLF1SLF2SLF3SLF4SGC1SGC2S"
V2=1
DO WHILE S3<8
S4=SUBSTR(S1,S2,2)
W3=SUBSTR(W1,W2,3)
V3=SUBSTR(V1,V2,4)
S5=0
S6=40
@ 41,VAL(S4)-2 SAY &W3
DO CASE
 CASE S3<2
 SET COLOR TO G+/B
 IF G1="2".AND.S3=0.AND.UPPER(PR2)="B"
 SYM="█"
 ELSE
 SYM="▓'"
 ENDIF
 IF G1="2".AND.S3=1.AND.UPPER(PR2)="A"
 SYM="█"
 ENDIF
 CASE S3>1.AND.S3<6
 SET COLOR TO GR+/B
 IF G1="2".AND.S3=2
 SYM="█"
 ELSE
 SYM="█'"
 ENDIF
 CASE S3>5
 SET COLOR TO R+/B
 SYM="█'"
ENDCASE
DO WHILE S5<32
S6=S6-1
@ S6,VAL(S4) SAY "|"
S5=S5+1
ENDDO
S6=40
S5=0
DO WHILE S5<&V3
S6=S6-1
@ S6,VAL(S4)-1 SAY SYM
S5=S5+1
ENDDO
SET COLOR TO W+/B
S3=S3+1
S2=S2+2
W2=W2+3
V2=V2+4
ENDDO
READ
SET DISPLAY TO VGA25
ENDDO
CASE G1="3"
@ 17,0 CLEAR TO 24,79
DO WHILE .T.
@ 17,0 CLEAR TO 24,79
@ 17,0 TO 23,79
@ 18,7 SAY "THINGUIDE: WATER USE EFFICIENCY OF GRASSES AND C. MOPANE LEAVES"
ET=SPACE(5)
@ 20,12 SAY "ETTE/ha:"
@ 20,21 GET ET
@ 22,24 SAY "(Press 'Q' to return to previous menu)"
READ
IF UPPER(ET)="Q"
@ 16,0 CLEAR TO 24,79
EXIT
ENDIF
RAI=SPACE(3)
@ 22,1 CLEAR TO 22,78
@ 22,12 SAY "Rainfall:              (Total seasonal rainfall in mm)"
@ 22,22 GET RAI
READ
ETS=ET
ET=VAL(ET)
ERAI=RAI
RAI=VAL(RAI)
WUE1=3.2928-(0.000506*ET)-(0.001605*RAI)
IF WUE1<0
```

```
WUE1=0
ENDIF
WUE2=2.35038+(0.000901*ET)-(0.00719*RAI)
IF WUE2<0
WUE2=0
ENDIF
WUE3=WUE1+WUE2
CLEAR
SET DISPLAY TO VGA43
@ 1,5 TO 3,73 DOUBLE
SET COLOR TO R+*/B
@ 2,7 SAY "Prediction for:"
ETS=RTRIM(ETS)+" ETTE/ha AND "
ERAI=RTRIM(ERAI)+" mm rainfall (total seasonal)"
@ 2,23 SAY ETS
@ 2,40 SAY ERAI
SET COLOR TO W+/B
@ 16,2 TO 24,31
@ 18,6 SAY "WUE - grasses (kg/ha/mm)"
@ 20,6 SAY "WUE - leaves (kg/ha/mm)"
@ 22,6 SAY "WUE - total (kg/ha/mm)"
SET COLOR TO G+/B
@ 18,4 SAY "█"
SET COLOR TO GR+/B
@ 20,4 SAY "█"
SET COLOR TO R+/B
@ 22,4 SAY "█"
SET COLOR TO W+/B
@ 4,0 TO 42,79 DOUBLE
IF WUE3>7
SCL=34/10
AX="10.0"
ELSE
SCL=34/7
AX=" 7.0"
ENDIF
WU1S=WUE1*SCL
WU2S=WUE2*SCL
WU3S=WUE3*SCL
WUE1=STR(WUE1,6,1)
WUE2=STR(WUE2,6,1)
WUE3=STR(WUE3,6,1)
S1="405570"
S2=1
S3=0
W1="WUE1WUE2WUE3"
W2=1
V1="WU1SWU2SWU3S"
V2=1
DO WHILE S3<3
S4=SUBSTR(S1,S2,2)
W3=SUBSTR(W1,W2,4)
V3=SUBSTR(V1,V2,4)
S5=0
S6=40
@ 41,VAL(S4)-4 SAY &W3
 SYM="███"
DO CASE
 CASE S3=0
 SET COLOR TO G+/B
 @ 6,39 SAY "┐"
 @ 6,34 SAY AX
 CASE S3=1
 SET COLOR TO GR+/B
 @ 6,54 SAY "┐"
 @ 6,48 SAY AX
 CASE S3=2
 SET COLOR TO R+/B
 @ 6,69 SAY "┐"
 @ 6,64 SAY AX
ENDCASE
DO WHILE S5<33
S6=S6-1
@ S6,VAL(S4) SAY "|"
S5=S5+1
ENDDO
S6=40
S5=0
DO WHILE S5<&V3
S6=S6-1
```

```
@ S6,VAL(S4)-1 SAY SYM
S5=S5+1
ENDDO
SET COLOR TO W+/B
S3=S3+1
S2=S2+2
W2=W2+4
V2=V2+4
ENDDO
READ
SET DISPLAY TO VGA25
ENDDO
CASE G1="4"
DO WHILE .T.
@ 18,0 CLEAR TO 24,79
@ 18,0 TO 24,79
@ 19,14 SAY "THINGUIDE: SEASONAL LEAF CARRIAGE FROM ETTE-VALUES"
ET=SPACE(7)
@ 21,13 SAY "ETTE/ha:              (Press 'Q' to return to previous menu)"
@ 21,22 GET ET
READ
ETS=ET
IF UPPER(ET)="Q"
CLEAR
EXIT
ENDIF
ET=VAL(ET)
JUL=4.60989-(0.0000388326*ET)
JUL=EXP(JUL)
AUG=4.55438-(0.0000322059*ET)
AUG=EXP(AUG)
SEP=4.52149-(0.0000974901*ET)
SEP=EXP(SEP)
OCT=3.38501-(0.000255063*ET)
OCT=EXP(OCT)
NOV=3.32549-(0.00075763*ET)
NOV=EXP(NOV)
DEC=4.62408-(0.0000238521*ET)
DEC=EXP(DEC)
IF DEC>100
DEC=100
ENDIF
JAN=100
FEB=100
MRT=100
APR=100
MAY=100
JUN=100
SCL=32/100
JULS=JUL*SCL
AUGS=AUG*SCL
SEPS=SEP*SCL
OCTS=OCT*SCL
NOVS=NOV*SCL
DECS=DEC*SCL
JANS=JAN*SCL
FEBS=FEB*SCL
MRTS=MRT*SCL
APRS=APR*SCL
MAYS=MAY*SCL
JUNS=JUN*SCL
JUL=STR(JUL,3,0)
AUG=STR(AUG,3,0)
SEP=STR(SEP,3,0)
OCT=STR(OCT,3,0)
NOV=STR(NOV,3,0)
DEC=STR(DEC,3,0)
JAN=STR(JAN,3,0)
FEB=STR(FEB,3,0)
MRT=STR(MRT,3,0)
APR=STR(APR,3,0)
MAY=STR(MAY,3,0)
JUN=STR(JUN,3,0)
CLEAR
SET DISPLAY TO VGA43
@ 1,27 TO 3,58 DOUBLE
SET COLOR TO R+*/B
@ 2,29 SAY "Prediction for:"
ETS=RTRIM(ETS)+" ETTE/ha"
@ 2,45 SAY ETS
```

```
SET COLOR TO W+/B
@ 4,0 TO 42,79 DOUBLE
@ 6,1 TO 6,78 DOUBLE
@ 5,4 SAY "%    JUL    AUG    SEP    OCT    NOV    DEC    JAN    FEB    MAR    APR    MAY    JUN"
@ 0,0 CLEAR TO 42,0
S5=0
S6=40
SET COLOR TO W+/B
DO WHILE S5<32
S6=S6-1
@ S6,5 SAY "║"
DO CASE
 CASE S5=0
 @ S6,4 SAY "╜"
 @ S6,0 SAY "  0"
 CASE S5=8
 @ S6,4 SAY "╢"
 @ S6,0 SAY " 25"
 CASE S5=16
 @ S6,4 SAY "╢"
 @ S6,0 SAY " 50"
 CASE S5=24
 @ S6,4 SAY "╢"
 @ S6,0 SAY " 75"
 CASE S5=31
 @ S6,4 SAY "╖"
 @ S6,0 SAY "100"
ENDCASE
S5=S5+1
ENDDO
S1="091521273339455157636975"
S2=1
S3=0
W1="JULAUGSEPOCTNOVDECJANFEBMRTAPRMAYJUN"
W2=1
V1="JULSAUGSSEPSOCTSNOVSDECSJANSFEBSMRTSAPRSMAYSJUNS"
V2=1
DO WHILE S3<12
S4=SUBSTR(S1,S2,2)
W3=SUBSTR(W1,W2,3)
V3=SUBSTR(V1,V2,4)
S5=0
S6=40
@ 41,VAL(S4)-1 SAY &W3
SYM="███"
SET COLOR TO G+/B
DO WHILE S5<32
S6=S6-1
@ S6,VAL(S4) SAY "|"
S5=S5+1
ENDDO
S6=40
S5=0
DO WHILE S5<&V3-0.5
S6=S6-1
@ S6,VAL(S4)-1 SAY SYM
S5=S5+1
ENDDO
SET COLOR TO W+/B
S3=S3+1
S2=S2+2
W2=W2+3
V2=V2+4
ENDDO
READ
SET DISPLAY TO VGA25
ENDDO
ENDCASE
ENDDO
```