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24510 DIMENSIONS OF STEM AND LEAF FIBERS ^{1/} _{Δ/Δ}

~~4~~ Robert E. Perdue, Jr. ^{2/}

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1/ Supplementary table for: Fiber Dimensions of Nonwoody Plant
Materials, by R. E. Perdue, Jr. and H. J. Nieschlag,
Tappi 44(11): 776-784 (1961).

2/ Crops Research Division, Agricultural Research Service,
U. S. Department of Agriculture, Beltsville, Maryland.

DIMENSIONS OF STEM AND LEAF FIBERS

Robert E. Perdue, Jr.

This compilation of data from the literature provided a basis for the report: Fiber Dimensions of Nonwoody Plant Materials, by R. E. Perdue, Jr. and H. J. Nieschlag, published in Tappi, volume 44, number 11, November 1961.

The accompanying tabulation, with certain exceptions, lists all available data on the dimensions of the ultimate fibers of nonwoody plant materials. Species for which only measurements of fiber diameter are available were excluded. The table does not include data for seed fiber such as Gossypium (cotton) or Asclepias (milkweed) or for woody plants except for those referring to the bast fibers of such species. Data on bast fibers of woody plants were included primarily to provide additional information for families which are poorly represented by data on the bast of nonwoody species. While bamboos are "woody" in the sense of the hardness of their tissues, they are structurally similar to the more typical grasses as are such other "woody" grasses as Arundo donax L. and Phragmites communis Trin.

The table shows, from left to right, the name of the plant species, a symbol designating the type of material examined, minimum, maximum, and average fiber lengths, minimum, maximum, and average fiber diameters, length: diameter ratio (L/D), appropriate remarks, and source of data.

The species are divided into the two primary groups: monocotyledons and dicotyledons. Within these two groups the plants are arranged alphabetically according to family, genus, and species, with the exception of the grasses in which the genera are arranged by tribes.

The names used in the table are those employed in the most recent floras covering the areas to which the plants are native. In cases in which the name given in a reference is a synonym, it follows the correct name parenthetically in the table. In most instances the original reference does not give the authority for the name used and it is frequently impossible to determine the correct name in cases in which several species have been described under the name used in the original reference.

The type of material from which the data for each sample were obtained is indicated in the second column, headed "Material Tested", by the following symbols:

Stem fibers

- SBA bast-fiber samples extracted from annual or perennial herbs ("soft fibers")
- SBB bast-fiber samples extracted from woody stems
- SC the "woody core" of herbaceous stems (material remaining after removal of the bast)
- SWA whole stems of nonwoody plants, both dicotyledons and monocotyledons (grass samples in many cases probably included more or less leaf material)
- SWB whole stems of bamboos

Leaf fibers

- LF samples of fiber extracted from leaves ("hard-fiber" - the structural elements of leaves)
- LP petioles of leaves, primarily from species of palms
- LW whole leaves

Minimum, maximum, and average fiber lengths are here rounded off to the first decimal place even though in the literature they were frequently given in hundredths or thousandths of a millimeter. Minimum, maximum, and average fiber diameters are given in thousandths of a millimeter.

The length: diameter ratios were calculated from the averages given in the table except where the source gave no average but did cite a length: diameter ratio or where the dimensions given here represent a series of analyses of a single species. In the latter case the length: diameter ratio is indicated as a range.

The numbers indicating the source of the data refer to items in the bibliography.

For the well-known plant sources of fiber such as flax (Linum usitatissimum L.), true hemp (Cannabis sativa L.), kenaf (Hibiscus cannabinus L.), etc., a large number of fiber analyses are available in the literature. Some are based on independent work, others are repetitions of analyses previously published. Some of the latter are erroneous as a result of typographical or other errors. In preparing the compilation, the following system was used: If all of the available analyses were essentially uniform, only a single representative analysis was incorporated in the table. Where considerable variation was involved, representative analyses were used to indicate minimum recorded average length, maximum recorded average length and, where practicable, a mean recorded average length. To cite every recorded analysis would greatly increase the length of the table without any real increase in its value; 20 or 30 analyses could be included for some plants.

DIMENSIONS OF STEM AND LEAF FIBERS

Species	Material Tested	Fiber Dimensions					L/D	Remarks	Ref.
		Length (mm.)		av.	Diameter (mm.)				
		min.	max.			min.	max.	av.	
Amaryllidaceae									
Agave americana (A. karatto)	LF	1.5	4	2.5	0.020	0.032	0.024	104	164
A. cantala	LF	1.3	3.8	2.4	0.010	0.017	0.014	171	9
	LF	1.7	5.7	3.0	0.015	0.025	0.018	167	9
A. fourcroydes (A. rigida)	LF	1.3	2.2	1.9	0.014	0.021	0.018	106	9
	LF	1.2	4.0	2.7	0.012	0.022	0.017	159	9
A. lurida (A. mexicana)	LF	1.5	2						76
A. rumphii	LF	1.5	2.5						76
A. sisalana	LF	1.2	4.7	2.7	0.013	0.021	0.017	159	9
A. tequilana (A. azul)	LF	1.8	2.2						98
A. zapupe	LF	1.5	2.5	1.9	0.014	0.016	0.015	127	9
	LF	1.5	3.8	2.5	0.011	0.022	0.016	156	9
Furcraea gigantea	LF	1.4	4.3	2.9	0.017	0.031	0.025	116	9
	LF	2.4	4.3	3.2	0.034	0.054	0.041	78	9
F. hexapetala (F. cubensis)	LF	1.5	4						76
F. selloa var. marginata (F. lindeni)	LF	2.3	4.2						98
Araceae									
Montrichardia aculeata (Caladium aculeatum)	SWA	2	2.3	2.1	0.023	0.030	0.025	84	57
M. arborescens	SWA			2.0 = 2.4	0.020	0.030			165

Scirpus californicus	SWA	0.4	1.5	0.9	0.006	0.013	0.009	100	49
S. grossus	SWA	0.6	1.5	1.1			0.013	85	66
S. lacustris	SWA	0.5	1.3		0.006	0.012			130
<u>Gramineae: Bambuseae</u>									
Arundinaria alpina	SWB	1.6	2.7	2.3			0.023	100	4
Bambusa arundinaceae (Dendrocalamus arundinacea)	SWB	0.7	4.1	2.7	0.016	0.055	0.030	90	103
	SWB	0.6	3.8	2.4	0.008	0.034	0.024	100	132
B. hofii	SWB	0.8	5.1	2.2	0.006	0.031	0.015	147	113
B. longispiculata	SWB	0.3	4.1	1.4	0.002	0.021	0.009	156	70
B. multiplex (B. nana)	SWB	0.3	4.5	1.6	0.003	0.021	0.008	200	70
B. oldhami	SWB	0.5	3.3	1.6					156
B. oldhami (Sinocalamus oldhami)	SWB	0.5	3.7	1.9					156
B. polymorpha	SWB	1.0	1.9	1.5	0.009	0.014	0.012	125	153
B. spinosa (B. blumeana, B. lumampao)	SWB	0.6	2.9	2.5	0.009	0.036	0.027	93	132
B. stenostachya (B. stenostachia)	SWB	1.0	5.8	3.2			0.008	225	16
B. tulda	SWB	0.8	3.3	1.8					135
	SWB	1.2	4.1	2.6	0.005	0.028	0.016	163	163
	SWB	1.1	1.8	1.5	0.008	0.016	0.012	125	136
	SWB	0.3	4.7	1.9	0.008	0.014	0.011	173	70
	SWB	0.3	3.7	1.3	0.003	0.027	0.009	144	70
	SWB	0.7	4.0	2.6	0.009	0.036	0.027	96	132
	SWB	1.0	5.0	3.0					16
B. tuldoidea	SWB	0.4	4.4	1.7	0.004	0.031	0.010	170	70
	SWB	0.4	4.7	1.7	0.003	0.017	0.009	189	70
B. vulgaris	SWB	0.3	6.8	2.2	0.003	0.033	0.009	244	70
	SWB	0.9	6.5	3.8	0.007	0.050	0.018	211	113
B. vulgaris var. "stricta" (var. striata?)	SWB	1.0	5.4	2.7	0.006	0.027	0.015	180	114

base of culm
upper section of culm
immature stems
mature stems

base of culm
upper section of culm
base of culm
upper section of culm

Cephalostachyum pergracile	SWB	0.6	3.9	2.3	0.007	0.027	0.020	115	132
Dendrocalamus aspera	SWB			3.8			0.019	200	154
(Gigantochloa aspera)									
D. hamiltoni	SWB	1.5	6.8	3.4					16
D. latiflorus	SWB	1.1	1.7	1.4	0.010	0.013	0.012	117	153
(Sinocalamus latiflorus)									
D. longispethus	SWB	0.9	4.8	2.5	0.006	0.030	0.016	156	114
	SWB	1.0	5.5	3.5					16
D. merrillianus	SWB			2.2			0.014	157	154
	SWB	0.6	4.2	2.4	0.006	0.035	0.020	120	37
D. strictus	SWB	1.2	6.1	3.3	0.009	0.036	0.018	183	114
	SWB	0.8	5.4	2.2	0.009	0.032	0.015	147	114
Gigantochloa apus	SWB	1.6	4.6	2.7	0.008	0.024	0.014	193	75
	SWB	0.9	5.5	3	0.008	0.050	0.026	115	113
G. aspera	SWB	0.9	5.7	3.1	0.009	0.030	0.017	182	114
G. atter	SWB	0.8	6.2	3.2	0.008	0.029	0.014	228	114
G. verticillata	SWB	1.4	3.6	2.4					105
G. wrayi	SWB	0.4	4.0	1.6	0.006	0.027	0.013	123	70
Guadua angustifolia	SWB	0.3	4.0	1.6	0.007	0.015	0.010	160	70
	SWB	1.0	4.8	2.7					16
Melocanna baccifera	SWB	0.8	2.9	2.2	0.007	0.022	0.018	122	132
(M. bambusoides)	SWB	1.1	4.8	2.3	0.008	0.037	0.018	128	147
Oxytenanthera abyssinica	SWB	1.0	6.0	3.6					105
O. nigroclliata	SWB	1.0	4.2	2.3					105
Ochlandra ridleyi	SWB	0.9	5.5	2.5					114
O. travancorica	SWB	1.0	9.0	4.0	0.004	0.032	0.017	147	16
	SWB	0.3	3.8	1.4					70
Phyllostachys arcana	SWB	0.2	4.3	1.6	0.003	0.030	0.011	145	70
	SWB	0.3	2.7	1.2	0.004	0.021	0.008	150	70
P. aurea	SWB	0.5	4.4	1.7	0.004	0.023	0.010	170	70
	SWB	0.4	4.4	1.8	0.004	0.027	0.013	138	70
	SWB	0.5	2.9	1.3	0.004	0.015	0.009	144	70
	SWB	0.2	4.6	0.8	0.003	0.030	0.008	72	70
P. aureosulcata				1.8			0.017	173	
P. bambusoides	SWB	0.2	1.3	0.6	0.010	0.035	0.021	29	70
	SWB	1.3	1.8	1.6	0.012	0.014	0.013	123	153
							nodal partition		

<i>P. congesta</i>	SWB	0.3	4.4	2.0	0.005	0.024	0.012	167	base of culm, 2 samples	70
<i>P. dulcis</i>	SWB	0.3	3.8	1.0	0.004	0.024	0.009	111		70
	SWB	0.3	3.5	1.5			0.010	150	upper section of culm, 2 samples	70
	SWB	0.3		1.0	0.003	0.024	0.009	111		
	SWB			1.4			0.010	140		
<i>P. flexuosa</i>	SWB	0.4	3.9	1.6	0.003	0.020	0.010	160		70
<i>P. lithophila</i>	SWB	1.1	1.8	1.4	0.014	0.016	0.015	93		153
<i>P. maki noi</i>	SWB	0.7	4.0	2.5	0.007	0.029	0.015	167		153
<i>P. meyeri</i>	SWB	0.3	3.7	1.3	0.003	0.027	0.010	130	base of culm	70
	SWB	0.4	4.5	2.0	0.003	0.027	0.009	222	upper section of culm	70
	SWB	0.3	2.9	1.3	0.004	0.016	0.009	144	base of culm	70
<i>P. nidularia</i>	SWB	0.5	4.4	1.6	0.003	0.018	0.009	178	upper section of culm	70
	SWB	0.3	3.4	1.3	0.003	0.017	0.009	144	base of culm	70
<i>P. nigra</i> cv. <i>henon</i>	SWB	0.4	4.4	1.6	0.004	0.015	0.009	167	upper section of culm	70
	SWB	1.5	1.9	1.7	0.016	0.016	0.016	106		153
	SWB	0.2	4.4	1.2	0.003	0.024	0.009	119	base of culm, range of 3 samples	70
<i>P. pubescens</i> (<i>P. edulis</i>)	SWB	0.2	4.4	1.3	0.003	0.024	0.010	160		70
	SWB			1.4			0.008	133	upper section of culm, range of 3 samples	153
	SWB	1.3	1.8	1.6	0.012	0.014	0.013	123		70
<i>P. purpurata</i>	SWB	0.2	5.1	1.1	0.002	0.025	0.008	133	range of 8 samples	
	SWB			2.0			0.012	185		
<i>P. rubromarginata</i>	SWB	0.3	5.2	1.8	0.003	0.016	0.009	200	base of culm	70
	SWB	0.4	3.6	1.7	0.003	0.023	0.010	170	upper section of culm	70
<i>P. viridis</i>	SWB	0.4	4.4	1.9	0.005	0.021	0.012	158	base of culm	70
	SWB	0.5	4.7	1.9	0.004	0.024	0.012	158	middle section of culm	70
	SWB	0.3	2.6	1.1	0.005	0.015	0.009	122	upper section of culm	70
<i>P. vivax</i>	SWB	0.3	4.7	1.6	0.004	0.023	0.011	145	base of culm	70
	SWB	0.3	3.5	1.4	0.006	0.015	0.010	140	middle section of culm	70
	SWB	0.2	2.0	1.0	0.008	0.012	0.009	111	upper section of culm	70
<i>Pseudosasa japonica</i> (<i>Sasa japonica</i>)	SWB	0.7	4.0	2.1	0.006	1.028	0.016	131		114
<i>Sasa kurilensis</i>	SWB	0.8	6.0	2.9	0.010	0.033	0.017	171		114
	SWB	0.3	3.5	1.3	0.004	0.034	0.014	93		44
<i>Schizostachyum lumampao</i> (<i>Bambusa lumampao</i>)	SWB	1.2	4.1	2.6	0.005	0.028	0.016	163		135
<i>Teinostachyum dulloa</i> (<i>Neohouzeaua dulloa</i>)	SWB	1.0	6.0	3.6						16

Gramineae: Andropogoneae

Andropogon auctus	SWA	0.3	3.9	1.0-2.0						101
A. dregeanus	SWA	0.3	3.8	1.0-2.0						101
A. semiberbis (A. hirtiflorus var. semiberbis)	SWA	0.4	1.2	0.6-0.7						101
Cymbopogon nardus var. validus	SWA	0.3	4.7	2.1						97
Dichanthium annulatum (Andropogon comosus)	SWA			1.2						75
Hyparrhenia buchananii (Andropogon buchananii)	SWA	1.0	4.0	1.5-2.5						101
H. filipendula	SWA	0.5	4.2	2.1						110
H. glauca	SWA			1.5						39
H. hirta (Cymbopogon hirtus or C. validus)	SWA	0.3	4.9	2.0-3.0						102
H. rufa (Andropogon rufus)	SWA	2.0	3.5							75
H. ruprechtii (Cymbopogon ruprechtii)	SWA	0.4	3.5	0.8-2.0						102
Imperata cylindrica (I. arundinacea)	SWA	0.5	1.9	0.8						133
I. exaltata	SWA	1	3.5	1.8						48
Ischaemum angustifolium	SWA	0.6	3.2	1.3						66
Miscanthus (sinensis or japonicus)	SWA	0.5	1.8	1						135
Saccharum aegyptiacum	SWA	1	4	2						50
S. arundinaceum (S. procerum)	SWA									148
S. munja	SWA	0.6	4.5	0.009						
S. narenga	SWA	0.8	4.5	0.007						
S. officinarum	SWA	0.5	5.5	0.012						
	SWA	0.7	3.8	0.008						
	SWA	0.5	6.5	0.013						
	SWA	0.6	2.6	0.006						
	SWA	0.8	2.8	0.012						
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	SWA	0.5	3.8	0.010						
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	SWA	0.8	2.8	0.010						
	SWA	0.5	3.8	0.010						
	SWA	0.6	2.8	0.010						
	SWA	0.8	2.8	0.010						
	SWA	0.5	3.8	0.010						
	SWA	0.6	2.8	0.010						
	SWA	0.8	2.8	0.010						
	SWA	0.5	3.8	0.010						
	SWA	0.6	2.8	0.010						
	SWA	0.8	2.8	0.010						
	SWA	0.5	3.8	0.010						
	SWA	0.6	2.8	0.010						
	SWA	0.8	2.8	0.010						
	SWA	0.5	3.8	0.010						
	SWA	0.6	2.8	0.010						
	SWA	0.8	2.8	0.010						
	SWA	0.5	3.8	0.010						
	SWA	0.6	2.8	0.010						
	SWA	0.8	2.8	0.010						
	SWA	0.5	3.8	0.010						
	SWA	0.6	2.8	0.010						
	SWA	0.8	2.8	0.010						
	SWA	0.5	3.8	0.010						
	SWA	0.6	2.8	0.010						
	SWA	0.8	2.8	0.010						
	SWA	0.5	3.8	0.010						
	SWA	0.6	2.8	0.010						
	SWA	0.8	2.8	0.010						
	SWA	0.5	3.8	0.010						
	SWA	0.6	2.8	0.010						
	SWA	0.8	2.8	0.010						
	SWA	0.5	3.8	0.010						
	SWA	0.6	2.8	0.010						
	SWA	0.8	2.8	0.010						
	SWA	0.5	3.8	0.010						
	SWA	0.6	2.8	0.010						
	SWA	0.8	2.8	0.010						
	SWA	0.5	3.8	0.010						
	SWA	0.6	2.8	0.010						
	SWA	0.8	2.8	0.010						
	SWA	0.5	3.8							

S. spontaneum	SWA	0.7	3.1	2.0	0.012	0.025	0.016	125	133
	SWA		3.2	1.5	0.008			67	67
Sorghum halepense	SWA	0.5	1.7	0.7-		0.025	0.015	100	101
				1.1					
S. vulgare	SWA	1	5	2	0.010	0.040	0.018	111	167
	SWA	3	6		0.010	0.015		200	58
	SWA			5	0.030	0.035		143	58
	SWA	0.4	6	2.0-	0.006	0.030	0.012	188	121
				2.5					
	SWA	0.3	3	1.3-	0.006	0.030	0.015	93	121
				1.5					
	SWA	0.1	3.3	0.9					117
	SWA	0.2	3.8	1.0	0.003	0.043	0.013	77	33
	SWA	1	5	2.0-					157
S. vulgare var. saccharatum				2.5					
Themeda arundinacea	SWA	0.6	6.8	2.9	0.010	0.035	0.016	181	21
T. cymbaria	SWA	0.5	2.5	1.1	0.009	0.020	0.014	79	17
T. forskalii var. mollissima	SWA	0.8	3.8	1.5-					102
				2.0					
T. gigantea	SWA	0.7	4.7	2.9	0.014	0.035	0.022	132	133
(Anthistiria gigantea ssp. arundinacea)									
Trachypogon plumosus	SWA	0.4	2.9	1.0-					102
(T. polymorphus)				2.0					
Vetiveria zizanioides	SWA	0.4	3.5	1.2	0.004	0.028	0.009	133	22
(Andropogon muricatus, A. squarrosus)	LW	1.5	2		0.010	0.015		150	48
	SWA	1.5	2.0	1.8	0.010	0.015	0.012	150	155
Vossia procera	SWA	0.5	5.6	1.6	0.005	0.025	0.013	123	45
(V. cuspidata)	SWA			1.3			0.009	144	32
<u>Gramineae: Agrostideae</u>									
Ammophila arenaria	SWA			0.7					3
Aristida burkei	SWA	0.1	2.5	0.9					91
Muhlenbergia macroura	SWA	0.5	3.0	1.7	0.005	0.013	0.009	189	27
(Epicampes macroura)									
Sporobolus pyramidalis	SWA	0.5	4	2	0.005	0.012	0.005-	364	60
							0.006		
Stipa tenacissima	LW	0.5	3.5	1.5	0.007	0.018	0.012	125	164
	LW	0.6	1.6	1.1	0.007	0.014	0.009	122	170

fine fibers
coarse fibers

Gramineae: Oryzeae

Lygeum spartum
Oryza sativa

SWA
SWA

1.370

SWA	1.3	4.5	2.5	0.012	0.020	0.015	167
SWA	0.7	3.5	1.5	0.005	0.014	0.009	167
SWA			0.9				300

Grammi neae : Pani ceae

Panicum obscurans

SWA	0.3	2.3	0.9-
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102

Pennisetum purpureum
Setaria italica

SWA	1.3	3.6	2.0
SWA	0.2	2.4	

94
128

0.006 0.035

128

SWA

Gramineae: Phalarideae

Phalaris arundinacea

SWA	0.7	3.3	2.0	0.005	0.033	0.014	143
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110

Gramineae: Tripsaceae

Zea mays

SWA	0.5	1.5	0.024	0.018	83
SWA	0.1	0.7	0.014		
	2.9				
	1.9				

170
117

SWA	0.1	1.9	0.7
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227

Iridaceae

Moraea tricuspis

LF 0.4 1.6 0.7

77

Juncaceae

Prionium palmita

SVA	0.5	2.0	1.0	0.005	0.020	0.012	167
SVA	1.0	3.2	2.0	0.020	0.012	167	

118
107

SWA 1.0

LOT

Liliaceae

Aloe vera

LF	1.3	3.7	0.015	0.024
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172

(*A. perfoliata*)

A. zebri na

LF	0.8	3.6	1.8
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96

(A. lugardiana)

<i>Cordyline australis</i>	LF	0.8	8.1	3.3					93
<i>C. australis</i> var. <i>veitchii</i>	LF	1.5	2.5						76
<i>C. banksii</i>	LF	1.6	2.4						76
<i>C. baueri</i>	LF	1.3	1.5						76
<i>C. cookii</i>	LF	1.3	7.1						76
<i>C. stricta</i>	LF			2					76
<i>Dracaena draco</i>	LF	0.4	2.6	1.4					77
<i>Kniphofia aurea</i>	LF	1.5	2.4						76
<i>K. recurvata</i>	LF			1.8					76
<i>K. rooperi</i>	LF	1.5	4.6						76
<i>Phormium tenax</i>	LF	3.9	15	9	0.007	0.028	0.016	563	170
<i>Sansevieria cylindrica</i>	LF	3	6.5	4.7					79
<i>S. ehrenbergii</i>	LF	1.3	5.1		0.025	0.040			84
<i>S. guineensis</i>	LF	1.5	5.1		0.020	0.035			84
<i>S. latifolia</i>	LF		8	5				200	164
<i>S. volkensii</i>	LF	0.8	3.1		0.020	0.030			84
<i>S. zeylanica</i>	LF	1.5	6	3	0.015	0.026	0.020	150	164
<i>Scilla rigidiifolia</i>	LW	0.8	1.6	1.0					96
<i>Xanthorrhoea</i> sp.	SWA	2	5	3.4					53
<i>Yucca aloifolia</i>	LF	1.2	5.2	1.3	0.007	0.014			29
<i>Y. filamentosa</i>	LF	0.5	3	1.0-1.3	0.006	0.019	0.008-0.011	121	144
<i>Y. flexilis</i>	LF	1.6	3.6						76
<i>Y. glauca</i>	LF	1.6	4.7		0.011	0.014			29
<i>Y. angustifolia</i> (Y. <i>gloriosa</i>)	LF	0.5	6	3.5-4.0	0.007	0.020	0.010-0.011	357	13
<i>Y. gloriosa</i>	LF			1.5-2.5	0.006	0.022	0.011-0.014	160	144
<i>Y. karlsruhensis</i>	LF	0.5	4.5						

Marantaceae

Maranta arundinacea

SWA

1

0.007

0.015

131

Musaceae

Heliconia sp. LF 3 9 5 0.013 0.028 0.018 278 109
Musa *ensete* LF 0.5 5 2.3- 0.007 0.026 0.018 133 119

M. livingstoniana LF 2.6 5.9 3.8 0.027 133 81
M. malaccensis LF 1.4 6.0 3.6 0.016- 163- 88
M. paradisiaca LF 0.9 5.7 3.9- 0.032 363 24A
(M. sapientum var. *paradisiaca)* LF 6.9 0.027 0.018 0.020 275 135
M. paradisiaca var. *likuensis* LF 4.2 7.3 5.5 0.018 0.026 0.020 275 138
(M. sapientum var. *likuensis)* LF 2.7 6.4 3.0- 0.018 0.031 0.022 205 24A

M. paradisiaca var. *sapientum* LF 2.3 6.3 4.5 0.021 0.017 0.018 235 135
(M. sapientum) LF 2.5 6.0 4.0 0.007 0.040 0.018 333 170
M. textilis LF 2.5 6.0 4.0 0.021 0.017 0.018 235 135
(M. mindanensis) LF 2.5 6.0 4.0 0.021 0.017 0.018 235 135

M. ulugurensis LF 2.5 12.0 6 0.007 0.040 0.018 333 170
M. violascens LF 2.2 4.7 3.1 0.025 176 81
Ravenala *madagascariensis* LF 2.5 6.3 4.4 0.030 0.015- 186 24A
(M. mindanensis) LF 2.5 6.0 4.0 0.030 0.015- 186 24A

M. ulugurensis LF 2.5 12.0 6 0.007 0.040 0.018 333 170
M. violascens LF 2.2 4.7 3.1 0.025 176 81
Ravenala *madagascariensis* LF 2.5 6.3 4.4 0.030 0.015- 186 24A
(M. mindanensis) LF 2.5 6.0 4.0 0.030 0.015- 186 24A

Naiadaceae

Posidonia *australis* SWA 0.8 1.3 3.0 0.020 0.076 0.006 500 77
Zostera *marina* SWA 0.8 1.3 3.0 0.020 0.076 0.006 500 120

Palmae

Acrocomia *sclerocarpa* LF 1 3 2.1 0.020 0.076 0.006 500 76
A. totai LF 1 3 2.1 0.020 0.076 0.006 500 160

Astrocaryum sp.	LF	1.4	2.6	2.0	0.013	0.027	0.018	111	141
Borassus flabellifer	LF	0.5	5.5	4.2	0.030	0.040	0.035	120	55
	LP	3.0	3.6	3.0	0.030	0.040	0.035	86	55
Chamaerops humilis	LF	1.0	3.0	2.0	0.010	0.013		167	165
	LF			1.5			0.010	150	150
Corypha laevis	LW	0.4	1.8	1.4			0.010	140	62
C. umbraculifera	LP	1.1	2.8	2.1	0.010	0.015	0.013	162	135
Elaeis guineensis	LF	1.5	3.5	2.5	0.010	0.013	0.011	227	164
Hyphaene crinita	LW	0.4	5.0	2.1	0.010	0.022	0.015	140	146
H. schatan	LP	0.5	2.0	1.4	0.010	0.020	0.015	93	61
	LW	2.0	2.5	2.3	0.015	0.030			61
H. thebaica	LP	0.5	3.6	2.1	0.013	0.015		150	119
	LW	0.8	2	1.5	0.010	0.025	0.015	100	59
Medemia nobilis	LP	0.8	2.5	1.7	0.010	0.020	0.015	113	61
	LW	0.5	2.3	1.5	0.010	0.020	0.015	100	61
Mauritia flexuosa	LF	1	3	1.5	0.010	0.016	0.012	130	164
Nannorhops ritchieana	LF	1.1	2.5						85
Nipa fruticans	LP	0.7	2.5	1.4					91
	LW	0.3	2.3	0.9					96
Phoenix dactylifera	LP	2	6	3	0.016	0.024	0.020	150	164
Raphia taedigera	LF	1.5	3	2.5	0.012	0.020	0.016	156	164
R. vinifera	LF	1.5	2.5						1
Tri thrinax campestris	LW	0.7	2.5		0.008	0.020		100	46
<u>Pandanaceae</u>									
Pandanus fascicularis	LF	1.0	4.2				0.020		172
(P. odoratissimus)									
<u>Restionaceae</u>									
Ecdeiocloea monostachya	SWA	2.0	5.4						99
<u>Typhaceae</u>									
Typha angustifolia	SWA	0.6	1.7	0.9	0.005	0.012	0.009	100	13
	SWA			1.5			0.025	60	130

lamina only

<i>T. angustifolia</i> var. brownii	LW	0.6	3.0	1.4	0.005	0.018	0.008	175	107
<i>T. domingensis</i>	SWA	1	4.6		0.030	0.055			165
<i>T. latifolia</i>	LW	0.8	4.6	2.1	0.005	0.025	0.011	191	110

Zingiberaceae

<i>Alpina speciosa</i> (A. nutans)	SWA	0.6	6.2	2.6	0.005	0.051	0.016	163	106
<i>Anomum granum-paradisi</i>	SWA	0.5	2.5	1.1					104
<i>A. hemisphaericum</i>	SWA			2.5					2
<i>Costus afer</i>	SWA	0.5	2.8	1.5					104
<i>Hedychium coronarium</i>	SWA			2.6			0.083	31	2

Dicotyledoneae

Annonaceae

<i>Annona reticulata</i>	SBB	1	2						34
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Apocynaceae

<i>Apocynum cannabinum</i>	SBA	18	30		0.008	0.071		570-790	52
<i>Pachypodium rutenbergianum</i>	SBB	30	80	50	0.025	0.060	0.035	1429	68

Asclepiadaceae

<i>Asclepias curassavica</i>	SBA	10.0	30.0	20.5	0.020	0.044			173
<i>A. fruticosa</i>	SBB	17.8	30.5	22.9	0.010	0.025	0.015	1527	77
<i>A. incarnata</i>	SBA	17.8	58.4	30.5	0.012	0.035	0.020	1525	108
	SC			0.5					42
<i>A. semilunata</i>	SBA	20	27					632-	83
<i>A. sullivantii</i>	SBA	15	25		0.008	0.079		1055	52
<i>A. syriaca</i>	SBA						0.012-	833-	
							0.020	1500	136

H. tuberosus	SWA	0.5	1.6	0.8	0.014	0.028	0.020	40	11
Helichrysum sp.	LW	3.4	4.2	3.5					77
Onopordum acanthium	SBA			5.9			0.006	983	142
	SWA	0.1	3.3	0.9					117
Solidago sp.	SBA	0.8	1.3	1.0	0.007	0.017	0.012	83	7
	SC	0.2	0.6	0.4	0.007	0.020	0.014	29	7
	SWA	0.1	1.7	0.5					117
<u>Cruciferae</u>									
Brassica napus var. oleifera	SWA	1.0	3.4		0.016	0.022		64-155	125
Camelina sativa	SWA			0.3			0.011	27	125
<u>Euphorbiaceae</u>									
Manniophyton africanum	SBB	9.2	20.0	14.0	0.015	0.030	0.020	700	100
Ricinus communis	SBA	3.5	9.3	5.5					18
	SC	0.5	1.1	0.8					18
<u>Leguminosae</u>									
Bauhinia vahlii (B. racemosa)	SBB	1.5	4.0		0.008	0.020			172
Brachystegia randii	SBB	1.3	2.6						99
Grotalaria juncea	SBA			5.0			0.022	227	72
	SC			0.8-			0.021-	35-	72
				0.9			0.026	38	
C. usaramoensis	SBA	2.3	6.9	3.8	0.014	0.042	0.027	141	73
Cytisus scoparius (Genista scoparia, Sarothamnus scoparius)	SBB	2	9	5	0.010	0.025	0.015	333	164
Hardwickia binata	SBB	1	2	1.3					34
Lespedeza cuneata (L. sericea)	SBA			0.6					28
	SWA			0.6					28
Lupinus albus	SWA	0.1	2.3	0.6					117
L. angustifolius	SWA	0.1	2.5	0.5					117
L. luteus	SWA	0.1	2.7	0.6					35
	SBA			2.0-			0.016-	139	
Lupinus sp.	SBA			3.0			0.020		
				10			0.030	333	164
Melilotus alba	SBA	5	18		0.020	0.036			

M. officinalis	SWA	0.1	1.7	0.5						117
Parkinsonia aculeata	SBB	1	2	2.0-						34
Pueraria thunbergiana	SBA			3.0			0.012		208	127
Sesbania aculeata	SBA	2	4							149
S. grandiflora	SBB	1.8	3.7	2.7	0.008	0.037	0.022		123	126
Glycine soja	SBA	1.0	4.5		0.008	0.055	0.022-			143
(Soja max)							0.028			
Sophora flavescens	SBB	2.1	4.2	3.0			0.039-		71	140
							0.045			
							0.020			
Spartium junceum	SBB	5	16	10						164
Trifolium pratense	SBA		6.5	3.0-	0.012	0.025				50
				4.5						
Vigna sinensis var. textilis	SBA	1.1	8.7	4	0.011	0.066	0.030		133	54
Wisteria sinensis (W. chinensis)	SBB	1.3	3.7		0.010	0.020				138
<u>Linaceae</u>										
Linum usitatissimum	SBA	4	66	25	0.007	0.037	0.016		1563	170
	SC	0.1	0.4	0.2	0.010	0.039	0.019		11	112
<u>Malvaceae</u>										
Abutilon asiaticum	SBA	1	4							82
A. avicennae	SBA	1	2.1		0.008	0.037				138
A. bedfordianum	SBA	2	3.7							76
A. graveolens	SBA	1	3.5							82
(A. tortuosum)	SC	0.5	1.3	0.9						104
A. indicum	SBA	1.1	1.8	1.3	0.010	0.015				13
	SBA			1.9			0.015		127	15
	SBA			2.5			0.007-		294	14
Althaea officinalis	SBA						0.010			
	SBA						0.017			
	SBA						0.019			
	SBA						0.018-			
A. rosea	SWA			0.5					29	125
	SWA			0.6					32	125
Gossypium herbaceum	SBA	1.5	3	2					105	69
	SC			0.8			0.012		67	69

Gossypium sp.	SBA	0.7	4.2	1.9	0.010	0.028	0.020	95	111
Hibiscus abelmoschus	SBA	2.5	4.5						76
H. cannabinus	SBA	2	6	5	0.014	0.033	0.021	238	164
	SBA	1.5	2.8	2.0	0.001	0.030	0.020-	93	73
H. elatus	SBB	1	1.5				0.021		34
H. esculentus	SBA	1.5	8.8	3.7	0.012	0.032	0.020	185	26
	SBA			8.3	0.012	0.027	0.015-	436	171
H. floccosus	SBA	2.5	3.6	1.8		0.031	0.017	106	15
H. grandiflorus	SBB	2.5		3.2	0.012	0.023	0.026	123	25
H. heterophyllus	SBB	2.5	4.0	8.8					171
H. lasiocarpus	SBA	2.1	3.1						76
H. macrophyllus	SBB	1.8	4.5	3.3		0.029	0.026	127	86
H. mutabilis	SBB	1.5	2.4						25
H. quinquelobus	SBB	1.0	3.2						76
H. rosa-sinensis	SBB			6	0.005	0.012	0.006-	857	86
							0.008		171
H. sabdariffa	SBB	1.2	3.3	1.2		0.032	0.012	100	15
H. syriacus	SBB	0.6	1.7	1.9	0.010	0.035	0.020	95	126
	SBB	2.5	5.4	3.2	0.012			213	138
H. tetraphyllus	SBA	1.0	1.6			0.020	0.015	123	13
	SBA			1.6	0.008	0.013	0.016	125	120
H. tiliaceus	SBB	0.6	2.3	1.5-	0.010	0.018	0.014	125	15
				2.0					161
	SBB			7	0.007	0.015	0.008-	667	171
Kydia calycina	SBB	1.0	2.0		0.017	0.024	0.013		
Lavatera arborea	SBA	1	1.5						172
L. maritima	SBA	2.4	3.4	2.8				187	76
Malachra capitata	SBA	1.6	4.5	2.1	0.007	0.029	0.015	31	126
	SBA			2.0		0.042	0.016	125	15
M. fasciata	SBA	1.2	5.1	17.0	0.006	0.022	0.015	1133	126
Malva sp.	SBA	11.3	29.1	2	0.009				142
(M. castilla)	SBA	0.8	6					121	162
Pavonia urens	SBB	1.3	6.2	2.3	0.012	0.030	0.019		40
P. zeylanica	SBA	1	1.5						34
Plagianthus betulinus	SBB	1.5	2						76

Species	SBB	SC	SBA	SBB	SBB	SBA	SBB	SBA	SBB	SBA	SBB	SBA	SBB
P. pulchellus	SBB												
Sida arborea	SBB	1.05	4.3	2.0									
S. carpinifolia	SBB	1.5	2.5	3.0	0.012	0.028	0.017	176					
(S. acuta)	SBB												
S. cordifolia	SBA	1.5	3	1.4			0.013	108					
S. mollis	SBA	1	1.5										
S. rhombifolia	SBA			1.5			0.010	150					
Sphaeralcea umbellata	SBA	2.5	4.0										
Thespesia lampas	SBB			1.9			0.018-	100					
T. macrophylla	SBB	0.9	4.7		0.012	0.021	0.016						
T. populnea	SBB	5.2	8	6.9	0.020	0.030							
Urena lobata	SBA	1.5	5.1	2.3									
	SBA	0.9	2.5	1.4	0.009	0.027	0.013	108					
	SBA			1.7			0.013	131					
Wissandula rostrata	SBB	1.8	3										
(Abutilon periplocifolium)													
Meliaceae													
Melia azadirachta	SBB	1	2										
Moraceae													
Artocarpus kunstleri	SBB	9	27	18		0.044	0.033	545					
Broussonetia kazinoki	SBB	1.5	10		0.010	0.034							
B. papyrifera	SBB	6	25	15			0.025-	545					
							0.030						
Cannabis sativa	SBA	5	55	20	0.007	0.050	0.022	909					
	SC			0.7									
Ficus bengalensis	SBB	1	3										
Humulus lupulus	SBA	4	19	10	0.012	0.018	0.016	625					
Morus alba	SBB	7	32	16			0.025	640					
	SBB	2.7	5.1	4.3			0.025	172					
Papaveraceae													
Papaver somniferum	SWA			1.5			0.028	54					

Polygalaceae

Polygala butyracea
Securidaca longepedunculata

SBA 15.2 33.0
SBB 15 47 23

92

77

Polygonaceae

Polygonum cuspidatum

SWA 0.1 3.9 1.1

117

Pontederiaceae

Elchornia crassipes

LW 2 3 0.012 0.030

168

Salicaceae

Salix viminalis
Salix sp.

SBB 1.0
SBB 3

0.012

83

152
124

Solanaceae

Nicotiana tabacum
Solanum tuberosum

SC 0.7 0.8
SWA 0.1 3.1 0.8
SBA 2.0 45.1 15.9

0.035

21

796

6
117
71

Sterculiaceae

Abroma augusta
Firmania plataniifolia
Guazuma tomentosa
Helicteres isora
Kleinovia hospita
Melochia corchorifolia
M. umbellata
Sterculia acerifolia
S. diversifolia
S. villosa

SBA 4.0 6.4
SBA 1.4 4.2
SBB 1.5 3.0
SBB 1.0 2.0
SBB
SBB
SBB 0.9 2.4
SBA 1.1 3.1
SBB 2.5 3.5
SBB 0.5 1.5
SBB 1.5 3.6

2.2 0.006 0.039 0.017
0.015 0.020
1.3 1.0 0.008 0.031
1.5 1.1 0.011 0.027 0.016
0.017 0.025 0.020

129
100
100
100
100
100
125

82
126
138
34
123
15
126
126
76
76
172

Thymelaeaceae

Daphne mezereum
D. pseudo-mezereum

SBB 2.0 3.5 2.9
SBB 1.3 6.2

0.010 0.018 0.012
0.010 0.025

242

120
138

<i>Daphnopsis brasiliensis</i>	SBB	0.9	3.7	2.0-					161
	SBB			3.0					
<i>Edgeworthia papyrifera</i>	SBB	2.4	3.6	2.9	0.015	0.025	0.018	161	74
	SBB		5	3.0-	0.012	0.027		170	
	SBB			4.0	0.012	0.016		165	
<i>Lagetta funifera</i>	SBB			5			0.012-	385	120
	SBB						0.014		
	SBB						0.010	500	164
<i>L. lintearia</i>	SBB	3	6	5	0.008	0.029			172
<i>Lasiosiphon eriocephalus</i>	SBB	0.4	5.1		0.006	0.024	0.015	300	65
<i>Rhamnoneuron balansae</i>	SBB	2.6	5.3	4.5	0.012	0.013			137
<i>Thymelaea microphylla</i>	SBB	5	8		0.003	0.021	0.012	250	126
<i>Wikstroemia ovata</i>	SBB	1.7	4.2	3.0	0.010	0.030			138
<i>W. sikokianum</i>	SBB	2.5	5.3						

Thliaceae

<i>Gorchorus acutangulus</i>	SBA			1.0	0.010	0.025	0.011	91	15
<i>G. capsularis</i>	SBA	1.5	5	2	0.010	0.025	0.020	100	170
	SC			0.8			0.025	31	116
<i>G. olitorius</i>	SBA	1.0	5.3	2.6	0.010	0.025	0.017	153	8
	SBA			1.5			0.016	94	15
<i>Columbia serratifolia</i>	SBB	0.9	2.5	1.6	0.005	0.027	0.014	114	126
<i>Grewia asiatica</i>	SBB			0.9			0.011	82	15
<i>G. multiflora</i>	SBB	1.1	2.7	1.8	0.006	0.024	0.015	120	126
<i>G. occidentalis</i>	SBB			1.6					76
<i>G. oppositifolia</i>	SBB	1	1.5						34
<i>G. tiliaefolia</i>	SBB			1.4			0.013	108	15
<i>Honkenya ficiifolia</i>	SBB			2.1					90
<i>Sparmannia africana</i>	SBB	1.4	3.0	3.3					76
<i>Tilia europaea</i>	SBB			2	0.014	0.020	0.016	125	164
<i>T. japonica</i>	SBB	1.3	5		0.017	0.023		125	138
<i>Triumfetta bartramia</i>	SBA	1.5	2.4	2.0	0.009	0.027	0.016	126	126
<i>T. pilosa</i>	SBA	1.1	2.8	1.5			0.011	136	15
<i>T. rhomboidea</i>	SBB								80
<i>T. semitriloba</i>	SBB	2.0	2.8	2.2	0.015	0.018			64
<i>T. cordifolia</i>	SBB								

Ulmaceae

<i>Holoptelea integrifolia</i>	SBB	0.9	2.1		0.009	0.014	0.012		172
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<i>Boehmeria nivea</i>	SBA	60	250	120	0.011	0.080	0.050	2400	170
<i>B. nivea</i> var. <i>tenacissima</i>	SBA		250	40			0.055	727	47
<i>B. platyphylla</i>	SBB	30	60		0.002	0.030	0.014		115
	SBB			27			0.008	3375	115
<i>Girardinia heterophylla</i>	SBA	150	500						77
<i>Laportea crenulata</i>	SBB	8	16						34
<i>Pipturus arborescens</i>	SBB	3.8	6.0	5.1	0.042	0.100	0.069	74	126
<i>Pouzolzia andongensis</i>	SBA	10	20		0.016	0.030	0.022		115
					0.002	0.018	0.013		
<i>P. hypoleuca</i>	SBA	6	26	11	0.023	0.040	0.030	367	31
<i>Urera cordifolia</i>	SBB	165	175		0.040	0.090	0.070		115
							0.030		
<i>Urtica dioica</i>	SBB	4	55	25-	0.020	0.070	0.050	550	164
				30					
<i>U. thunbergiana</i>	SBA	5	60		0.020	0.063			138
<i>U. urens</i>	SBA			25					47
<i>Villebrunia integrifolia</i>	SBB	40					0.040	625	76
Vitaceae									
<i>Vitis coignetiae</i>	SBB	1	3		0.025	0.030			138
	SBB	0.4	1		0.010	0.025		primary bast secondary bast	138

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