

CONTENTS

ABSTRACT	I
ACKNOWLEDGEMENT	III
CONTENTS	VI
LIST OF TABLES	XI
LIST OF FIGURES	XII
LIST OF PLATES	XV
CHAPTER ONE	
INTRODUCTION	1
CHAPTER TWO	
LITERATURE REVIEW	7
2.1 Coconut palm	7
2.1.1 Origin	7
2.1.2 The coconut sector in Sri Lanka	8
2.1.3 Coconut consumption	9
2.1.4 Constraints to productivity	10
2.1.5 Morphology of the coconut palm	11
2.2 Coconut varieties	13
2.2.1 Characters of four selected coconut varieties	15
2.2.1.1 San Ramon	15
2.2.1.2 Sri Lanka Dwarf Brown	17

	2.2.1.3 Cameroon Red Dwarf	18
	2.2.1.4 Sri Lanka Green Dwarf	19
	2.2.2 Germplasm conservation	20
2.3	Climatic requirements of coconut	21
	2.3.1 Latitude and altitude	22
	2.3.2 Temperature	23
	2.3.3 Rainfall	23
	2.3.4 Atmospheric Humidity	25
	2.3.5 Wind velocity	25
	2.3.6 Sunshine	26
	2.3.7 Solar radiation	26
2.4	Water requirement of coconut	27
2.5	Water and its functions in plants	28
2.6	Drought	30
2.7	Stress and stress resistance	31
	2.7.1 Plant responses to drought	32
	2.7.1.1 Effect of water stress on cell expansion	34
	2.7.1.2 Effect of water stress on Photosynthesis	36
	2.7.1.3 Osmotic adjustment	38
	2.7.1.4 Variation of water use efficiency (WUE) under water stress	42
	2.7.1.5 Leaf abscission and water deficit	43

2.7.1.6	Root growth under water stress	44
2.7.1.7	Role of ABA under water deficit	45
2.7.2	Visual effects of drought on coconut	49
2.7.3	Screening for drought tolerance in coconut	50

CHAPTER THREE

MATERIALS AND METHODS		55
3.1	Planting material	55
3.2	Physiological parameters	56
3.2.1	Gas exchange measurements	57
3.2.2	Leaf water status	58
3.3	Vegetative growth parameters	59
3.3.1	Total canopy area	59
3.4	Biochemical parameters	60
3.4.1	Leaf total chlorophyll content	60
3.4.2	Extraction procedure for soluble compounds in leaves	61
3.4.2.1	Determination of leaf proline content	62
3.4.2.2	Determination of leaf total soluble sugars content	63
3.4.2.3	Determination of leaf starch content	63
3.5	Soil and weather parameters	64

3.5.1	Soil moisture content	64
3.5.2	Rainfall and other climatic data	64
3.6	Evaluation of genotypic differences	65
3.6.1	Primary data analysis	65
3.6.2	Analysis of the interaction between genotype and environment	66
3.6.3	Genotype variation determined by drought Susceptibility Index (SI)	68
3.6.4	Genotype variation determined by Index of stomatal performance (ISP)	69

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1	Meteorological characteristics during the experimental period	71
4.1.1	Rainfall and soil moisture content	71
4.1.2	Analysis of other climatic data	74
4.2	Variation of physiological parameters	76
4.2.1	Leaf water status	76
4.2.2	Gas exchange measurements	79
4.2.3	Water use efficiency	91
	4.2.3.1 Instantaneous water use efficiency	92
	4.2.3.2 Intrinsic water use efficiency	94
4.2.4	Leaf temperature	96

4.2.5	C_i/C_a ratio	98
4.3	Leaf biochemical parameters	99
4.3.1	Proline, starch and total soluble sugar	99
4.3.2	Leaf total chlorophyll content	105
4.4	Vegetative growth parameters	106
4.4.1	Total number of fronds and canopy area	106
4.5	Relationships between parameters	108
4.5.1	Relationship with soil moisture content	108
4.6	Screening for drought tolerance	112
4.6.1	Genotype x environment interaction	112
4.6.2	Susceptibility Index	115
4.6.3	Index of stomatal performance	118
4.6.4	Limitation on drought screening based on physiological parameters	121
CHAPTER FIVE		
	CONCLUSION	123
	REFERENCES	125

LIST OF TABLES

Table 4.1	Weather conditions of the experimental area during the study period	75
Table 4.2	Variation of canopy area (m ²) at the beginning and at the end of the drought period	87
Table 4.3	Leaf total chlorophyll content (mg g ⁻¹ Fresh weight) of four genotypes prior to the drought period	106
Table 4.4	Genotypic variation of rate of photosynthesis (<i>A</i>), Instantaneous water use efficiency (ω_{inst}), Stomatal conductance (g_s) and rate of transpiration (<i>E</i>) of four genotypes at 6 % θ	109
Table 4.5	Stomatal conductance of individual leaves of four genotypes during the moisture stress period	119
Table 4.6	Leaf water potential of individual leaves of four genotypes during the moisture stress period	119
Table 4.7	Calculation of index for stomatal performance	120

LIST OF FIGURES

Figure 3.1	The field layout of the plantation	56
Figure 4.1	Variation of rainfall during the experimental period	72
Figure 4.2	Variation in soil moisture content (θ , %) with time during the experimental period in plots containing the four genotypes of coconut	73
Figure 4.3	The effects of drought on leaf relative water content (RWC , %) of four coconut genotypes	77
Figure 4.4	The effects of drought on leaf water potential (Ψ , MPa) of four coconut genotypes	78
Figure 4.5	The effects of drought on stomatal conductance (g_s) of individual leaves of four coconut genotypes	80
Figure 4.6	The effects of drought on rate of transpiration (E) of individual leaves of four coconut genotypes	84

Figure 4.7	Relationships between rate of transpiration (E) and stomatal conductance (g_s) of four coconut genotypes	85
Figure 4.8	The effects of drought on rate of photosynthesis (A) of individual leaves of four coconut genotypes	88
Figure 4.9	The effects of drought on instantaneous water use efficiency (ω_{inst}) of individual leaves of four coconut genotypes	93
Figure 4.10	The effects of drought on intrinsic water use efficiency (ω_{intr}) of individual leaves of four coconut genotypes	95
Figure 4.11	The effects of drought on leaf temperature ($^{\circ}\text{C}$) of individual leaves of four coconut genotypes	97
Figure 4.12	The effects of drought on intercellular/ambient CO_2 ratio (C_i/C_a) of individual leaves of four coconut genotypes	98
Figure 4.13	The effects of drought on leaf proline, content of individual leaves of four coconut genotypes	100
Figure 4.14	The effect of drought on total soluble sugar content of individual leaves of four coconut genotypes	102

Figure 4.15	The effects of drought on starch content of individual leaves of four coconut genotypes	103
Figure 4.16	The effects of drought on total number of fronds of individual palms of four coconut genotypes	107
Figure 4.17	Variation of rate of photosynthesis (A) of individual leaves with soil moisture depletion in four genotypes	110
Figure 4.18	Variation of stomatal conductance (g_s) of individual leaves with soil moisture depletion in four genotypes	111
Figure 4.19	Variation of instantaneous water use efficiency (ω_{inst}) of individual leaves with soil moisture depletion in four genotypes	112
Figure 4.20	The relationship of Regression coefficient and variety mean " A " and mean ω_{inst} of four coconut genotypes	115
Figure 4.21	Susceptibility index (SI) for ω_{inst} , E and g_s of four genotypes	116

LIST OF PLATES

Plate 2.1	General view of a coconut palm	11
Plate 2.2	Opened coconut inflorescence	12
Plate 2.3	Parts of a mature nut	13
Plate 2.4	A plantation of San Roman (Clovis)	16
Plate 2.5	A young Sri Lanka Dwarf Brown palm	18
Plate 2.6	A young Cameroon Red Dwarf palm	19
Plate 2.7	A young palm of Sri Lankan Green Dwarf	20
Plate 2.8	Palms with drooped fronds	50