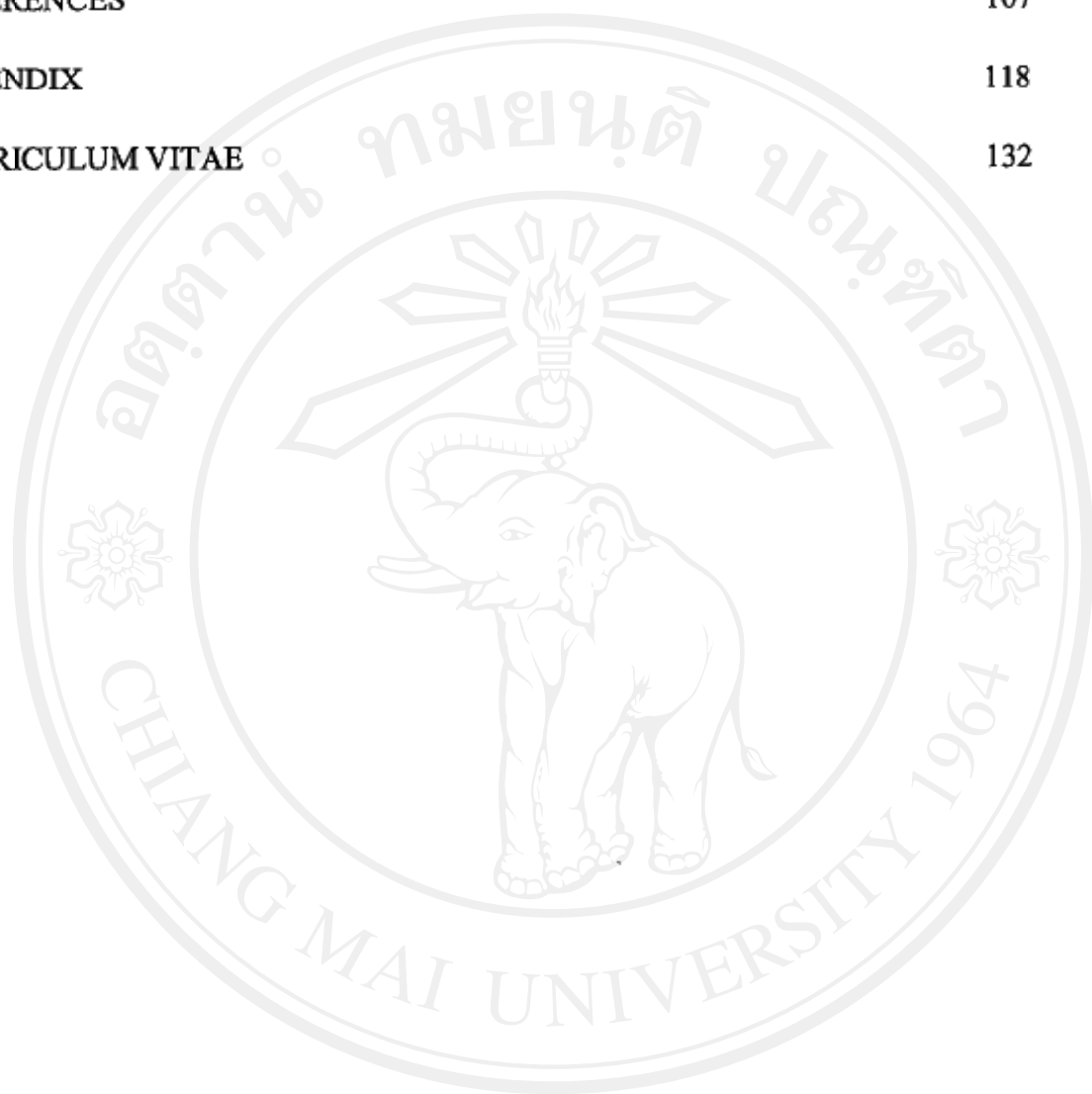


TABLE OF CONTENTS

Acknowledgements	iii
Abstract in English	v
Abstract in Thai	x
Table of Contents	xiv
List of Tables	xvii
List of Figures	xx
Abbreviations and Symbols	xxv
CHAPTER 1 INTRODUCTION	1
CHAPTER 2 LITERATURE REVIEW	4
2.1 Effects of water stress on maize growth and yield	4
2.1.1 Nutrient uptake under water stress	6
2.1.2 Vegetative growth under water stress	8
2.1.3 Reproduction and yield under water stress	9
2.2 Drought tolerance in maize	12
2.2.1 Mechanisms of drought tolerance	13
2.2.2 Genotypic variation in drought tolerance (Or in other crops)	14
CHAPTER 3 MATERIALS AND METHODS	19
3.1 Experiment 1: To establish the levels of water stress	19
3.2 Experiment 2: To evaluation on performance of eleven maize varieties under different two water levels	20

3.3	Experiment 3: To evaluation on performance of four maize varieties under different three water levels	22
3.4	Experiment 4: To examine root distribution at different water levels on four maize varieties	22
3.5	Experiment 5: To examine root distribution at different soil deep and water levels on two maize varieties	23
3.6	Experiment 6: To examine grain yield potential distribution at different period of time irrigation on four maize varieties	24
CHAPTER 4 RESULTS		26
4.1	Experiment 1	26
4.2	Experiment 2	43
4.3	Experiment 3	53
4.4	Experiment 4	67
4.5	Experiment 5	75
4.6	Experiment 6	88
CHAPTER 5 DISCUSSION		95
5.1	Establishing the effect of water stress on maize	95
5.2	Exploration of drought tolerance in 11 maize varieties	96
5.3	Difference in drought tolerance on four maize varieties	97
5.4	Drought and root growth	100
5.5	Root distribution and drought tolerance	101
5.6	Grain yield responses to drought of the maize varieties in the field	103

CHAPTER 6 CONCLUSION	106
REFERENCES	107
APPENDIX	118
CURRICULUM VITAE	132



ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright© by Chiang Mai University
All rights reserved

LIST OF TABLES

Table	Page
3.1 Eleven maize varieties used in experiment 2	21
4.1.1 Reduction (%) of studied parameters of 888 maize variety at 67%FC 50%FC and 33%FC compared to 100%FC at 3 and 6 weeks after pl	39
4.1.2 Reduction (%) of total NPK content in shoot and root of 888 maize variety at 67%FC, 50%FC and 33%FC compared to 100%FC at 3 and 6 weeks after planting.	40
4.1.3 Effect of water levels on total NPK concentration of 888 maize variety at 3 weeks after planting.	41
4.1.4 Effect of water levels on total NPK concentration of 888 maize variety at 6 weeks after planting.	42
4.2.1 Effect of water levels on plant height (cm) of 11 maize varieties at 6 weeks after planting.	46
4.2.2 Effect of water levels on leaf area (cm ²) of 11 maize varieties at 6 weeks after planting.	47
4.2.3 Effect of water levels on root length (mg/plant) of 11 maize varieties At 6 weeks after planting.	48
4.2.4 Effect of water levels on shoot dry weight (cm) of 11 maize varieties weeks after planting.	49
4.2.5 Effect of water levels on root dry weight (g/plant) of 11 maize varieties at 6 weeks after planting.	50

4.2.6	Effect of water levels on total dry weight (g/plant) of 11 maize varieties at 6 weeks after planting.	51
4.2.7	Mean of ranking of reduction (%) of studied parameters of maize varieties at 50%FC compared to 100%FC.	52
4.3.1	Reduction (%) of studied parameters of maize varieties at 50%FC compared to 100%FC.	60
4.3.2	Reduction (%) of studied parameters (Total NPK content) of maize varieties at 50%FC compared to 100%FC.	62
4.3.3	Effect of water levels on total NPK concentration of 888 maize variety at 3 weeks after planting.	65
4.3.4	Effect of water levels on total NPK concentration of 888 maize variety at 3 weeks after planting.	66
4.4.1	Differences of plant height and root length at 6 weeks after planting of four maize varieties.	70
4.4.2	Effects of water levels on the averages of plant height and root length of all maize varieties at 6 weeks after planting.	71
4.4.3	Effects of water levels on leaf area (cm ²) of maize varieties at 6 weeks after planting.	71
4.4.4	Effect of water levels on shoot dry weight (g/plant) of maize varieties at 6 weeks after planting.	72
4.4.5	Effect of water levels on root dry weight (g/plant) of maize varieties at 6 weeks after planting.	72

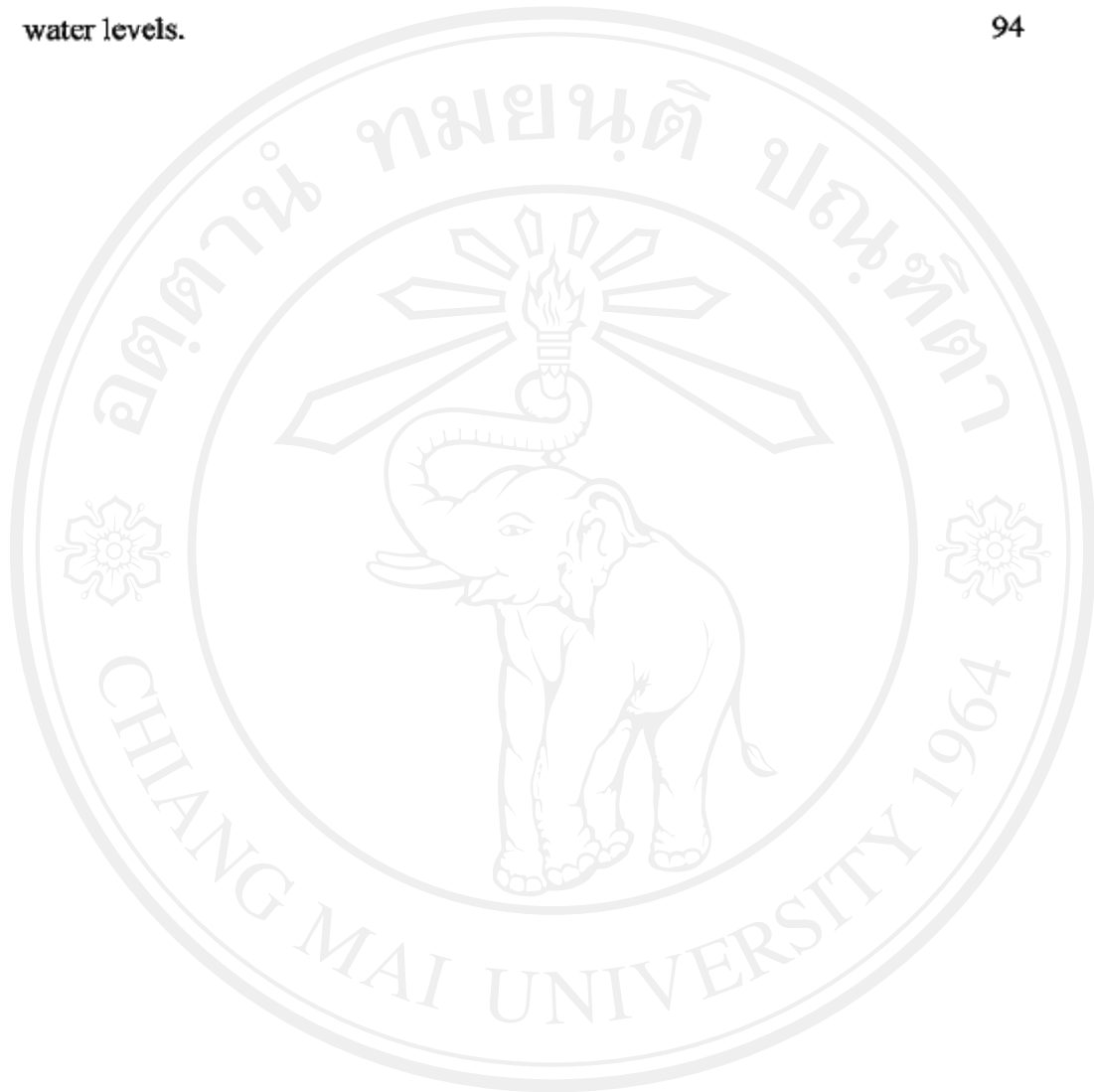
4.4.6	Effect of water levels on total dry weight (g/plant) of maize varieties at 6 weeks after planting.	73
4.4.7	Reduction (%) of studied parameters of maize varieties at 50%FC compared to 100%FC.	73
4.4.8	Root and shoot ratio at 6 weeks after planting of different maize varieties at different water levels.	74
4.5.1	Reduction (%) of studied parameters of maize varieties at 50%FC compared to 100%FC.	81
4.5.2	Differences of root dry weight at 25cm to 50cm and 75cm to 100cm deep soil layer.	84
4.5.3	Effects of water levels on the average of root dry weight at 25cm to 50cm and 75cm to 100cm deep soil layer of two maize varieties.	84
4.5.4	Effect of water levels on total N content in shoot and root (mg/plant) of maize varieties at 4 weeks after planting.	86
4.5.5	Effect of water levels on total P content in shoot and root (mg/plant) Of maize varieties at 4 weeks after planting.	86
4.5.6	Effect of water levels on total K content in shoot and root (mg/plant) of maize varieties at 4 weeks after planting.	86
4.5.7	Reduction (%) of studied parameters (Total NPK) of maize varieties at 50%FC compared to 100%FC.	87
4.6.1	Effect of water levels on days to flowering of four maize varieties.	89
4.6.2	Reduction (%) of studied parameters of maize varieties at W30 days	

compared to W15 days.

93

- 4.6.3 Harvest index at maturity of different maize varieties at different water levels.

94



ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright© by Chiang Mai University
All rights reserved

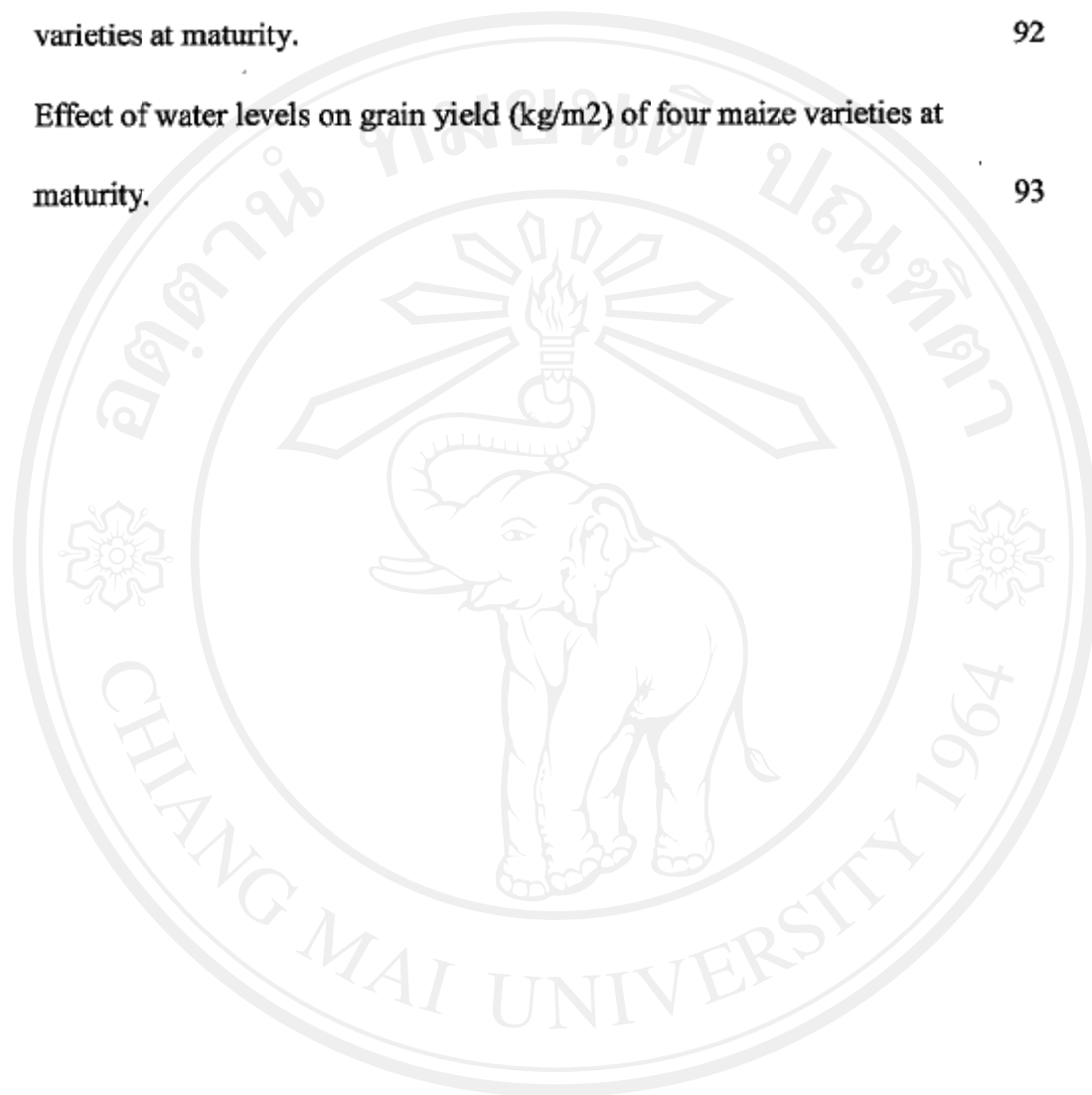
LIST OF FIGURES

Figure	Page
4.1.1 Effect of four water levels on plant height of 888 maize variety at 3 weeks (A) and 6 weeks (B) after planting.	28
4.1.2 Effect of four water levels on leaf area of 888 maize variety at 3 weeks (A) and 6 weeks (B) weeks after planting.	28
4.1.3 Effect of four water levels on root length of 888 maize variety at 3 Weeks (A) and 6 weeks (B) after planting.	29
4.1.4 Effect of four water levels on shoot dry weight (Shoot DW) of 888 maize variety at 3 weeks (A) and 6 weeks (B) after planting.	29
4.1.5 Effect of four water levels on root dry weight (Root DW) of 888 maize variety at 3 weeks (A) and 6 weeks (B) after planting.	30
4.1.6 Effect of four water levels on total dry weight (Total DW) of 888 maize variety at 3 weeks (A) and 6 weeks (B) after planting.	30
4.1.7 Effect of water levels on N content in shoot of 888 maize variety at 3 weeks (A) and 6 weeks (B) after planting.	32
4.1.8 Effect of water levels on N content in root of 888 maize variety at 3 weeks (A) and 6 weeks (B) after planting.	33
4.1.9 Effect of water levels on N content in total shoot and root of 888 maize variety at 3 weeks (A) and 6 weeks (B) after planting.	33
4.1.10 Effect of water levels on P content in shoot of 888 maize variety at 3 weeks (A) and 6 weeks (B) after planting.	35

4.1.11	Effect of water levels on P content in root of 888 maize variety at 3 weeks (A) and 6 weeks (B) after planting.	35
4.1.12	Effect of water levels on P content in total shoot and root of 888 maize variety at 3 weeks (A) and 6 weeks (B) after planting.	36
4.1.13	Effect of water levels on K content in shoot of 888 maize variety at 3 weeks (A) and 6 weeks (B) after planting.	37
4.1.14	Effect of water levels on K content in root of 888 maize variety at 3 weeks (A) and 6 weeks (B) after planting.	38
4.1.15	Effect of water levels on K content in total shoot and root of 888 maize variety at 3 weeks (A) and 6 weeks (B) after planting.	38
4.3.1	Effect of water levels on plant height (cm) of four maize varieties at 6 weeks after planting.	57
4.3.2	Effect of water levels on leaf area (cm ² /plant) of four maize varieties at 6 weeks after planting.	57
4.3.3	Effect of water levels on root length (cm) of four maize varieties at 6 weeks after planting.	58
4.3.4	Effect of water levels on shoot dry weight (g/plant) of four maize varieties at 6 weeks after planting.	58
4.3.5	Effect of water levels on root dry weight (g/plant) of four maize varieties at 6 weeks after planting.	59
4.3.6	Effect of water levels on total dry weight (g/plant) of four maize	

varieties at 6 weeks after planting.	59
4.3.7 Effect of water levels on total N content in shoot and root (mg/plant) of four maize varieties at 6 weeks after planting.	63
4.3.8 Effect of water levels on total P content in shoot and root (mg/plant) of four maize varieties at 6 weeks after planting.	63
4.3.9 Effect of water levels on total K content in shoot and root (mg/plant) of four maize varieties at 6 weeks after planting.	64
4.5.1 Effect of water levels on plant height (cm) of four maize varieties at 4 weeks after planting.	78
4.5.2 Effect of water levels on Leaf area (cm ² /plant) of four maize varieties at 4 weeks after planting.	78
4.5.3 Effect of water levels on root length (cm) of four maize varieties at 4 weeks after planting.	79
4.5.4 Effect of water levels on shoot dry weight (g/plant) of four maize varieties at 4 weeks after planting.	79
4.5.5 Interaction effect of maize varieties and water levels on root dry weight (g/plant) at 4 weeks after planting.	80
4.5.6 Effect of water levels on total dry weight (g/plant) of four maize varieties and water levels at 4 weeks after planting.	80
4.5.7 Effect of water levels on root dry weight every 25 cm deep soil (g/plant) of two maize varieties at 4 weeks after planting.	83
4.6.1 Effect of water levels on plant height (cm) of four maize varieties at	

maturity.	92
4.6.2 Effect of water levels on biomass dry weight (kg/m^2) of four maize varieties at maturity.	92
4.6.3 Effect of water levels on grain yield (kg/m^2) of four maize varieties at maturity.	93



ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright© by Chiang Mai University
All rights reserved

ABBREVIATIONS AND SYMBOLS

N	=	Nitrogen
P	=	Phosphorus
K	=	Potassium
R	=	Replication
V	=	Variety
SD	=	Standard Deviation
PH	=	Plant Height
LA	=	Leaf Area
RL	=	Root length
FC	=	Field Capacity
WL	=	Water level
DW	=	Dry Weight
LSD	=	Least Significant Difference
SDW	=	Shoot Dry Weight
RDW	=	Root dry Weight
TDW	=	Total Dry Weight
RCB	=	Randomized Complete Block
WL*R	=	Water Level by Replication
WL*V	=	Water Level by Variety
ANOVA	=	Analysis of Variance