

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENT	iii
ABSTRACT	iv
THAI ABSTRACT	vi
TABLE OF CONTENTS	viii
LIST OF TABLES.....	xi
LIST OF ILLUSTRATIONS.....	xii
LIST OF SCREENS	xiii
Chapter 1 introduction	1
Chapter 2 Literature review	3
System Simulation and Modeling.....	3
Modeling Potential Crop Production.....	5
Principle of Phenology Model	6
Development Stages	6
Development Rate and Environmental Factor.....	7
Temperature.....	7
Daylength.....	8
Previous Research about Sugarcane	12
Sugarcane Simulation Models	12
Sugarcane Flowering and Environmental Effects	13
Daylength.....	13
Temperature.....	14
Chapter 3 materials and methods.....	16
Generation of Sugarcane Flowering Data Set	16
Design and Treatments	17
First Experiment	17
Second Experiment.....	17
Data Collection	18
Weather Data	18
Plant Data	18
Data Analysis.....	21
Panicle Initiation Data Analysis	21
Others Plant Data Analysis.....	22

TABLE OF CONTENTS (continue)

	Page
Sugarcane Flowering Model.....	23
Model Assumptions.....	23
Model Inputs and Outputs	24
Model Operations	26
Sugarcane Development Stages.....	28
ISTAGE 7 Planting or Start of Simulation.....	29
ISTAGE 8 Planting to Root germination	29
ISTAGE 9 Root germination to Emergence.....	29
ISTAGE 1 Emergence to End of Juvenile.....	30
ISTAGE 2 End of Juvenile to Panicle Initiation	31
ISTAGE 3 Panicle Initiation to Panicle Emergence.....	32
Chapter 4 Results and discussion	34
Experiment data.....	34
Planting to Emergence.....	34
Leaf development	36
First experiment.....	36
Second Experiment.....	36
Tiller and visible leaf position.....	38
Panicle Initiation.....	40
First Experiment	41
Second Experiment.....	41
Panicle Emergence	44
First Experiment	44
Second Experiment.....	44
Sugarcane Flowering Model (ScFM 1.0)	45
Introducing Sugarcane Flowering Model (ScFM 1.0).....	45
Welcome to Sugarcane Flowering Model (ScFM 1.0).....	45
Requirements	45
Installation	46
Sugarcane Flowering Model Interface	47
Main Form	47
Simulation Result	56
CBM and CERES model daylength simulation	58
CBM model	58
CERES model.....	60
Estimation of Coefficients	62
Thermal threshold.....	62
Planting to Emergence.....	62
Emergence to Panicle emergence.....	63
Photoperiod Sensitivity Coefficient (PS)	64

TABLE OF CONTENTS (continue)

	Page
Model Testing.....	68
Emergence Date.....	68
Leaf development	69
Panicle initiation	71
Panicle emergence	72
Sensitivity Analyses	74
Sensitivity test of crop parameters.....	74
Sensitivity of Planting Dates	80
Chapter 5 Conclusion	85
References	85
APPENDIX	90
Sugarcane Flowering Model Source Code	91
Main Form (Screen 1).....	91
Variety Form (Screen 2).....	97
Weather (Screen 3)	99
Simulation Option Form (Screen 4)	101
Output File (Screen 5)	104
Simulation result (Screen 6)	106
Chart (Screen 7).....	107
Module.....	109
Curriculum Vitue.....	116

LIST OF TABLES

Table	Page
3-1 Sugarcane genetic coefficients used in the ScFM 1.0 model	25
3-2 Daylength definitions defined by the position of the sun with respect to the horizon	28
3-3 Sugarcane development phases	29
4-1 Comparisons of the number of day, SUMGDD ₈ , SUMGDD ₁₀ , and SUMGDD ₁₆ since planting to emergence between experiment of each variety.....	35
4-2 SUMGDD ₈ since planting to emergence of all four varieties	35
4-3 The average leaf development rate and phyllochron of all leaf of four sugarcane varieties in both experiment (Tbase =16°C)	37
4-4 Slope of the relationship between CUMGDD and number of fully expanded leaf of all treatments in the second experiment.....	38
4-5 Percent of the initiated panicle and the date of initiation in average on each sampling date.	42
4-6 Number of days and growing degree day since panicle initiation to emergence in average of U-Thong2 variety in the first experiment.....	44
4-7 Calculated statistics testing model	61
4-8 The genotype specific coefficient, which were estimated from the first experiment data set.....	67
4-9 The difference between simulated and observed emergence date	69
4-10 Calculated statistics for the leaf number prediction	71
4-11 Comparison between simulated and observed panicle initiation date using ScFM 1.0 based on CBM daylength model.....	72
4-12 Comparison of the simulated and the observed panicle emergence date	73
4-13 Standard values of crop parameter used.....	75
4-14 Standard simulated panicle initiation date by ScFM 1.0 at Chiang Mai latitude.	75
4-15 Panicle initiation dates as affected by changing P22, PS, and P2O sugarcane genetic coefficients.	76
4-16 Effect of changing the threshold photoperiod (P2O) on simulated panicle initiation date by ScFM 1.0 model.....	77

LIST OF ILLUSTRATIONS

Figure	Page
2-1 Responses of short-day plant to daylength as function of number days (A), growing degree days (B), and relative induction rate (C).....	11
3-1 The experiment field layout for extended daylength experiment in sugarcane and photograph, Multiple Cropping Center, Chiang Mai University.	19
3-2 Photomicrographs (6×) of shoot dissection, showing the vegetative meristem (A); the change to an elongated dome, which indicates the shift to the flowering phase of a sugarcane plant (B).	20
3-3 Model inputs requirement and its simulation results	26
3-4 Flow chart of the sugarcane flowering model ScFM 1.0	27
4-1 Tiller numbers per plant at each visible leaf position of four sugarcane varieties from four photoperiod treatments.	39
4-2 Panicle initiation of four varieties under natural photoperiod treatment.	40
4-3 The panicle initiation delayed and was more variation as sampling dates.....	43
4-4 Comparison of the simulated daylength from the CBM model and published daylength data by Meteorological Department at Chiang Mai latitude (1998).59	59
4-5 Errors of CERES daylength model compared to CBM model at Chiang Mai latitude during 1998.	61
4-6 The required genotype specific coefficient for simulation of sugarcane development stages with the ScFM 1.0 model.	63
4-7 Simulation of panicle initiation of U-Thong2 (A) and K84-200 (B) variety with the ScFM 1.0 based on CBM and CERES-model.	65
4-8 Simulated panicle initiation date at various PS of U-Thong2 and K84-200 variety with 12.5-hour P2O.....	66
4-9 One-to-one line comparison of simulated and observed leaf number of four sugarcane varieties in both experiments in 1997 and 1998.	70
4-10 Simulated daylength from CBM model at Chiang Mai latitude during 1998....	78
4-11 Simulated panicle initiation date at P2O 12.5 hours and various PS (A), and at 6.0 PS values and various P2O (B).	80

LIST OF SCREENS

Screen	Page
1: Main form of the Sugarcane Flowering Model 1.0	47
1A: Description of each part in the main form.....	48
1B: The required management input	49
1C: The required input files, and simulation options	50
1D: The operation part of the main form.....	51
2: Selection of a variety in the selected genotype file.....	52
3: Selection of the relevant weather file.....	53
4: Options for simulation in the ScFM 1.0	54
5: Create the output file name and its position.....	55
6: The stored simulation results in the output file.....	56
7: Graphical view of the simulation results.....	57