

UNIVERSITI TEKNOLOGI MARA

**GROWTH, PHYSIOLOGICAL AND
FLOWERING RESPONSES OF
Xanthostemon chrysanthus (F. Muell.) Benth.
TO PACLOBUTRAZOL AND
POTASSIUM NITRATE**

**AHMAD NAZARUDIN
BIN MOHD ROSELI**

Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Plantation and Agrotechnology

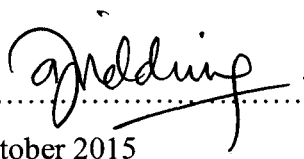
October 2015

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulation for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student : Ahmad Nazarudin bin Mohd Roseli
Student I.D. No. : 2010898724
Programme : Doctor of Philosophy
Faculty : Plantation and Agrotechnology
Thesis Title : Growth, Physiological and Flowering Responses of *Xanthostemon chrysanthus* (F. Muell.) Benth. to Paclobutrazol and Potassium Nitrate

Signature of Student : 

Date : October 2015

ABSTRACT

Xanthostemon chrysanthus (F. Muell.) Benth. or golden penda (locally known as jambu kuning) is gaining its popularity in Malaysian landscape. However, under local climatic condition, the flowering of *X. chrysanthus* is very erratic and inconsistent. An investigation on the growth, physiology, flowering and identification of a suitable practice to induce flowering of this species was carried out. Based on the Biologische Bundesanstalt, Bundessortenamt and Chemical Industry scale, nine principal growth stages, i.e. bud development (stage 0), leaf development on tree branches (stage 1), formation of side shoots (stage 2), shoot elongation (stage 3), inflorescence emergence (stage 5), flowering (stage 6), fruit development (stage 7), maturity or ripening of fruit and seed (stage 8) and fruit senescence (stage 9) were determined in *X. chrysanthus*. Vegetative and reproductive stages of this species were completed within 198 and 176 days, respectively. *Xanthostemon chrysanthus* planted in loamy sandy soil at two selected urban sites in Kuala Lumpur, i.e. Metropolitan Batu Park (MBP) and Pusat Bandar Manjalara (PBM) showed that trees at MBP, which is a recreation park with bigger planting area, had better growth performance than those trees at road median at PBM. Significant higher coarse sand content in soil of PBM influenced the water holding capacity, causing significantly lower growth responses, especially the relative growth rate of canopy diameter and leaf area index. Physiologically, higher photosynthetic rate, transpiration rate and stomatal conductance were recorded during rainy season with vegetative branches as compared to reproductive branches. Profuse flowering was observed with some trees at MBP in certain times while none of the trees flowered at some other times. On the other hand, moderate flowering was observed with all under study trees at road median at PBM at all time. A suitable approach to induce flowering was identified using a synthetic plant growth regulator (paclobutrazol, PBZ) combined with potassium nitrate (KNO_3). Nine treatments with nine replicates, of different concentrations of PBZ and KNO_3 , were assigned in a completely randomized design. PBZ lengthened the flowering period to up to 73 days as compared to only 40 days for the control tree. However, smaller flower and lower flower abundance were observed with PBZ treatment. Concurrent vegetative growth inhibition included reduced tree height, diameter at breast height, canopy diameter and leaf area, while leaf area index and relative chlorophyll content increased with PBZ alone or with combined treatment of PBZ and KNO_3 . Palisade parenchyma thickness in the leaf was drastically increased, while xylem thickness in the stem reduced with PBZ existence. Similarly, photosynthetic rate, transpiration rate and stomatal conductance were reduced with PBZ. Total phenolic content was found increased, while total non-structural carbohydrate was reduced with the existence of PBZ. However, lower dosage of 0.125 mg l^{-1} PBZ combined with 100 g KNO_3 per tree produced highest number of flowers per inflorescence and increased the inflorescence size. In addition, photosystem efficiency measurement showed that the trees were well adapted with the treatments. The practice of using PBZ and KNO_3 has the potential as a tool to improve the aesthetic value of this species. It can be considered as a good candidate for the urban landscape. Besides being able to be induced to flower better, it also tolerates the harsh urban environments that are highly exposed to various biotic and abiotic stresses.

TABLE OF CONTENTS

	Page
CONFIRMATION BY PANEL OF EXAMINERS	ii
AUTHOR'S DECLARATION	iii
ABSTRACT	iv
ACKNOWLEDGEMENTS	v
TABLE OF CONTENTS	vi
LIST OF TABLES	xi
LIST OF FIGURES	xiv
LIST OF PLATES	xvi
LIST OF ABBREVIATIONS	xvii
CHAPTER ONE: INTRODUCTION	1
1.1 Background	1
1.2 Statement of Problems	3
1.3 Significance of Study	4
1.4 <i>Xanthostemon chrysanthus</i>	6
1.5 Research Questions	9
1.6 Objectives of Research	9
CHAPTER TWO: LITERATURE REVIEW	10
2.1 Malaysia's Climate and Vegetation	10
2.2 Plant Growth and Development	12
2.2.1 Genetic	14
2.2.2 Environment	14
2.3 Flowering	17
2.3.1 Factors Influencing Flowering	18
2.3.1.1 Environmental Factors	19

2.3.1.2	Endogenous Factors	22
2.3.2	Flowering of Urban Trees	25
2.4	Phenology	28
2.4.1	Phenological Changes and Environmental Interactions	29
2.4.2	Bundesanstalt, Bundessortenamt and Chemical Industry Scale	31
2.5	Phytohormones	34
2.5.1	Gibberellins (GAs)	35
2.5.2	Abscisic Acid (ABA)	36
2.5.3	Auxins	38
2.5.4	Cytokinins (CKs)	39
2.5.5	Ethylene (ET)	40
2.6	Plant Growth Regulators	41
2.6.1	Characteristics of Paclobutrazol	43
2.6.2	Mode of Actions	44
2.6.3	Application Methods	46
2.6.4	Plant Response to Paclobutrazol Application	48
2.6.4.1	Morphological Response	48
2.6.4.2	Physiological Response	52
2.6.4.3	Flowering Response	53
2.6.4.4	Biochemical Response	55
2.6.4.5	Other Benefits of Paclobutrazol Application	56
2.7	Major Plant Nutrients	57
2.7.1	Nitrogen (N)	58
2.7.2	Phosphorus (P)	59
2.7.3	Potassium (K)	59
2.7.4	Various K Fertilizers	62
2.8	The Need to Improve Flowering in Malaysian Cities	63
 CHAPTER THREE: MATERIALS AND METHODS		 65
3.1	Phenology of <i>X. chrysanthus</i>	65
3.1.1	Study Location and Plant Materials	65
3.1.2	Study Procedure	66