



UNIVERSITI PUTRA MALAYSIA

***TAXONOMIC REVISION OF MOLINERIA SPECIES IN PENINSULAR
MALAYSIA AND THEIR AGRONOMIC REQUIREMENTS***

ROZILAWATI BINTI SHAHARI

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THEIR AGRONOMIC REQUIREMENTS**

By

ROZILAWATI BINTI SHAHARI

**Thesis Submitted to the School of Graduate Studies, Universiti Putra
Malaysia, in Fulfilment of the Requirements for the Degree of Philosophy**

AUGUST 2014



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Dedicated with love to

Shahari Ibrahim,

Roa Mohd Yassin,

Zulkifli Hassan,

Zaiton Sahir,

Firdaus Zulkifli,

Ainul Nur Hayat Firdaus,

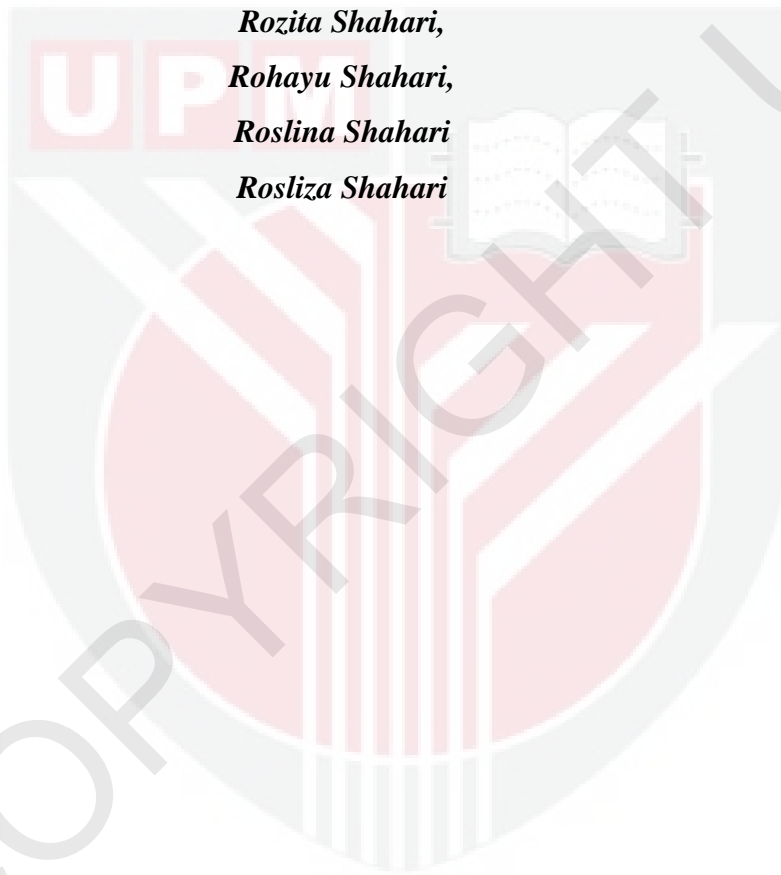
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Abstract of the thesis presented to the Senate of Universiti Putra Malaysia in
fulfilment of the Degree of Doctor of Philosophy

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By

ROZILAWATI SHAHARI

AUGUST 2014

Chairman : Assoc. Prof. Nurashikin Psyquay Abdullah, PhD

Faculty : Agriculture

The genus *Molineria* is mainly distributed in the tropical region of Africa and South East Asia. There are five species of *Molineria* recorded in Malaysia but only two species were recorded in Peninsular Malaysia which are *M. latifolia* and *M. capitulata*. The fruit of *Molineria* species is of high interest because curculin found in the fruit is a type of sweet proteins and a taste modifying proteins, which change a sour taste into a sweet taste. Morphological variations were detected among these plants between population and localities. The importance of curculin found in the fruit has been discussed but cultivation of Lemba for fruit production has not been established and to date, all plants are considered as wild and underutilized. Therefore, comprehensive studies were set up to identify varietal differences among Lemba and to establish the cultivation of Lemba for its fruit production. The objective of this study were : (1) to identify, describe and classify *Molineria* species and variety from Peninsular Malaysia, (2) to determine suitable planting medium and shade requirement for growth of two *Molineria* species under nursery conditions, and (3) to determine the effect nitrogen and potassium rates on growth and yield of two *Molineria* species under field conditions.

The first study was on the morphological and taxonomic characterization for identification of new *Molineria* species in Peninsular Malaysia. Materials for this study were obtained from both field and herbarium collection. The type specimen of *M. latifolia* var. *megacarpa* deposited at Royal Botanic Garden Kew (RBGK) and the other recorded and previously described *M. latifolia* var. *latifolia* were referred to and used for cross reference. Based on the morphological and taxonomic characterization, seven species of *Molineria* namely *M. latifolia*, *M. capitulata* *M.*

rubriclavata, *M. atropurpurea*, *M. nitida*, *M. trichobunda*, and *M. erythrofolia* were recorded found in Peninsular Malaysia.

The second study was on the growth performance of *M. latifolia* var. *megacarpa* and *M. rubriclavata* under nursery condition as affected by light intensity and planting media. The plants were grown under 2 shade levels consisting of 50% and 70% shade. Top soil, peat growth and sand were used as growing medium at 10 different ratios. Growth parameters such as plant height, number of leaves and fresh and dry weight were collected. Based on this study, the best shade level for both varieties was 70%. This study concluded that the best media for maintaining *Molineria* species under nursery condition is 1:3:1 and 2:3:1 (top soil:peatgro:sand) media composition for *M. latifolia* var. *megacarpa* and *M. rubriclavata*, respectively.

The third study was on the vegetative components and yield of *M. latifolia* var. *megacarpa* and *M. rubriclavata* under field condition as affected by nitrogen and potassium. Single fertilizer (Urea, and Muriate of Potash) was used as N and K sources. Sixteen treatment combinations of nitrogen and potassium were used. Data such as plant height, number of leaf, number of inflorescence, yield and nutrient concentration in plant tissue were taken. Therefore the recommended fertilizer rate for *M. latifolia* var. *megacarpa* is 80:40:120 (N:P₂O₅:K₂O) kg/ha and for *M. rubriclavata* was 120:40:120 (N:P₂O₅:K₂O) kg/ha. *M. rubriclavata* is recommended as new crop for cultivation because it produces higher yield compared to *M. latifolia* var. *latifolia*.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

SEMAKAN TAKSONOMI *MOLINERIA* SPESIS DI PENINSULAR MALAYSIA DAN
KEPERLUAN PERLADANGAN

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Genus *Molineria* banyak dijumpai di kawasan tropika Afrika dan Asia Tenggara. Terdapat lima spesies *Molineria* direkodkan di Malaysia tetapi hanya dua spesies sahaja direkodkan di Semenanjung Malaysia iaitu *M. latifolia* dan *M. capitulata*. Buah *Molineria* mengandungi curculin dan ia adalah sejenis protein yang manis dan boleh mengubah rasa masam kepada rasa yang manis. Variasi morfologi telah dikesan di antara tumbuh-tumbuhan ini di beberapa tempat yang berbeza. Kepentingan curculin terdapat dalam buah-buahan telah dibincangkan tetapi penanaman Lembu untuk pengeluaran buah-buahan belum dijalankan dan sehingga kini, semua tumbuh-tumbuhan dianggap sebagai liar dan tidak digunakan sepenuhnya. Oleh itu, kajian yang komprehensif telah ditubuhkan untuk mengenal pasti perbezaan antara variasi Lembu dan menjalankan penanaman Lembu untuk produksi buahnya. Objektif kajian ini ialah: (1) untuk mengenal pasti, menerangkan dan mengelaskan spesies *Molineria* dan variasi dari Semenanjung Malaysia, (2) untuk menentukan medium tanaman yang sesuai dan keperluan cahaya untuk pertumbuhan dua spesies *Molineria* bawah keadaan nurseri, dan (3) menentukan kesan nitrogen dan kalium pada pertumbuhan dua spesies *Molineria* di ladang.

Kajian pertama adalah pada pencirian morfologi dan taksonomi untuk mengenal pasti spesies *Molineria* di Semenanjung Malaysia. Bahan untuk kajian ini diperolehi daripada kedua-dua lapangan dan koleksi herbarium. Herbarium spesimen bagi *M. latifolia* var. *megacarpa* yang terdapat di Royal Botanic Garden Kew (RBGK) dan spesies yang telah direkodkan digunakan dan dirujuk untuk pengecaman spesies. Berdasarkan pencirian morfologi dan taksonomi, tujuh spesies *Molineria* iaitu *M. latifolia*, *M. capitulata*, *M. rubriclavata*, *M. atropurpurea*, *M. nitida*, *M. trichobunda*, dan *M. erythrofolia* boleh dijumpai di Semenanjung Malaysia.

Kajian kedua adalah kesan media tanaman dan keamatan cahaya terhadap prestasi pertumbuhan *M. latifolia* var. *megacarpa* dan *M. rubriclavata*. Pokok diletakkan di bawah 2 jenis rumah lindungan 50% dan 70% teduhan. Tanah, bahan organik dan

pasir telah digunakan sebagai medium tanaman pada kadar 10 nisbah yang berbeza. Parameter seperti ketinggian, berat segar dan kering untuk daun dan akar telah dikumpulkan. Berdasarkan kajian ini, teduhan yang terbaik untuk kedua-dua jenis adalah 70%. Kajian ini menyimpulkan bahawa media yang terbaik untuk mengekalkan spesies *Molineria* bawah keadaan nurseri ialah 1: 3: 1 dan 2: 3: 1 (tanah atas: bahan organik: pasir) komposisi media untuk *M. latifolia* var. *megacarpa* dan *M. rubriclavata* masing-masing.

Kajian ketiga ialah kesan nitrogen dan kalium terhadap komponen vegetatif dan hasil *M. latifolia* var. *megacarpa* dan *M. rubriclavata*. Baja tunggal (Urea, dan Muriate of Potash) digunakan sebagai sumber N dan K. Gabungan 16 nitrogen dan kalium telah digunakan. Data seperti ketinggian tumbuhan, bilangan daun, bilangan jambak bunga, hasil buah dan kepekatan nutrien dalam tisu tumbuhan telah diambil. Oleh itu kadar baja yang disyorkan untuk *M. latifolia* var. *megacarpa* ialah 80: 40: 120 (N: P205: K20) kg / ha dan *M. rubriclavata* adalah 120: 40: 120 (N: P205: K20) kg / ha. *M. rubriclavata* telah disyorkan sebagai tanaman baru untuk penanaman kerana ia menghasilkan buah yang lebih banyak berbanding dengan *M. latifolia* var. *latifolia*.

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TABLE OF CONTENTS

	Page
ABSTRACT	i
ABSTRAK	iii
ACKNOWLEDGEMENTS	v
APPROVAL	vi
DECLARATION	viii
LIST OF TABLES	xiii
LIST OF FIGURES	xv
LIST OF APPENDICES	xviii
CHAPTER	
1 INTRODUCTION	1
2 LITERATURE REVIEW	4
2.1 Taxonomic Position of Asparagales	4
2.2 Taxonomic Position of hypoxidaceae	4
2.3 Taxonomic Confusion Between <i>Molineria</i> and <i>Curculigo</i>	5
2.4 Taxonomic Position of <i>Molineria</i>	5
2.5 Classification and Collection of <i>Molineria</i> in Peninsular Malaysia	5
2.5.1 Description of genus <i>Molineria</i>	6
2.5.1.1 Botany of Botany of <i>Molineria latifolia</i> (Dryand.) Herb. ex Kurz.	6
2.5.1.2 Botany of <i>Molineria latifolia</i> (Dryand.) Herb. ex Kurz. var. <i>latifolia</i>	7
2.5.1.3 Botany of <i>Molineria latifolia</i> (Dryand.) Herb. ex Kurz var. <i>megacarpa</i> (Ridl.) I.M.Turner	7
2.5.1.4 Botany of <i>Molineria capitulata</i> (Lour.) Herb	7
2.5.2 Geographic Distribution of <i>Molineria</i>	7
2.5.3 Ecology and Habitat	8
2.5.4 Uses and important	8
2.6 Plant growth and Development	8
2.6.1 Planting Medium	9
2.6.2 Light intensity	10

	2.6.3	Nutrient	10
		2.6.3.1 Nitrogen	11
		2.6.3.2 Potassium	11
3		MORPHOLOGICAL CHARACTERIZATION AND TAXONOMIC REVISION FOR IDENTIFICATION OF NEW <i>MOLINERIA</i> SPECIES	13
	3.1	Introduction	13
	3.2	Materials and Methods	14
		3.2.1 Plant collection	14
		3.2.1 Morphological characterization	15
		3.2.3 Multivariate analysis	15
		3.2.4 Ultra structures observations using Scanning Electron Microscope	17
		3.2.5 Histology	17
		3.2.6 Leaf miromorphology	17
	3.3	Results and Discussion	18
		3.3.1 Proposal to conserve the name <i>M. latifolia</i> and <i>M. megacarpa</i>	18
		3.3.2 Gross morphology	20
		3.3.2.1 Vegetative morphological characterization	27
		3.3.2.2 Reproductive characteristics	34
		3.3.3 Leaf micromorphology	38
		3.3.3.1 Petiole anatomy	39
		3.3.3.2 Epidermis structure	43
		3.3.4 Ecology and Geographical Distribution	49
		3.3.5 Miniflora	51
		3.3.5.1 Relationships among species	51
		3.3.6 Taxonomic Treatment	54
	3.4	Conclusion	79
4		GROWTH PERFORMANCE OF TWO <i>MOLINERIA</i> SPECIES UNDER NURSERY CONDITION AS AFFECTED BY LIGHT INTENSITY AND PLANTING MEDIA	80
	4.1	Introduction	80
	4.2	Materials And Methods	81
	4.3	Results And Discussion	83
		4.3.1 Plant height	83
		4.3.2 Number of leaves	85
		4.3.3 Fresh and Dry weight of root	85
		4.3.4 Fresh and Dry weight of Leaves	94
	4.4	Conclusion	94

5.	VEGETATIVE COMPONENTS AND YIELD OF TWO <i>MOLINERIA</i> SPECIES UNDER FIELD CONDITION AS AFFECTED BY NITROGEN AND POTASSIUM	95
5.1	Introduction	95
5.2	Materials And Methods	96
5.3	Results And Discussion	98
5.3.1	Plant height	98
5.3.2	Number of Leaf	98
5.3.3	Number of Inflorescence	102
5.3.4	Fruit bunches weight	102
5.3.5	Fruit weight	102
5.3.6	Photosynthesis rate	103
5.3.7	Nutrient content	103
5.4	Conclusion	106
6	SUMMARY, GENERAL CONCLUSION AND RECOMMENDATION FOR FUTURE RESEARCH	107
	REFERENCES	110
	APPENDICES	126
	BIODATA OF STUDENT	142
	LIST OF PUBLICATIONS	143

LIST OF TABLES

Table	Page
2.1. List of <i>Molineria</i> species can be found in Peninsular Malaysia	6
3.1. Vegetative and reproductive descriptors used for the <i>Molineria</i> accessions	16
3.2. Morphological characteristic of <i>Molineria</i> collected from Peninsular Malaysia.	21
3.3. Reproductive structure of <i>Molineria</i> from Peninsular Malaysia.	23
3.4. Leaf micromorphology	44
3.5. Epidermal cell shape class based on the ratio of cell length and width.	46
3.6. <i>Molineria</i> species found in Peninsular Malaysia.	79
4.1. Shade level and soil for growth of two <i>Molineria</i> species under nursery condition.	82
4.2. Mean square of plant growth parameter of two <i>Molineria</i> species as affected by light intensity and media composition	84
4.3. The effect of light intensity and growing media on the growth parameter (plant height and number of leaf) of <i>Molineria</i> species under nursery condition.	86
4.4. The effect of light intensity and growing media on the growth parameter (shoot and root) of <i>Molineria</i> species under nursery condition.	87
4.5. Height rate of plant height in 10 media with two shading levels with functions of $dy/dx = abce^{-cx}/(1+be^{-cx})^2$ for <i>M. latifolia</i> var. <i>megacarpa</i> ,	92
4.6. Height rate of plant height in 10 media with two shading levels with functions of $dy/dx = abce^{-cx}/(1+be^{-cx})^2$ for <i>M. rubriclavata</i> ,	93
5.1. Nitrogen and potassium rates for two <i>Molineria</i> species grown under field condition	97
5.2. Means square of plant height, number of leaves, yield and photosynthetic rate of two <i>Molineria</i> species as affect by nitrogen and potassium	99
5.3. Means square of nutrient content in leaves tissue of two <i>Molineria</i> species as affect by nitrogen and potassium	100

5.4.	Effect of nitrogen and potassium on plant height, number of leaves, yield of two <i>Molinera</i> species	101
15.5	Photosynthetic rate of two <i>Molinera</i> species at vegetative and reproductive stage	104
5.6	Nutrient content in leaves tissue of two <i>Molinera</i> species as affected by nitrogen and potassium rate at vegetative and reproductive stage	105



LIST OF FIGURES

Figure	Page
3.1. A herbarium voucher for type specimen deposited at herbarium Royal Botanic Garden Kew (RBGK) by Ridley in 1902.	15
3.2. Plants of <i>Molineria</i> spp. in their natural habitat, showing green foliage.	20
3.3. The (a) root , (b) corm and (c) rhizome of <i>Molineria</i> spp.	27
3.4. Petiole colour of <i>Molineria</i> spp a) green b) maroon c) green with maroon stripe	28
3.5. Leaf shape, elliptic, broadest at the middle, with numerous parallel primary veins of <i>Molineria</i> spp.	29
3.6. Leaf base shape of <i>Molineria</i> spp.	30
3.7. <i>Molineria</i> spp. with green petiole and lamina.	32
3.8. Petiole and leaf blade colour of <i>Molineria</i> spp. a) green petiole maroon abaxial lamina b) maroon petiole green lamina c) maroon petiole and abaxial.	33
3.9. Inflorescence of <i>Molineria</i> spp. a)short peduncle b) long peduncle	34
3.10. Flower of <i>Molineria</i> spp. With 2 whorl of 3 lower tepal and 3 upper tepal.	35
3.11. Stamen number of a) <i>Molineria racemosa</i> b) <i>Molineria megacarpa</i> c) <i>Molineria sp</i>	36
3.12. Perigone tube size of <i>Molineria</i> species a) <i>Molineria latifolia</i> var <i>megacarpa</i> b) <i>Molineria latifolia</i> var. <i>latifolia</i> c) <i>Molineria</i> spp	37
3.13. Fruit shape of <i>Molineria</i> species a) ovoid b) botuliform c) capitate	38
3.14. Petiole shape of <i>Molineria</i> spp.	39
3.15. Sclerenchymatous mucilage ducts of <i>Molineria</i> spp.	40
3.16. The structure of sclerenchymatous bundle sheath or fibers	40
3.17. The structure of sclerenchymatous bundle sheath or fibers	41
3.18. The structure of fibre bundle increasing in number and size, and finally forming a fibre ring.	42

3.19.	Type of stomata a) paracytic with tapering end subsidiary cell b) square subsidiary cells.	45
3.20.	Epidermal cell shape a) box-like b) rectangular c) rectangular with tapering end	47
3.21.	Type of trichome a) Unicellular b) stellate c) dendritic d) bifid	48
3.22.	Geographical distribution of <i>Molineria</i> spp. in Peninsular Malaysia	49
3.23.	Classification of <i>Molineria</i> species and varieties generated from gower's general of similarity coefficient based on their vegetative and reproductive morphological characteristics	52
3.24.	Classification of <i>Molineria</i> species and varieties generated from gower's general of similarity coefficient based on their vegetative morphological characteristics	53
3.25.	Classification of <i>Molineria</i> species and varieties generated from gower's general of similarity coefficient based on their reproductive morphological characteristics.	54
3.26.	<i>Molineria rubriclavata</i> a) whole plant b) petiole c) trichome d) flower e) infructescence	58
3.27.	<i>Molineria nitida</i> a) whole plant b) adaxial leaf c) abaxial leaf d) Inflorescence e) Infructescence f) fruit	60
3.28.	<i>Molineria erythrofolia</i> a) whole plant b) leaf c) fruit	62
3.29.	<i>Molineria atrorubens</i> a) whole plant b) leaf c) flower	64
3.30.	<i>Molineria trichobunda</i> a) whole plant b) trichome	66
3.31.	<i>Molineria capitulata</i> a) whole plant b) inflorescence c) flower d) infructescence e) fruit	70
3.32.	<i>Molineria latifolia</i> var. <i>latifolia</i> a) whole plant b) petiole c) flower d) infructescence e) fruit	73
3.33.	<i>Molineria latifolia</i> var. <i>megacarpa</i> a) habitat b) whole plant c) inflorescence d) infructescence e) fruit	76
3.34.	<i>Molineria latifolia</i> var. <i>rutilovenis</i> a) whole plant b) petiole c) flower	78
4.1	Plant height growth of <i>M. megacarpa</i> var. <i>latifolia</i> in (a) 50% shade and (b) 70% shade grown in 10 types of media ratio The media is in the form of $Y=a/1+be^{-cx}$	88

- 4.2. Plant height growth of *M. rubriclavata* in (a) 50% shade and (b) 70% shade grown in 10 types of media ratio The media is in the form of $Y=a/1+be^{-cx}$ 89
- 4.3. Plant height increase rate of *M. latifolia* var. *megacarpa* in (a) 50% shade and (b) 70% shade in 10 types of media ratio 90
- 4.4. Plant height increase rate of *M. rubriclavata* in (a) 50% shade and (b) 70% shade in 10 types of media ratio 91



LIST OF APPENDICES

APPENDIX	Page
Plant collections	126
Specimen examined	127
Scoring data	137
Experimental layout for chapter 4	139
Experimental layout for chapter 5	140
Phosphorus content in leaves tissue of two <i>Molineria</i> species as affected by nitrogen and potassium rate at vegetative and reproductive stage	141

CHAPTER 1

INTRODUCTION

Obesity is becoming a major problem for Asia's residents including Malaysia and has become an epidemic disease for many developing countries. In 2011, Malaysia was ranked first as the country with the most residents who are morbid obese and sixth in the Asia Pacific region. Obesity can lead to many complications and one of the major diseases which are an outcome of obesity is diabetes. A survey which was conducted by National Health and Morbidity Survey (NHMS) showed that in 2011, 2.6 million Malaysian citizens have diabetes problem. This statistic indicates that diabetes in Malaysia has increased by 31% in the past five years. This increment was mainly due to changes in lifestyle with easy access to fast food, high intake of sugar and lack of regular exercise.

Sugar is one of the favourite additives in many foods but high sugar intake brings many health complications. Some opt to reduce intakes but to most health conscious with a sweet tooth prefer to substitute sugars with alternative or artificial sweeteners. Sugar cane or tapioca based sweeteners are still high in calorie and some are thought to be carcinogenic. Sweet proteins are known as the better sugar substitute. At present, *Synsephyllum dulcicum* (miracle fruit) and *Stevia rebaudiana* (stevia) has been used as sweet protein based artificial sweetener. These species however are not originally from Malaysia and still require studies to further understand their adaptability towards Malaysian environment for better growth and yield. Another potential source of artificial sweetener which is locally found is *Molineria latifolia* Colla or lembea.

Botanists observed local villages used the fruits to sweeten their tea and subsequently Yamashita *et al.* (1990) discovered the sweet proteins curculin and neoculin were the source of sweetness found in its fruits. Ismail *et al.* (2011) reported that the protein has chemical properties as anticancer and antidiabetes. Since then, lembea has become one of the herbal plants that has caught much interest of research institutions and farmers. Curculin is 9 000 times sweeter than sucrose and has very low calories. In Malaysia, *Molineria latifolia* can be found in abundance in the rubber plantation and some by the roadside on clay soil. To date, the cultivation of this species is not known and its uses as string in Sarawak was classified as under utilized.

Two species of *Molineria* were reported to be found in Peninsular Malaysia namely *M. capitulata* and *M. latifolia*. *M. latifolia* consists of two varieties which are *M. latifolia* var. *latifolia* and *M. latifolia* var. *megacarpa* (Turner, 1995; Geerinck, 1993). These two varieties differ from one another based on their perigone tube length. *Molineria latifolia* var. *latifolia* has short perigone tube while *Molineria latifolia* var. *megacarpa* has long perigone tube. The plant was considered of minor importance and the main use was from its leaves where they were mainly used as strings. In Sarawak, the leaves of *Molineria* have been used as food wrapper. Decoction of the rhizome can be used to treat poisons. Besides that, the root can be eaten raw to treat fever. In Bukit Larut Taiping, lembea was used as ornamental plant which were also seen in Singapore National Zoo. Due to its foliage and short plant height is attractive as ground covers, borders and because of this

features it was also found planted as far as in the tropical house in Maxwell Zoo, UK (pers. comm. NAP Abdullah).

The systematic and taxonomy of the *Molineria* is still confusing. The last revision done by Geerinck (1993) was mainly done observing by herbarium specimens. So classification of this species becomes difficult because of the lack of references. Since 1993, no comprehensive study was carried out on *Molineria* from Malaysia and prior to introducing this plant as a new crop for cultivation, taxonomic revision to identify the variety or species is required. The taxonomy of the *Molineria* offers an unexpected challenge in its systematic because of the confusion on the presence of beak where *Molineria* species can be recognized based on the leaf shape, colour and the yellow flower with six tepals. However, taxonomic revision based on the morphological and anatomical characteristics requires further study in order to obtain the actual number of *Molineria* species that can be found in Peninsular Malaysia.

Due to its new found uses and importance with high economic potential, *Molineria* was categorized as one of the important herbal plants in Malaysia. However they are still considered as wild, at times as weeds with no prior reports on their cultivations. Agronomic practices and planting requirement for this plant is required for its cultivation. Due to its abundance, this plant is considered as easy to grow and also this plant is able to vegetatively reproduce through its rhizome and corms.

Domestication of wild plants indubitably will alter the growth condition and plants with higher capability to adapt will survive. However, in agriculture adaptation is not the main factor in selection of wild plant as new crop. The plant with high quality and yield traits were desirable for selection. In order to obtain high quality and yield of the plant, of the growth factors such as light intensity and planting media are usually manipulated. Light intensity is the main growth factor for shaded plant. Besides, the planting medium also plays an important role in plant growth. The medium will affect the absorption rate of nutrients by the root. Generally, *Molineria* is mostly found growing in soil with high humus or organic matter and shaded area such as under rubber plantation and secondary forest. Although the 3:2:1 ratio of top soil, organic matter and sand is known as the standard medium type for most crop, some may prefer different ratio or type of media. Before *Molineria* species can be grown under field condition, factors influencing their growth under nursery condition must be studied. In addition, plants collected from the wild require the hardening process, adaptation and gradually introduction into a new environment.

Beside light and planting medium, the plant also needs the right combination of nutrients to grow and produce larger plant with high yield. Plants will attain optimum growth and produce high yield if they received the optimum nutrient rate. In their natural habitat, dried leaves and rotting wood served as source of nutrient for *Molineria* as it was mostly found in high organic soils, with an exception of one species that was found in open area with clay soils. Nutrient uptake by plant will influence the quality and quantity of the curculin in the *Molineria* fruit. Therefore, observation on the

nutrient requirement of *Molineria* species for better quality and high yield seems to be an important task before going for commercialization as artificial sweetener.

This study looks at two different approaches of taxonomic revision for species identification, species suitable for cultivation and growth performance studies under nursery and field conditions. The objectives of this study were:

- 1) To identify, describe and classify *Molineria* species and varieties from Peninsular Malaysia.
- 2) To determine suitable planting medium and shade requirement for growth of two *Molineria* species under nursery conditions.
- 3) To determine the effect nitrogen and potassium rates on growth and yield of two *Molineria* species under field conditions.

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