UNIVERSITI PUTRA MALAYSIA

# CONSERVATION AND DIVERSITY OF HEMPEDU BUMI (ANDROGRAPHIS PANICULATA NEES) GERMPLASM IN MALAYSIA

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FP 2003 14

# CONSERVATION AND DIVERSITY OF HEMPEDU BUMI (*Andrographis paniculata* Nees) GERMPLASM IN MALAYSIA

**By**

**MELAKU ADDISU BIFFA**

**Thesis Submitted in Fulfilment of the Requirement for the Degree of Master of Agricultural Science in the Faculty of Agriculture Universiti Putra Malaysia**

**November 2003**

## DEDICATION

Dedicated to my wife Ayesha Muhidin, my daughter Hawi Melaku, my mother Aberash G/Mariam and my father Addisu Biffa.

Abstract of the thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Agricultural Science

**CONSERVATION AND DIVERSITY OF HEMPEDU BUMI** (*Andrographis paniculata* Nees) **GERMPLASM IN MALAYSIA**

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**Faculty: Agriculture**

*Andrographis paniculata*, a member of *Accantaceae* family, is a soft wooded herbaceous plant having multiple uses in traditional as well as pharmacological (modern) medicine. Collection was carried out on *A. paniculata* germplasm from Selangor, Negeri Sembilan and Perak states of Peninsular Malaysia. The objectives of the study were to conserve *A. paniculata* germplasm from different agroecological conditions of Peninsular Malaysia, to analyze variability and rationalize the germplasm accessions using agro-morphological traits and to evaluate the germplasm and thereby identify promising genotypes.

As noticed during the collection activity, the habitat preference of the plant was wide. The ranges of habitats include neglected fields invaded with noxious weeds, rocky and poor soil conditions and backyard of houses in villages.

Of the total 38 accessions collected, 26 were evaluated in the field using Randomized Complete Block Design in three replications. The coefficient of variation values for most of the quantitative morphological characters were generally moderate. Moreover, the qualitative traits such as mature and immature leaf color, leaf shape, plant growth habit and stem color showed the presence of different types within the germplasm studied.

Cluster analysis done on 26 accessions showed the presence of four distinct groups. However, this grouping pattern did not show parallelism between the geographical and genetic diversity. The result generally showed the existence of similar genotypes in all of the three states considered under this study.

Principal component analysis showed the first two axes represent 66.67% of the total variation that identified the importance of flowering date, shoot fresh weight, root fresh weight, leaf dry weight, stem dry weight, root dry weight and root volume towards genetic divergence. The first axis was able to differentiate the first two groups from the 3$^{rd}$ and 4$^{th}$ groups from the cluster analysis.

Heritability values revealed high to moderate for flowering date, shoot fresh weight, root dry weight, root fresh weight, branch length, root volume, plant height, leaf dry weight and leaf width.

The association between morphological characters showed strong positive correlation between flowering time and most of the vegetative characters. Significant and negative correlation was obtained between flowering time and plant height, branch length and internode length.

The result of this study revealed that five accessions, namely; 11549, 11300, 11284, 11261 and 11233, had promising potential for the production of high shoot and root biomass.

Abstrak tesis diserahkan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains Pertanian.

**PENGEKALAN DAN KEPELBAGAIAN GERMPLASMA HEMPEDU BUMI (*Andrographis paniculata* Nees) DI MALAYSIA**

**Oleh**

**MELAKU ADDISU BIFFA**

**November 2003**

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**Fakulti : Pertanian**

*Andrographis paniculata*, dari famili *Accantaceae*, merupadalah tumbuhan herba berkayu lembut yang mempunyai pelbagai kegunaan tradisional dan moden terutamanya dalam bidang perubatan farmakologi. Koleksi germplasma *A. paniculata* telah dikumpulkan dari tiga negeri di Semenanjung Malaysia, iaitu Selangor, Negeri Sembilan dan Perak. Objektif kajian ini adalah untuk menganalisa variasi genetik pada spesis tumbuhan tersebut, serta mengenalpasti kepelbagaian germplasma dengan menggunakan ciri-ciri agronomi dan morfologi bagi menentukan genotip yang berkualiti.

Semasa melaksanakan aktiviti pengumpulan germplasma, didapati bahawa habitat kesesuaiannya adalah amat luas. Antara kawasan-kawasan yang diperhatikan termasuklah lapangan-lapangan terbiar yang telah ditumbuhi

rumpai-rumpai di kawasan tanah yang berbatu dan kurang subur di halaman rumah-rumah kampung. Sejumlah 38 sampel telah dikumpul, kan dan 26 daripadanya diuji diladang menggunakan Rekabentuk Blok Lengkap Rawak dengan tiga replikasi. Keputusan koefisien variasi hasil pemerhatian sifat-sifat kuantitatif menunjukkan kdengan ehadiran variasi yang sederhana. Sifat-sifat kualitatif seperti warna daun matang, warna daun belum matang, bentuk daun, corak pertumbuhan pokok dan warna batang didapati menunjukkan kehadiran sifat pelbagai jenis dalam germplasma yang dikaji.

Analisis kluster telah dibuat ke atas 26 aksesi menunjukkan kehadiran empat kumpulan yang berbeza. Walau bagaimanapun, kumpulan ini tidak menunjukkan persamaan di antara geografi dan kepelbagaian genetik. Secara umumnya, keputusan yang diperolehi mengenai kewujudan persamaan genotip dalam kesemua tiga negeri masih lagi didalam kajian.

Analisis komponen utama menunjukkan dua paksi yang pertama mewakili 66.67% jumlah variasi yang mengenal pasti kepentingan masa pembungaan, berat bersih pucuk, berat bersih akar, berat kering daun, berat kering stem, berat kering akar dan isipadu akar terhadap perbezaan genetik. Paksi pertama berupaya membezakan dua kumpulan yang pertama daripada kumpulan ketiga dan keempat daripada analisis kluster.

Nilai heritabiliti luas menunjukkan julat antara tinggi hingga sederhana bagi waktu pembungaan, berat basah pucuk, berat kering akar, berat basah akar, panjang batang, isipadu akar, panjang pokok, berat kering daun dan lebar daun.

Perhubungan di antara sifat-sifat morfologi tersebut menunjukkan korelasi yang tinggi antara waktu pembungaan dengan kebanyakkan sifat-sifat yang lain, manakala korelasi negatif diperolehi antara waktu pembungaan dengan ke tinggian pokok, panjang batang dan panjang antara ruas.

Keputusan kajian ini meununjukkan bahawa lima aksesi, iaitu 11549, 11300, 11284, 1 1261 d an 11233, mempunyai potensi yang terbiak untuk penghasilan biomass pucuk dan akar yang tinggi.

## ACKNOWLEDGEMENT

I am grateful to my major supervisor Assoc. Prof Dr. Mohd Said Saad, and supervisory committee members; Assoc. Prof Dr. Ghizan Saleh and Assoc. Prof Dr. Abdul Ghani Yunus, for their indispensable assistance and advice in the accomplishment of this work.

I would like to thank the Ethiopian Agricultural Research Organization for its full sponsor of my study through the Agricultural Research and Training Project. I further extend my gratitude to the Ethiopian students at Universiti Putra Malaysia for their unreserved all time help.

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# CHAPTER 1

## INTRODUCTION

According to Christoph (2000), there are more than 250,000 species of flowering plants world wide, of which about 150,000 species are found in the tropics. About 6,000 of the tropical species have been reported to possess medicinal properties, of which 21% have been recorded in Malaysia as plants used in traditional medicine, where *Andrographis paniculata* is one of them.

Despite its enormous medicinal and economic importance, attempts to cultivate *A. paniculata* have seldom been undertaken in Malaysia, in particular, and in most parts of the world. However, systematic cultivation have been experimented especially in India (Gupta and Srivastava, 1995) and South east Asia (Zhou, 1987; Ramesh *et al*., 1997; Alagesaboopathi and Balu, 1997; Nandi, 1992; Muniramappa *et al*., 1997). It should be noted here that even basic biological data are lacking in this economically valuable species, as is also the case with many other medicinal plants. The involvement of *A. paniculata* in research work and breeding programs for genetic improvement has not been fully realized until recently. There is little information on the genetics of the plant, and the biotic and abiotic factors under its ecological habitat, and germplasm characterization and evaluation data for adaptive traits relevant to specific agronomic or medicinal goals. Consequently very little attempt has been made to identify potential cultivars for medicinal purposes from within the species.

Since the early years, Malaysians have been using the leaves, roots, stems and fruits as ingredients in the preparation of traditional medicine. However, scientific information on medicinal values of the plants is lacking. Documentation on the use of the plants could provide an alternative method for effective and sustainable utilization of resources (Henry, 1923; Mohamed and Mustefa, 1994).

*Andrographis paniculata,* introduced from India, is known locally in most parts of Malaysia, as 'Hempedu bumi'. However, several other names are being used by the local people under different areas of the country. It grows as a wild plant in the open fields but at times planted specially for medicinal purposes to treat hypertension, diabetes, flu and fever among other uses (Kirtikar and Basu, 1975; Robert and Henry, 1980; Mohamed and Mustefa, 1994).

References on genetic variations among medicinal plants are lacking although analysis of such variations hold great promise owing to the location specific attributes of the herbs and the diversity in plant specific compounds of therapeutic and industrial value. It is understood that loss of genetic variations within a given species (genetic depletion) is usually much more serious and occurs earlier than the total extinction of the species itself. The only solution proposed to this rapid exhaustion of diversity is selection and cultivation of promising genotypes.

The present study was undertaken with the following objectives;

1 To conserve *A. paniculata* germplasm from different agroecological conditions of Peninsular Malaysia.

2 To analyze variability and rationalize the germplasm accessions using agro-morphological traits.

3 To evaluate the germplasm and thereby identify promising genotypes.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Botany of *Andrographis paniculata*

*Andrographis paniculata* is a softwooded herbaceous plant belonging to the *Acanthaceae* family. According to Sabu (2002), the genus *Andrographis* consists of 28 species of small annual shrubs essentially distributed in tropical Asia. Only a few species are medicinal, of which *A. paniculata* is the most popular. As outlined by various scientists (Christoph, 2000; Kirtikar and Basu, 1975; Mohamed and Mustefa, 1994; Robert and Henry, 1980), this plant species, in general, has stem of about 30-90cm high, erect, stiff thickened at the lower nodes, quadrangular with the angles slightly winged, smooth, with numerous long divaricats branches. The leaves are opposite, tapering at both ends especially at the base of the petiole, smooth and dark green above but much paler beneath. It produces numerous small flowers, distantly arranged singly or in pairs in a somewhat unilateral manner along the upper side of elongated, arching or slender branches, the whole forming a very wide-spreading, much branched pyramidal paniculate inflorescence. There are two stamens inserted in the throat of the corolla. The filaments are flattened and hairy in the upper part. The anther and the ovary are two celled. The fruits are 0.5 to 1 inch long and acute at both ends and seeds are numerous (6-10 per capsule), glabrous with yellowish brown color.

In the study conducted by Sabu (2002) on the breeding behavior of the plant, both manual selfing and bagging experiments indicated self compatibility of *A. paniculata*. Bagging experiment showed a mean fruit set value of 56.7% under conditions of limited chance for external stimuli (e.g. wind) which could otherwise establish effective contact between stigma and anthers. Manual selfing, netting and open pollination resulted in about 72% fruit set. The bagging experiment was performed on the corridor of the lab to avoid falling of rainwater on the plant. Other experimental plants were grown in the field plot where there was enough natural wind to agitate the plants. The favorable effect of wind on pollination was further confirmed by indoor pollination experiments. When plants were kept in a room where the windows were closed and the fans switched off, there was only 10.8% fruit set. An experiment carried out by same author at the same time indicated that the germination of freshly harvested seeds was negligible (<5%). However, after a period of 3-4 month storage, 85-95% germination was recorded. The reason behind this fact was reported to be due to high moisture content of freshly harvested seeds.

## 2.2 Origin and Distribution

*Andrographis paniculata* is distributed in tropical Asian countries often in isolated patches. It can be found in a variety of habitats viz. plains, hill slopes, wastelands, farm, dry or wet lands, seashore and even roadsides. Native