



**UNIVERSITI PUTRA MALAYSIA**

**FUNGAL PATHOGENS ASSOCIATED WITH *MIKANIA MICRANTHA* AND  
THEIR POTENTIAL AS BIOLOGICAL CONTROL AGENT**

**NURUL SYUHaida ABD KADIR**

**FP 2016 64**

**FUNGAL PATHOGENS ASSOCIATED WITH *MIKANIA MICRANTHA* AND  
THEIR POTENTIAL AS BIOLOGICAL CONTROL AGENT**



**NURUL SYUHaida BT ABD KADIR**

**FACULTY OF AGRICULTURE**

**UNIVERSITI PUTRA MALAYSIA**

**SERDANG, SELANGOR DARUL EHSAN**

**2015/2016**

**FUNGAL PATHOGENS ASSOCIATED WITH *MIKANIA MICRANTHA* AND  
THEIR POTENTIAL AS BIOLOGICAL CONTROL AGENT**

**BY**

**NURUL SYUHaida BT ABD KADIR**

**173391**

**A project report submitted to Faculty of Agriculture, Universiti Putra Malaysia, in  
fulfillment of the requirement of PRT 4999 (Final Year Project) for the award of  
the degree of Bachelor of Agricultural Science.**

**FACULTY OF AGRICULTURE  
UNIVERSITI PUTRA MALAYSIA**

**2015/2016**

## CERTIFICATION

This project report entitled Fungal Pathogens Associated With *Mikania Micrantha* And Their Potential As Biological Control Agent is prepared by Nurul Syuhaida Bt Abd Kadir and submitted to the Faculty of Agriculture in fulfillment of the requirement of PRT 4999 (Final Year Project) for the award of the degree of Bachelor of Agricultural Science.

Student's name:

Nurul Syuhaida bt Abd Kadir (173391)

Student's signature:

.....

Certified by:

.....  
Prof. Madya Dr. Jugah Kadir

Project Supervisor

Department of Plant Protection

Faculty of Agriculture

University Putra Malaysia.

Date : .....

## ACKNOWLEDGEMENTS

First and above all, I would like to thank and praise Allah the Almighty for providing me this opportunity and granting me the capability to run this Final Year Project successfully. This Final Year Project Report appears in its current form due to the assistance and guidance of several important people. With this opportunity, I would therefore like to offer my sincere thanks to all of them.

Prof. Madya Dr. Jugah bin Kadir, my supervisor, my cordial thanks for accepting me as your Final Year Project student, your warm encouragement, thoughtful guidance and critical comments. Not be forgotten, your valuable advice and support during the whole period of study especially for your patience and guidance during the writing process and correction of the thesis.

I want to express my deep thanks to all the laboratory staff of Department of Plant Protection especially Mr. Mohd Razali Nasir, Madam Asmalina Abu Bakar, Mr. Mohamed Nazri Abdul Rahman, Mr. Johari Mohd Sarikat and Madam Junaina Jaafar for their excellent assistance with various problems during my laboratory work, advised for improvement and continuous spiritual support. For all post graduate students, I greatly appreciated your technical assistance in the laboratory, particularly for identification of fungi and your informative answers to my questions.

Thanks also to all the members of plant physiology, Farhana Burhanudin, Nur Asyiqin Othman, Mohd Alif Omar Mustaffa and Mohd Fardzryn Sani for providing a good atmosphere in our department and act as source of information during my critical situation.

My gratitude and deepest appreciation to my mother and family for their material and spiritual support in all aspects of my life, provided assistance in numerous ways and continuous prayer for my success. Thus, I can just thanks for everything and may Allah give you all the best in return.



## LIST OF CONTENT

CONTENT	PAGE
CERTIFICATION	i
ACKNOWLEDGEMENTS	ii
LIST OF CONTENTS	iv
LIST OF TABLES	viii
LIST OF FIGURES	ix
ABSTRACT	x
ABSTRAK	xi
<b>CHAPTER</b>	
<b>1.0 INTRODUCTION</b>	<b>1</b>
<b>2.0 LITERATURE REVIEW</b>	
2.1 <i>Mikania micrantha</i> Kunth.	
2.1.1 Taxonomy	5
2.1.2 Biology	6
2.1.3 Ecology	7
2.1.4 Distribution	8
2.1.5 History of Introduction in Malaysia	9
2.1.6 Economic Importance	10

2.2 Method to Control <i>Mikania micrantha</i>	11
2.2.1 Mechanical/ physical Control	13
2.2.2 Chemical Control	12
2.2.3 Biological Control	14
2.2.3.1 Biological Control of <i>Mikania micrantha</i>	14
Using Insect Pest.	
2.2.3.2 Biological Control of <i>Mikania micrantha</i>	16
Using Fungal Pathogen.	
2.2.3.3 Biological Control of <i>Mikania micrantha</i>	17
Using Parasite Plant.	
2.3 Fungal Pathogen Associated with <i>Mikania micrantha</i>	18
<b>3.0 METHODOLOGY</b>	
3.1 Samples Collection	22
3.2 Isolation of Fungi	22
3.3 Purification of Fungi and Inoculum Production	23
3.4 Identification of Fungi	23
3.5 Pathogenicity Test	24
3.5.1 Effect of Different Fungal Pathogen on Disease	25



development	
3.5.2 Effect of Different Leaf Stages on Disease	25
Development	
3.6 Disease Assessment Progress Rate	26
3.6.1 Data analysis	26
<b>4.0 RESULT AND DISCUSSION</b>	
4.1 Isolation and Fungal Pathogens Associated with <i>Mikania micrantha</i>	27
4.2 Identification of Fungi	27
4.3 Pathogenicity Test	31
4.4 Disease Progress	35
4.4.1 Effect of Different Fungal Pathogen on Disease	43
Development	
4.4.2 Effect of Different Leaf Stages on Disease	45
Development	
4.5 Discussion	48

## **5.0 CONCLUSION**

Conclusion 51

**REFERENCES** 52

**APPENDICES** 62



## LIST OF TABLES

<b>Table</b>	<b>Title</b>	<b>Page</b>
Table 1	Fungal pathogens recorded on weedy species of <i>Mikania</i> by all researchers.	18
Table 2	List of fungal isolates collected from <i>Mikania micrantha</i> from different locations in Universiti Putra Malaysia	28
Table 3	Effect of Different Fungal Pathogens on Disease Severity of <i>Mikania micrantha</i>	42
Table 4	Interaction of Different Leaf Stages of <i>Mikania micrantha</i> and <i>Curvularia</i> sp. on Disease Development	45
Table 5	Interaction of Different Leaf Stages of <i>Mikania micrantha</i> and <i>Colletotrichum</i> sp. on Disease Development	45

## LIST OF FIGURES

<b>Figure</b>	<b>Title</b>	<b>Page</b>
Figure 1	Morphological characteristics of isolated fungi (a) Colony of <i>Curvularia</i> sp. (top view), (b) Colony of <i>Colletotrichum</i> sp. (top view), (c) Colony of <i>Curvularia</i> sp. (bottom view), (d) Colony of <i>Colletotrichum</i> sp. (bottom view), (e) Conidia of <i>Curvularia</i> sp. , (f) Conidia of <i>Colletotrichum</i> sp.	29
Figure 2	Differential reactions of different leaf stages to inoculation of the isolated fungi (a) Control treatment on old leaf stage – no symptom development, (b) Control treatment on young leaf stage – no symptom development, (c) Chlorotic symptom development on older leaves, (d) Leaf spot and necrotic symptom developed on old leaf stage ( <i>Colletotrichum</i> sp.), (e) Severe necrosis development on young leaf stage ( <i>Curvularia</i> sp.), (f) Infection of <i>Colletotrichum</i> sp. on young leaf stage 10 days after infection	32
Figure 3	Effect of Different Fungal Pathogens on Disease Severity of <i>Mikania micrantha</i>	35
Figure 4	Regression of Disease Progress of Different Fungal Pathogens of <i>Mikania micrantha</i> after logit transformation data.	36
Figure 5	Effect of Different Leaf Stages of <i>Mikania micrantha</i> on Disease Development of <i>Curvularia</i> sp.	37
Figure 6	Regression of Disease Development of <i>Curvularia</i> sp. on Different Leaf Stages of <i>Mikania micrantha</i> after logit transformation data	38
Figure 7	Effect of Different Leaf Stages of <i>Mikania micrantha</i> on Disease Development of <i>Colletotrichum</i> sp.	39
Figure 8	Regression of Disease Development of <i>Colletotrichum</i> sp. on Different Leaf Stages of <i>Mikania micrantha</i> after logit transformation data	40

## ABSTRACT

*Mikania micrantha* is an invasive weed that is spreading rapidly to many parts of the world including tropical countries. The abundance of *M. micrantha* in Malaysia is at present a severe problem for plantation area and idle land. This study were conducted to investigate and identify the fungal pathogens associated with *M. micrantha* and their potential as biological control agent. Cultural and chemical control are used extensively to control this invasive weed but it become less effective with buildup of weed resistance on herbicide and labor intensive. Introduction of biological agent will become an alternative method as well as reduce the environmental pollution. In this study, the sample materials were collected based upon disease symptoms shown on the plant parts around UPM Serdang. Isolation and purification of fungi were done in laboratory and followed by identification of fungi based on their morphological characteristics. Pathogenicity test on detached leaf done with focus on the effect of different fungal pathogen and different leaf stages of *M. micrantha* was done. Disease assessments were done to examine the pathogenic level of the isolated fungi based on disease incidence and disease severity. From disease severity data, *Curvularia* sp. is very pathogenic to *M. micrantha* as indicated by high AUDPC value (258.07 unit,  $P < 0.05$ ) and faster disease progress rate (0.26 unit/day,  $P < 0.05$ ). The time taken to reach 50% of disease severity is faster (8 days) compared to *Colletotrichum* sp. (>10 day). Pathogenicity of pathogen on different leaf stages showed older leaf stage is more susceptible to both fungal pathogens. From this study, spot, lesion and necrotic symptoms were exhibited and observed on the leaf parts as a result of pathogenic affect from the isolated fungi and their ability to inhibit the growth of *M. micrantha* by the development of disease.

## ABSTRAK

*Mikania micrantha* merupakan rumpai invasif yang merebak dengan cepat ke merata tempat di dunia termasuk negara-negara tropika. Kehadiran *M. micrantha* yang banyak di Malaysia pada masa ini menjadi masalah kritikal bagi kawasan ladang dan tanah terbiar. Kajian ini telah dijalankan untuk menyiasat dan mengenalpasti patogen kulat yang berkaitan dengan *M. micrantha* dan potensi mereka sebagai agen kawalan biologi. Kawalan kultur dan kimia digunakan untuk mengawal rumpai invasif ini tetapi ia menjadi kurang berkesan dengan pembentukan rintangan rumpai terhadap racun herba dan memerlukan tenaga kerja yang ramai. Pengenalan agen biologi akan menjadi satu kaedah alternatif serta mengurangkan pencemaran alam sekitar. Dalam kajian ini, bahan-bahan sampel diambil berdasarkan tanda-tanda penyakit yang ditunjukkan pada bahagian tumbuhan *M. micrantha* di sekitar UPM Serdang. Pengasingan dan penulenan kulat telah dilakukan di makmal dan diikuti dengan pengenalpastian kulat berdasarkan ciri morfologi mereka. Kemudian, ujian kepatogenan pada daun dilakukan dengan memberi tumpuan kepada kesan patogen kulat yang berbeza dan peringkat daun *M. micrantha* yang berbeza. Penilaian penyakit telah dilakukan untuk meneliti tahap patogenik berdasarkan kejadian penyakit dan keterukan penyakit. Daripada data keterukan penyakit, *Curvularia* sp. adalah sangat patogenik terhadap *M. micrantha* sepertimana nilai AUDPC tertinggi (258,07 unit,  $P < 0.05$ ) dan kadar perkembangan penyakit yang lebih cepat (0.26 unit/hari,  $P < 0.05$ ). Masa yang diambil untuk mencapai 50% daripada keterukan penyakit adalah lebih cepat (8 hari) berbanding *Colletotrichum* sp. (> 10 hari). Patogenik patogen pada peringkat daun yang berbeza menunjukkan peringkat daun yang lebih tua adalah lebih mudah terdedah kepada kedua-dua patogen kulat. Dari kajian ini, bintik daun, luka dan gejala nekrotik telah muncul dan diperhatikan pada bahagian

daun kesan akibat patogenik kulat dan menunjukkan keupayaan mereka untuk menghalang pertumbuhan *M. micrantha* melalui perkembangan penyakit.



## CHAPTER 1

### INTRODUCTION

*Mikania micrantha* Kunth. (Family: Asteraceae) commonly known as mile-a-minute because of its vigorous fast growth habit (Waterhouse, 1994) that colonizes agricultural land and badly damages tree crops and agroforestry in moist tropical forest in Asia, particularly South-east Asia (Choudhury, 1972; Holm *et al.*, 1977; Muniappan and Viraktamath, 1993; Parker, 1972; Waterhouse, 1994). This herbaceous vines is locally known as ‘Selaput Tunggul’ have ability to propagates through wind-dispersed achenes and by stem fragments which easily roots at the nodes (Barreto and Evans, 1994). Its native distribution are South to Central America where it is found in tropical and subtropical areas from sea level up to relatively high altitudes (Holm *et al.*, 1977).

This species has become a major weed throughout Asia and 17 countries in the South Pacific (Waterhouse and Norris, 1987) including Malaysia where it was classified as invasive through Global Invasive Species Database managed by the Invasive Species Specialist Group (ISSG) of the IUCN Species Survival Commission. Besides that, it also listed in Federal Noxious Weed USDA in 2010.

Introductory of this invasive weed in Asia has probably started during the early part of the 20<sup>th</sup> century (Choudhury, 1972; Holmes, 1982; Waterhouse, 1994). Ismail (2001) stated that *M. micrantha* was introduced in Malaysia in the early 1950’s as non-



legume cover crop for rubber plantation due to scarcity of legume seeds. While in Indonesia, it's has been introduced as a ground cover in 1940's and quickly spread to the Pacific Islands, south-east Asia and Papua New Guinea and give problems to plantation and idle land (Waterhouse, 1994). Recently, the weed has spread more to southwestern India where it is invading both natural and planted forests, as well as subsistence and cash crops at the forest interface (Sankaran and Sreenivasan, 2001) and also to China (Zhang *et al.*, 2004).

*M. micrantha* became a problematic weed when it start to cut the light interception of the main crop by smothering on it (Huang *et al.*, 2000). *M. micrantha* successfully outcompeting many plant species by forming a thick ground cover, including food and industrial crops and can be concluded as a major weed of subsistence farms and plantation in many countries. In addition, *M. micrantha* causing a loss of production and localized death of plants which can lead to serious implication for income and food security by chokes and smother other crops. Besides lowering the crop yield, it's also give difficulty in harvesting because of its creeping and twinning habit (Holm *et al.*, 1991; Waterhouse and Norris, 1987). By 1960's, *M. micrantha* became problematic weed in plantation crops, particularly of tea in northeastern India and rubber and oil palm in southeastern Asia (Holm *et al.*, 1977; Parker, 1972; Waterhouse 1994). Teoh *et al.* (1985) reported that yield loss in oil palm up to 20% in the first 5 years was attributed to *M. micrantha* and about 5% of total weed control costs in rubber and oil palm plantation was used to controlled this invasive weed.

Sahid (1995) stated that weed can be host vector for pest and disease that causes reduction in crop yield for about 42% than other pest like insects (28%), pathogen (27%) and nematodes (3%). He added, *M. micrantha* released allelopathy biochemical during decaying and inhibit the vegetative growth of any nearby plants. While most of the seeds were viable up to 80% and can be found for about 3 262/ m<sup>2</sup> for oil palm plantation and 3 292/ m<sup>2</sup> for rubber plantation (Sahid, 1995).

In purpose to curb with these problems, all the mechanical, cultural, chemical and biological controls have been applied (Cock *et al.*, 2000; Ellison and Murphy, 2001; Ellison *et al.*, 2004; Parker, 1972; Zhang *et al.*, 2004). The current management methods are focused on cultural and chemical controls instead of biological controls due to lack of awareness and enforcement in plantation management. In spite of that, cultural and chemical controls are expensive and often ineffective where the weed can be recolonized within two weeks when control by slashing method (Choudhury, 1972) and chemical application were unsustainable as well as environmentally damaging (Sankaran and Sreenivasan, 2001).

According to biological control studies, biological agents has host specificity where it will not affect the non-target species as do as chemical herbicides (CAB International Institute of Biological Control, 1987). Through studies and researches, the natural enemies can be introduced and manipulated to inhibit the growth of uncontrolled invasive weed and reduced the application of herbicides.

Hence, this study will help in controlling the overpopulation of *Mikania micrantha* by using biological control agent as well as reducing the environmental pollution. The objective of this study is to investigate and identify the fungal pathogen associated with *M. micrantha* and their potential as biological control agent while the hypothesis of this study is at least there is a significant different among different fungal used to inhibit *M. micrantha* growth. The higher pathogenicity level exhibit severe damaged on the detached leaf as their ability to inhibit the growth of *M. micrantha*.



## REFERENCES

- ACIAR (Australian Centre for International Agricultural Research). Australian Government. Biological control of 'mile-a-minute' (*Mikania micrantha*) in Papua New Guinea and Fiji. 2006. Accessed on 20th Nov 2015 from <http://aciar.gov.au/project/pc/2004/064>.
- AFCD (Agriculture, Fisheries and Conservation Department) Hong Kong Special Administrative Region. 2006. Accessed on 15th Nov 2015 from [https://www.afcd.gov.hk/english/conservation/conflo/AboutMikania/about\\_mikania.html](https://www.afcd.gov.hk/english/conservation/conflo/AboutMikania/about_mikania.html).
- Armantir, B. 1989. Impact of *Mikania* Spp on Forestry and Agricultural Land. Buletin Penelitian Hutan, 511: 29-40.
- Baker, R.E.D. and Dale, W.T. 1951. Fungi of Trinidad and Tobago. Mycological Papers 33: 1-123.
- Barreto, R.W. and Dick, M.W. 1991. Monograph of *Basidiophora* (Oomycetes) with the description of a new species. Botanical Journal of the Linnean Society 107: 313-332.
- Barnes D.E. and Chan L.G. 1990. Common weeds of Malaysia and their control. Kuala Lumpur : Percetakan Seasons Sdn Bhd.
- Barreto, R.W. and Evans, H.C. 1994. The mycobiota of the weed *Mikania micrantha* in southern Brazil with particular reference to fungal pathogens for biological control. Mycol. Res. 99 (3): 343-352.
- Bavaz, F. A. 1984. Demographic consequences of plant physiological traits: some case studies in "Perspectives on Plant Population Ecology" (R. Dirzo and J. Sarukhan, Eds.), pp. 324- 346, Sinauer, Sunderland, MA.
- Bitancourt, A. and Jenkins, A. 1949. New discoveries of Myriangiiales in the Americas. In Proceedings of the Eighth American Science Congress. 149-172.
- CABI. 1987. *Mycosphaerella berkeleyi*. Distribution Maps of Plant Diseases; 1987. April Edition 5: Map 152. Wallingford, CAB International.

- Cabral, L.M., T.C. dos Santos and F. Alhaique. 2001. Development of a Profitable Procedure for the Extraction of 2-H-1-Benzopyran-2-one (Coumarin) from *Mikania glomerata*. *Drug Development and Industrial Pharmacy* 27: Pp.103-106.
- Caldwell, P.M. and Kluge, R.L. 1993. Failure of the introduction of *Actinote anteus* (Lep.: Acraeidae) from Costa Rica as a biological control candidate for *Chromolaena odorata* (Asteraceae) in South Africa. *Entomophaga*, 38: 475-478.
- Campbell, J.G.C. 1927. Report by the Government mycologist. Annual Report of the Fiji Department of Agriculture for 1926, 3-4.
- Ciferri, R. 1961. Mycoflora Domingensis Integrata. Quaderno Instituto Botanico dellaUniversita Pavia 19: 1-537.
- Choudhury, A.1972. Controversial *Mikania* (climber) – a threat to the forests and agriculture. *Indian Forester* 98, 178–186.
- Chupp, C. 1954. A Monograph of the Fungus Genus *Cercospora*.
- Cock, W.J.W. 1982a.potential biological control agents for *Mikania micrantha* HBK from the Neotropical Region. *Tropical Pest Management*, 28: 242-254.
- Cock, W.J.W. 1982b. The biology and host specificity of *Liothrips mikaniae* (Priesner) (Thysanoptera : Phlaeothripidae), a potential biological control agent of *Mikania micrantha* (Compositae). *Bulletin of Entomological Research*, 72: 523-533.
- Cock, M.J.W., Ellison, C.A., Evans, H.C., Ooi, and P.A.C. 2000. Can failure be turned into success for biological control of mile-a-minute weed (*Mikania micrantha*) In: Spencer, N.R. (Ed.), *Proceedings of the X International Symposium on Biological Control of Weeds*. USDA Agricultural Research Service, Bozeman, Montana, USA, Pp. 155–167.
- Day, M. and Bofeng, I. 2007. The status of biocontrol of *Chromolaena odorata* in Papua New Guinea. In *Proceedings of the Seventh International Workshop on Biological Control and Management of Chromolaena and Mikania*, ed. P.-Y.Lai, G.V.P. Reddy and R. Muniappan. Taiwan: National Pingtung University, pp. 53–67.

- Day M.D., Kawi A.P., and Ellison C.A. 2013. Assessing the potential of the rust fungus *Puccinia spegazzinii* as a classical biological control agent for the invasive weed *Mikania micrantha* in PNG : Biological control 67. Pp 253-261.
- Deng, X., Ye, W.H., Feng, H.L., Yang, Q.H., Cao, H.L. and Xu, K.Y. 2004. Gas exchange characteristics of the invasive species *Mikania micrantha* and its indigenous congener *M. cordata* (Asteraceae) in South China. Botanical Bulletin of Academia Sinica, 45: 213–220.
- Desmier de Chenon, R., Sipayung, A. and Sudharto, P. 2002. A new biocontrol agent, *Actinote anteas*, introduced into Indonesia from South America for the control of *Chromolaena odorata*. In Zacchariades, C., Muniappa, R. & Strathie, L.W. (eds). Proc. 5th Int. Workshop on Biological Control and Management of *Chromolaena odorata*. ARCPPRI. Pp.170-176.
- Ellison, C. and Murphy, S.T. 2001. Dossier on: *Puccinia spegazzinii* de Toni (Basidiomycetes:Uredinales) a Potential Biological Control agent for *Mikania micrantha* Kunth. Ex. H.B.K. (Asteraceae) in India. Pp.50.
- Ellison, C.A., Evans, H. C. and Ineson, J. 2004. The significance of intraspecies pathogenicity in the selection of a rust pathotype for the classical biological control of *Mikania micrantha* (mile-a-minute weed) in southeast Asia, In: Cullen, J.M., Briese, D.T., Kriticos, D. J., Lonsdale, W. M., Morin, L., Scott, J. K. (eds), proceedings of the XI International Symposium on Biological Control of Weeds, CSIRO Entomology, Canberra, Australia, Pp. 102-107.
- Ellison, C.A., Evans, H.C., Djeddour, D.H. and Thomas, S.E. 2008. Biology and hostrange of the rust fungus *Puccinia spegazzinii*: a new classical biological control agent for the invasive, alien weed *Mikania micrantha* in Asia. Biol. Control, 45: 133–145.
- Ellison, C. and Day, M. 2011. Current status of releases of *Puccinia spegazzinii* for *Mikania micrantha* control. Biocontrol News Info.32, 1N.
- Evans, H.C. 1987. Fungal pathogens of some subtropical and tropical weeds and the possibilities for biological control. Biocontrol News and Information 8: 7-30.
- Farr, D.F., Bills, G.F., Chamuris, G. P. and Rossman, A.Y. 1989. Fungi of Plants and Plant Products in the United States. APS Press: St Paul Minnesota.
- Fatima, M., Rais, M. and Nayeemullah, M. 1969. Some new records of fungi. Agriculture Pakistan 20: 443-445.

- Feng, H.L., Cao, H.L., Liang, X.D., Zhou, X. and Ye, W.H. 2002. The distribution and harmful effects of *Mikania micrantha* in Guangdong. *Journal of Tropical and Subtropical Botany*, 10: 263–270.
- Frischknecht, P. M., Ulmer-Dufek, J. U., and Baumann, T. W. 1986. Purine alkaloid formation in buds and developing leaflets of *Coffea arabica*: Expression of an optimal defense. *Phytochemistry* 25; 613-616.
- Gallegos, H.L. and Cummins, G.B. 1981. *Uredinales de Mexico*. Secretaria de Agricultura y Recursos Hidraulicos: Mexico City.
- Hansford, C.G. 1941. Contributions towards the fungus flora of Uganda. *Proceedings of the Linnean Society of London (1940-1941)*, 153: 4-52.
- Hansford, C.G. and Deighton, F.C. 1948. West African Meliolineae. *Mycological Papers* 23: 1-79.
- Hansford, C.G. 1961. The Meliolineae - a monograph. *Beihefte zur Sydowia*, 1 806.
- Haroun N.E. 2015. Bioherbicidal activity of *Curvularia lunata* on common cocklebur(*Xanthium strumarium* L.). *Int. J. Curr. Microbiol. App. Sci* 4(2): 623-631.
- Harper, J. 1989. The value of a leaf, *Oecologia* 80; 53-58.
- Hennings, P. 1896. Beitrage zur pilzflora Sudamerikas *Hedwigia* 35: 202-262 (English version).
- Holm, L.G., Pluckneet, D.L., Pancho, J.V., and Herberger, J.P. 1977. *The World's Worst Weeds: Distribution and Biology*. University Press of Hawaii, Honolulu, Hawaii.
- Holmes, W.C. 1982. Revision of the Old World *Mikania* (Compositae). *Botanisches Jahres Beitragefeur Systemati*, 103: 211-246.
- Holm, L.G., Pluckneet, L.D., Pancho, J.V., and Herberger, J.P. 1991. *The World's Worst Weeds: Distribution and Biology*. Malabar, FL: Krienger Publishing (The University Press of Hawaii, Honolulu). Pp. 609.

- Hu, Y. J. and But, P. H. 1994. A study on life cycle and response to herbicides of *Mikania micrantha*. *Acta Scientiarum Naturalium Universitatis Sunyatseni* 33, 88-95 (English version).
- Hu, Y.J. and But, P.H. 2000. Morphological and structural features of *Mikania micrantha* flower. *Scientiarum Naturalium Universitatis Sunyatseni* ,39: 123–125.
- Hua Yu, Fei-Hai Yu, Shi-Li Miao and Ming Dong. 2008. Holoparasitic *Cuscuta campestris* suppresses invasive *Mikania micrantha* and contributes to native community recovery. *Biological conservation*, 141: 2653-2661.
- Huang, Z.L., Cao, H.L., Liang, X.D., Ye, W.H., Feng, H.L. and Cai, C.X. 2000. The growth and damaging effect of *Mikania micrantha* in different habitats. *Journal of Tropical and Subtropical Botany*, 8: 131–138.
- Huang, H.J., Ye, W.H., Wei, X.Y. and Zhang, C.X., 2009. Allelopathic potential of sesquiterpene lactones and phenolic constituents from *Mikania micrantha* H.B.K. *Biochem. Syst. Ecol.*, 36: 867–871.
- Invasive Pest Fact Sheet. Asia- Pacific Forest Invasive Species Network. Asia Pacific Forestry Asia- Pacific Forestry Commission (APFC) - a statutory body of the Food and Agricultural Organization of the United Nations (FAO).
- Ismail A.A. 2001. Impact and management of selected alien and invasive weeds in Malaysia with some action plans instituted for biological diversity. In: *Proceedings of the Third International Weed Science Congress*. Oxford, UK: International Weed Science Society.
- Jackson, H.S. 1932. The rusts of South America based on the Holway collections *Mycologia* 24: 62-186.
- Johnston, A. 1960. A supplement to a host list of plant diseases in Malaya. *Mycological Papers* 77: 1-30.
- Jorstad, I. 1956. Uredinales from South America. *Arkiv for Botanik* 3: 443-490.
- Kong, G.H., Wu, Q.G. and Hu, Q.M. 2000. Appearing of exotic weed *Mikania micrantha* H.B.K. in China. *Journal of Tropical and Subtropical Botany* 8, 27 (English Version).



- Koirala, N.P., Thapa, C., Poudel, D., Silwal, D., Ghimire, K., Rasaily, S., Karki, S., Sanjel, S. Gyawali. A., Pandit, M., Pudasaini, R., Pokharel, P. and Hussain, M. S. 2011. *Mikania micrantha* in Citwan National Park and its Control Using Rust *Puccinia spegazzinii*.
- Kuo, L.K., Chen, T,Y, and Lin, C.C. 2002. Using a consecutive cutting method andallelopathy to control the invasive vine, *Mikania micrantha* H.B.K. Taiwan Journal of Forest Science 17, 171–181.
- Leather, R.I. 1967. A catalogue of some plant diseases and fungi in Jamaica. Ministry of Agriculture and Lands of Jamaica. Bulletin 61: 1-92.
- Li, W.H., Zhang, C.B., Jiang, H.B., Xin, G.R. and Yang, Z.Y. 2006. Changes in soilmicrobial community associated with invasion of the exotic weed, *Mikania micrantha* H.B.K. Plant and Soil 281: 309–324.
- McKey, D. 1974. Adaptive patterns in alkanoid physiology, Am. Nat. 108; 305-320.
- McKey, D. 1979. The distribution of secondary compounds within plants, in "Herbivores: Their Interactions with Secondary Plant Metabolites" (G. A. Rosenthal and D. H. Janzen, Eds.), pp. 56-206, Academic Press., New York.
- Mooney, H. A. and Gulmon, S. L. 1982. Constraints on leaf structure and function in reference to herbivory, BioScience 32; 198-206
- Muceneeki, R.S., C.M. Amorim, T.G. Cesca, M.W. Biavatti and T.M.B. Bresolin. 2009. A Simple and Validated LC method for the simultaneous determination of three compounds in *Mikania laevigata* extracts. Chromatographia, 69: 219-223.
- Muniapan, R., and Viraktamath, C. A. 1993. Biological control programmes in India – a review in retrospect, Curr. Sci., 65 : 899-901.
- Olive, E.W. and Whetzel H.H. 1917. Endophyllum-like rusts of Puerto Rico. American Journal of Botany 1: 44-52.
- Palit S. 1981. *Mikania* — a growing menace in plantation forestry in West Bengal. Indian Forester, 107: 97–107.

- Pandey, S. and Regmi. C. 2013. Nepal Journal of Science and Technology. Vol. 14, No.1.Pp.115-120. Accessed on 13th Dec 2016 from <http://www.nepjol.info/index.php/NJST/article/view/8931>.
- Parker, C. 1972. The Mikania problem. Pest Articles & News Summaries, 18: 312-315.
- PIER – Pacific Island Ecosystems at Risk., 2012. Plant threats to Pacific Ecosystems. Accessed on 30th Dec 2015 from <http://www.hear.org/pier/scientificnames/index.html>
- Piening, L.J. 1962. A check list of fungi recorded from Ghana. Ghana Ministry of Agriculture Bulletin 2: 1-130.
- Qi, H.Y., Hui, L.F., Wan, H.Y., Hong, L.C., Xiong, D. and Kai Y.X. 2003. An Investigation of the Effects of Environmental Factors on the Flowering and Seed Setting of *Mikania micrantha* H. B. K (Compositae). Journal of Tropical & Subtropical Botany. 11(2): 123-126.
- Rada, G.G. and Stevenson, J.A. 1942. La Flora Fungosa Peruana. Estacion Experimental Agricola de La Molina: Lima.
- Saccardo, P.A. 1886. Sylloge Fungorum 4: 723.
- Saccardo, P.A. 1895. Sylloge Fungorum 11: 267.
- Saccardo, P.A. 1913. Sylloge Fungorum 22: 225.
- Saccardo, P.A. 1926. Sylloge Fungorum 24: 251.
- Saccardo, P. A. 1931. Sylloge Fungorum 25: 495.
- Sahid, I. 1995. Rumpai Tropika : Impak Biologi DNA Pengurusan. Kuala Lumpur: Universiti Kebangsaan Malaysia.
- Sankaran, K.V. and Sreenivasan, M.A. 2001. Status of Mikania infestation in the Western Ghats. In: Sankaran KV, Murphy ST, Evans HC, eds. Alien weeds in moist tropical zones, banes and benefits. Kerala, Peechi, India: Kerala Forest Research Institute. Pp. 67–76.

- Schneider, R.W., Williams, R.J. and Sinclair J.B. 1976. Cercospora Leaf Spot of Cowpea: Models for Estimating Yield Loss. *Phytopathology* 66: 384-388.
- Sen Sarma, P.K. and S.C. Mishra. 1986. Biological control of forest weeds in India retrospect and prospects. *Indian Forester* 112: 1088-1093.
- Shao, H., Peng, S.L., Wei, X.Y., Zhang, D.Q. and Zhang, C. 2005. Potential allelochemicals from an invasive weed *Mikania micrantha* H.B.K. *J. Chem. Ecol.*, 31: 1657–1668.
- Shen H., Ye, W., Hong, L. and Wang, Z. 2005. Influence of the obligate parasite *Cuscuta campestris* on growth and biomass allocation of its host *Mikania micrantha*: *Journal of Experimental Botany*. 56 : 415. Pp. 1277-1284. Accessed on 12th Dec 2015 from <http://jxb.oxfordjournals.org/content/56/415/1277.full>
- Shen H., Hong L., Chen H., Ye W. H., Cao H. L. and Wang Z. M. 2011. The response of the invasive weed *Mikania micrantha* to infection density of the obligate parasite *Cuscuta campestris* and its implications for biological control of *M. micrantha*. *Botanical studies*. 52: 89-97.
- Shukla, M. and Mishra, M. 2012. *Curvularia* linata as bioherbicide for management of *Xanthium strumarium* L., an abnoxious weed – A Critical Evaluation. *Journal of Phytology* 4(5): 26-29.
- Stevenson, A. 1975. Fungi of Puerto Rico and the American Virgin Islands. *Contribution of Reed Herbarium* 23: 1-743.
- Swamy, P.S. and Ramakrishnan, P.S. 1987. Effect of fire on population dynamic of *Mikania micrantha* H.B.K. during early succession after slash-and-burn agriculture in Northeast India. *Weed Research*, 27: 397–404.
- Temur, H.A., Hameed, F.E. and Hameed A. 2014. The fungus *Curvularia clavata* Biological Control Agent against weed *Desmostachya bipinnata*. *Euphrates Journal of Agriculture Science* 6 (1): 9-18.
- Teoh, C.H., Chung, G.F., Liau, S.S., Ghani Ibrahim, Tan, A.M., Lee, S.A. and Mariati Mohammed. 1985. Prospects for biological control of *Mikania micrantha* HBK in Malaysia *Planter*, 61: 515-530.

The Global Invasive Species Database, Invasive Species Specialist Group (ISSG) of the IUCN Species Survival Commission. Accessed on 03th Nov 2015 from <http://www.issg.org/database/species/search.asp?st=100ss>.

Thompson, A. and Johnson, A. 1953. A host list of plant disease in Malaya. Mycological Papers, 52: 1-38.

Trotter, A. 1972. P. A. Saccardo's Sylloge Fungorum 26: 230.

Urriaga, R. 1986. Indice de Enfermedades en Plantas de Venezuela y Cuba.

Viegas, A.P. 1945a. Alguns fungos do Brasil 4 - Uredinales. Bragantia 5: 1-144.

Viennot-Bourgin, G. 1954. Etude de quelques Peronosporales de Cote D'Ivoire. Revue de Mycologie 19, Supplement Colonial 2: 45-54.

Wang, C.X., Zhu, M.X., Chen, X.H. and Qu, B. 2011. Review on allelopathy of exotic invasive plants. Procedia Eng., 18: 240–246

Waterhouse, D.F. and Norris, K.R. 1987. Biological Control: Pacific Prospects. Inkata Press, Melbourne.

Waterhouse, D.F. 1994. Biological Control of Weeds: Southeast Asian Prospects. ACIAR, Canberra. Weevers, Th. 1930. Die Funktion der Xantinderivate in Pflanzenstoffwechsel, Arch. Neerl. Sci. Ex. Nat. Ser. IIIB 5; 111-197.

Wei, Y.Z., Ming, G.L., Run, R.Z., Qi, J.Z. and Bo, S.W. 2005. Dynamics of Seeds Bank of *Mikania micrantha* Populations. Wuhan Zhiwuxue Yanjiu. 23(1): 49-52.

Wen, D.Z., Ye, W.H., Feng, H.L. and Cai, C.X. 2000. Comparison of basic photosynthetic characteristics between exotic invader weed *Mikania micrantha* and its companion species. Journal of Tropical and Subtropical Botany, 8: 139–146.

Winter, G. 1886. Fungi novi brasiliensis. Grevillea 15: 86-92.

Wirjahardja, S. 1976. Autecological study of *Mikania* spp. Proceedings of 5<sup>th</sup> Asian Pacific Weed Science Society Conference. Asian-Pacific Weed Science Society, Tokyo, Japan, Pp. 70–73.

- Whiteside, I.O. 1966. A revised list of plant diseases in Rhodesia. *Kirkia* 5: 87-196.
- Xie, Y., Li, Z., William, P.G. and Li, D. 2000. Invasive species in China – an overview. *Biodiversity and Conservation* 10, 1317–1341.
- Ye, W.H. and Zhou, X. 2001. The plant killer *Mikania micrantha* in South China. *Aliens* 13, 7.
- Yen, I. and Lim, G. 1983. Etudes sur les champignons parasites du Sud-est Asiatique, 47. Champignons parasites de Malasie, 24. *Bulletin de la Societi Mycologique de France* 99, 357-360 (English version).
- Yen, J. and Lim, G. 1980. *Cercospora* and allied genera of Singapore and the Malay Peninsula. *Gardens' Bulletin, Singapore* 33: 151-263.
- Zacchariades, C., Strathie, L.W. and Kluge, R.L. 2002. Biology, host specificity and Effectiveness of insects for the biocontrol of *Chormolaena odorata* in South Africa. In Zacchariades, C., Muniappa, R. & Strathie, L.W. (eds). *Proc. 5th Int. Workshop on Biological Control and Management of Chromolaena odorata*. ARC-PPRI. Pp. 160-166.
- Zan, Q.J., Wang, Y.J., Wang, B.S., Liao, W.B. and Li, M.G. 2000. The distribution and harm of the exotic weed *Mikania micrantha*. *Journal of Ecology*, 19: 58–61.
- Zangerl, A. R., and Bazzaz, F. A. 1992. Theory and pattern in plant defense allocation in "Plant Resistance to Herbivores and Pathogens" (S. Fritz and E. L. Simms, Eds.), pp. 363-391, Univ. Press, Chicago.
- Zhang, L.Y., Ye, W.H., Cao, H.L. and Feng, H.L. 2004. *Mikania micrantha* H.B.K. in China – an overview. *Weed Research*, 44: 42–49.