UNIVERSITI PUTRA MALAYSIA

EFFECTS OF FERTILIZER APPLICATION METHOD ON VEGETATIVE GROWTH OF *Andrographis paniculata* Wall ex. Ness

NURLIYANA ZAHID

FP 2015 95

EFFECTS OF FERTILIZER APPLICATION METHOD ON VEGETATIVE GROWTH OF *Andrographis paniculata* Wall ex. Ness

NURLIYANA ZAHID

FACULTY OF AGRICULTURE

UNIVERSITY PUTRA MALAYSIA

2014/2015

EFFECTS OF FERTILIZER APPLICATION METHOD ON VEGETATIVE GROWTH OF *Andrographis paniculata* Wall ex. Ness

BY

NURLIYANA BINTI ZAHID

A project paper report submitted to Faculty of agriculture, University Putra Malaysia, in fulfillment of the requirement of PRT4999 (Final Year Project) for the award of the degree of Bachelor of Horticulture Science

CERTIFICATION

This project paper report entitled Effects of Fertilizer Application Method on Vegetative Growth of *Andrographis paniculata* is prepared by Nurliyana Binti Zahid 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 Horticultural Sceience.

Student's name: Student's signature

……. ……..

Certified by:

…….

Associate Professor Dr. Siti Aishah binti Hassan

Department of Crop Science

Date:……...

ACKNOWLEDGEMENT

Firstly, grateful to ALLAH because give me courage, spirit, patience and strength to finish up the study. I would like to express my most appreciation to all individuals who contributed to this project especially my supervisor, Assoc. Prof Dr. Siti Aishah Hassan for her time, continuous guidance, great concern, value able comment, advice and suggestion from the beginning, till the end of this study.

I would like to thanks to Miss Suraya Saari and fellow friends to support and help me to complete this study. I would like also to thanks for all academic staff in the Agriculture faculty, UPM for their dedication in delivering knowledge and contribution towards the research in the faculty. In addition, I would like to thanks the entire science officers, Tuan haji Mohd Khoiri Gandar, Mr Mohd Yusoff, Mr Azhar for their guidance throughout the study conducted.

My deepest thanks go to my beloved family and siblings for their continuous understanding support and scarifies throughout the period of my study. I would like to thanks University Putra Malaysia for funding this study.

CONTENTS

PAGES

ACKNOWLEDGEMENT....i

CONTENTS.... ii

LIST OF TABLES....vi

LIST OF FIGURES....vii

ABSTRAK....viii

ABSTRACT....x

1.0 INTRODUCTION....1

2.0 LITERATURE REVIEW....3

2.2 *Andrographis paniculata*....3

2.1.1 Taxonomy and plant characteristic....3

2.1.2 Medicinal uses of andrographis paniculata....4

2.2 Fertilizer....5

2.2.1 Organic fertilizer....5

2.3 Integrated nutrient management....6

2.3.1 Application methods....7

2.3.1.1 Basal application 7

2.3.1.2 Foliar application 7

2.3.1.3 Timing of application 8

3.0 MATERIALS AND METHODS 9

3.1 Experimental location 9

3.2 Pre experiment analysis 9

3.2.1 Soil analysis 9

3.2.2 Nutrient composition fertilizer 9

3.3 Planting materials and seedling preparation 10

3.4 Planting media 11

3.5 Treatment and experimental design 12

3.6 Plant management 13

3.6.1 Fertilization 13

3.6.2 Water management 13

3.6.3 Weeding 13

3 .7 Data collection 13

3.8 Parameter collected 14

3.8.1 Growth 14

3.8.1.1 Plant height (cm) 14

3.8.1.2 Plant weight (g) 14

3.8.1.3 Number of branches 14

3.8.1.4 Total Leaf area (cm^2) 14

3.8.2 Physiological characters 15

3.8.2.1 Relative Chlorophyll Content 15

3.8.3 Phytochemical content 15

3.8.3.1 Nutrient analysis 15

3.8.3.2 Antioxidant activities 15

3.8.3.2.1 Extraction of antioxidant compound 15

3.8.3.2.2 Total Phenolic acid assay 16

3.8.3.2.3 Total flavonoid assay 16

3.8.3.2.4 DPPH free radical assay 17

3.8.3.2.5 Ferric reducing antioxidant power assay (FRAP) 17

3.9 Statistical analysis 18

4.0 RESULTS AND DISCUSSION 19

4.1 Pre treatement analysis 19

4.1.1 Soil analysis 19

4.1.2 Nutrient analysis 19

4.2 Plant growth 20

4.2.1 Plant height 20

4.2.2 Plant weight 22

4.2.3 Number of branches 24

4.2.4 Total Leaf area 25

4.3 Physiological characteristic 27

4.3.1 Relative chlorophyll content 27

4.4 Phytochemical content 29

4.4.1 Nutrient content 29

4.4.2 Antioxidant activity 31

5.0 CONCLUSION 33

REFERENCE 34

APPENDICES 44

LIST OF TABLES

Page

Table 1: Method and quantity of fertilizer application 12

Table 2: Composition of N in the organic fertilizer used in this experiment 19

Table 3: The number of branches of *Andrographis paniculata* as affected by methods of organic fertilizer application 24

Table 4: Total leaf area of *Andrographis paniculata* as affects to the methods of organic fertilizer application 26

Table 5: Nutrients content of *Andrographis paniculata* as affected by the methods of organic fertilizer application. 30

Table 6:Phytochemical content of *Andrographis paniculata* as affected by the methods of organic fertilizer application. 32

LIST OF FIGURE

Page

Figure 1: Seedling of *Andrographis paniculata* accession Harapan 2 weeks after sow. 11

Figure 2: Plant height as influence by organic fertilizer applications methods from 2 to 8 weeks after transplanting (WAT). 21

Figure 3: Mean of total plant weight as affected by methods of organic fertilizer application. 23

Figure 4: Mean of relative chlorophyll content affected by methods of fertilizer application 28

ABSTRAK

Permintaan terhadap herba organik meningkat disebabkan oleh kesedaran terhadap kesihatan dan kebaikan tumbuhan herba sebagai rawatan alternatif dalam perubatan. *Andrographis paniculata* yang dikenali dengan kebaikan dan khasiatnya yang antiglikemik, antimikrob dan antioksidan. Maka, kajian ini dijalankan untuk mengenalpasti kaedah pembajaan yang sesuai untuk pertumbuhan bahagian vegetatif *A.paniculata*. Lima rawatan telah diuji dalam kajian ialah, Kontrol (T0): pembajaan tahi ayam pada hari pemindahan ke polibeg (HP), T1: pembajaan tahi ayam berasingan (HP)dan 14 hari selepas pemindahan (HSP), T2: pembajaan tahi ayam berasingan (HP,14 HSP dan 21 HSP), T3:pembajaan tahi ayam (HP) bersama pembajaan cecair Biojadi (14 HSP), T4: pembajaan tah iayam (HP) bersama pembajaan cecair Biojadi (14 HSP dan 21 HSP). Pembajaan untuk kesemua adalah kadar yang sama iaitu 210kgN/ha. Hasil kajian menunjukkan bahawa terdapat perubahan signifiken pada jumlah berat basah, jumalah berat kering, kandungan klorofil relatif serta kandungan phosphorus dalam tumbuhan kesan daripada kaedah pembajaan yang berbeza. Antara applikasi pembajaan tahi ayam sahaja menunjukkan pembajaan pada hari pemindahan (HP) menghasilkan jumlah berat basah ,jumlah berat kering dan kandungan klorofil realtif yang tinggi. Manakala antara kesemua rawatan, pembajaan pada hari pemindahan (HP) dan kombinasi baja tahi ayam dan pembajaan cecair Biojadi (14 HSP dan 21 HSP) mengeluarkan hasil biomass dan kandungan klorofil relatif yang tinggi berbanding rawatan lain. Kandungan P yang tinggi didapati pada tanaman yang diberi 3 kali pembajaan tahi ayam secara berasingan (HP, 14 HSP dan 21 HSP). Hasil kajian

mencadangkan baja organik yang diberi pada hari perpindahan anak pokok ke polibeg adalah sesuai untuk pengeluaran bahagian vegetatif *A.paniculata*.

ABSTRACT

Demand for organic herbs is high due to health awareness and its uses for alternative medicinal treatment. *Andrographis paniculata* is known for its beneficial properties such as antiglychemic, antimicrobial and antioxidant. Hence this study was conducted to determine suitable methods of fertilizer application for vegetative growth production of *A.paniculata.* Five treatments tested in this study were, control (T0) :chicken manure 210kgN/ha fertilizer application at transplanting (AT), T1:chicken manure two times split applications (140kgN/ha AT and 70kgN/ha14 DAT), T2:chicken manure three time split applications (140kgN/ha AT, 35kgN/ha 14 DAT, 35kgN/ha 21 DAT), T3: chicken manure application 140kgN/ha (AT) combined with Biojadi foliar application (70kgN/ha 14 DAT), T4:chicken manure application 140kgN/ha (AT) combined with two time split Biojadi foliar application (35kgN/ha 14 DAT and 35kgN/ha 21 DAT). Equivalent rate of 210kgN/ha was applied for all treatments. Results indicate that, there were significant differences ($p<0.05$) in total fresh weight, total biomass, relative chlorophyll content and phosphorus content affected by method of fertilizer application. Plant that treated with chicken manure application only at transplant produced higher yield plant biomass and relative chlorophyll content. Among all treatments, plants that were treated with chicken manure fertilizer at transplanting (100%) and combine of chicken manure (AT) with two times split foliar application produced high plant biomass and relative chlorophyll content compared to other treatments. High P content was observed in plant treated with two times split chicken manure application.Results suggested that organic fertilizer application at transplant (AT) is the suitable method for high production of vegetative part of *A.paniculata.*

CHAPTER 1

INTRODUCTION

Malaysia government announced in 2010 its attention to make the country a serious player in the high value herbal product business. According to estimates by World Bank, the herbal market will increase from US$200bil in 2008 to US$5tril by 2050. This opportunity makes the herbal products industry a prime candidate to drive Malaysia's emerging bioeconomy. Herbs have been made into the first Entry Point Project (EPP1) for nation's Agriculture NKEA and was focused on commercialization of five types of herbs with the aim of producing high value products totaling RM2.2 billion of the Gross National Income (Heng., 2014). Five focused herbs are Hempedu Bumi (*Andrographis paniculata*), Tongkat Ali (*Eurycoma longifolia),* Misai Kucing (*Orthosiphon stamineus),* Kacip Fatima (*Labisia pumila)* and DukungAnak (*Phyllanthus niruri).*

Organic produces get a lot of attention by consumers nowdays due to increase awareness about health and food safety. Malaysia is still insufficient in producing organic vegetables, fruits and herbs for consumption because awareness among farmer is still low. Thus a standard guideline on planting organically was established by Department of Agriculture to encourage farmers to implement organic farming. Research institutions find methods that are suitable for farmers to implement organic farming and gave them highest production especially in herbal production.

Research on herbal crop such as *Andrographis paniculata* is still needed to be conducted to study the active compound and concentrations required for efficacy and safety of the product. Organic planting is one of the safety measures for food safety and

other method to increase the production of medicinal plant. Research proved that legal use of 'clinically proven' terms for its marketable value (Sharmilla., 2011).

As herbs demand increase, the demands of organic herbs also increase (Robert et al., 2004). In order to ensure 100 percent organically produce, plant need to undergo organically grown process from seed germination to harvesting by producing the highest yield of *Andrographis paniculata* with the highest andrographolide content. Moreover, for healthy growth and optimal yield, high dry herbage yield of *Andrographis paniculata,* nutrients must be available to plants in correct quantity, proportion and in a usable form at right time through organic fertilizer application ;combination of compost and liquid organic fertilizer.

The objectives of this study are to determine suitable method of organic fertilizer application for vegetative part production of *Andrographis paniculata* and interaction of method of application and frequency of application to vegetative growth of *Andrographis paniculata*.

REFERENCE

Ahmad, F. (2001). Sustainable agriculture system in malaysia. *Regional Workshop on Integrated Plant Nutrition System (IPNS), Development in Rural Poverty Alleviation, United Nations Conference Complex, Bangkok, Thailand,* 18-20.

Aizaki, M., Uwasawa, M., Kawasaki, A., Naito, N., Nakamura, M., Noguchi, A., .Yasui, A.,. (2013). *Testing methods for fertilizer*. Japan: Incorporated Administrative Agency, Food and Agricultural Materials Inspection Center.

Akanbi, W. B., Adebayo, T. A., Togun, O. A., Adeyeye, A. S., &Olaniran, O. A.,. (2007). The use of compost extract as foliar spray nutrient source and botanical insecticide in *Telfairia occidentalis*. *World Journal of Agricultural Sciences, 3*(5), 642-652.

Altenbach, S. B., DuPont, F. M., Kothari, K. M., Chan, R., Johnson, E. L., & Lieu, D. (2003). Temperature, water and fertilizer influence the timing of key events during grain development in a US spring wheat. *Journal of Cereal Science, 37*(1), 9-20. doi:http://dx.doi.org/10.1006/jcrs.2002.0483

Amujoyegbe, B. J., Opabode, J. T., &Olayinka, A.,. (2007). Effects of organic and inorganic fertilizer on yield and chlorophyll content of maize (*Zea mays* L.) and *Sorghum bicolour* (L.) moench. *African Journal of Biotechnology,6*(16), 1869-1873.

Arifin, Z.,WanMamat, W. Z.,Hussain, H., &Yaacob, M.,. (2006). *Manual teknologi penanaman hempedu bumi* Institut Penyelidikan dan Kemajuan Pertanian Malaysia (MARDI).

Badawi, M.A., M.M., Abou El Magd., Hassan, H.A. and Elshakry, M.F.Z. (2005). Effect of bio-fertilization nitrogen source, nitrogen levels and their interaction on vegetable growth, chemical content and oil yield of sweet fennel. Egyptian Journal of Basic and Applied Sciences 20(28):567-591.

Bansi, T. S., & Rout, G. R. (2013).Plant regeneration protocol of Andrographis *paniculata* (burm. f.)-an important medicinal plant. *African Journal of Biotechnology, 12*(39), 5738-5742.

Bansi, T. S., & Rout, G. R. (2013).Plant regeneration protocol of andrographispaniculata (burm. f.)-an important medicinal plant. *African Journal of Biotechnology, 12*(39), 5738-5742.

Bassirirad, H.,. (2000). Kinetics of nutrient uptake by roots: Responses to global change. *New Phytologist, 147*, 155-169. doi:10.1046/j.1469-8137.2000.00682.x,

Bhattacharya, S., Puri, S., Jamwal, A., & Sharma, S. (2012). Studies on seed germination and seedling growth in kalmegh (andrographispaniculata wall. ex. nees) under abiotic stress conditions.*Int.J.Sci.Environ.Technol, 1*(3), 197-204.

Caliskan, O., Odabas M.S. andCirak, C. (2009). The Modeling of the relation among the temperature and light intensity of Growth in *Ocimum basilicum L*. Journal of Medicinal Plants Research 3(11):967–979.

Chua, L. S., Yap, K. C., &Jaganath, I. B. (2013).Comparison of total phenolic content, scavenging activity and HPLC-ESI-MS/MS profiles of both young and mature leaves and stems of *Andrographis paniculata*. *Natural Product Communications, 8*(12), 1725-1729.

Coon JT, Ernst E. (2004) *Andrographis paniculata* in the treatment of upper respiratory tract infections: A systematic review of safety and efficacy. Planta Med;70:293-8.

Craswell, E. T., De Datta, S. K., Obcemea, W. N., &Hartantyo, M.,.(1981). Time and mode of nitrogen fertilizer application to tropical wetland rice. *Fertilizer Research, 2*(4), 247-259. doi:10.1007/BF01050197

Deora, G.,.(2014). *Andrographis paniculata*-a review on the biological activities of the plant. *International Journal of Pharmaceutical Research and Bio-Science (Ijprbs), 3*(4), 263-283.

Duthion, C., Ney, B., &Munier-Jolain, N. M.,. (1994). Development and growth of white lupin : Implication for crop management. *Agronomy Journal, 86*, 1039-1045.

Duthion, C., &Pigeaire, A.,.(1986). Intra and inter-annual variability of white lupin.influence of the seed number :Vegetative dry weight ratio. *Proceeding of the Fourth International Lupin Conference*, Geraldton, Western Australia., *281*

Food and Agriculture Organization of United Natio, (FOA),.Plant nutrient management. Retrieved from http://www.fao.org/agriculture/crops/thematic-sitemap/theme/spi/scpi-home/managing-ecosystems/integrated-plant-nutrient-management/ipnm-how/en/ Retrieved date: 26th November 2014

Gruhn, P., Goletti, F., &Yudelman, M. (2000).*Integrated nutrient management, soil fertility, and sustainable agriculture: Current issues and future challenges*. Intl Food Policy Res Inst.

Hassan, H., Sarrwy, S., &Mostafa, E. (2010). Effect of foliar spraying with liquid organic fertilizer, some micronutrients, and gibberellins on leaf mineral content, fruit set, yield, and fruit quality of" hollywood" plum trees. *Agriculture & Biology Journal of North America, 1*(4)

Hassan, S. A., Asiah, A. M., &KamarulZaidi, A. (2007). Light and nitrogen supply on biomass and growth of *Andrographis paniculata*. *Journal of ISSAAS [International Society for Southeast Asian Agricultural Sciences](Philippines),*

Hassan, S. A., Mijin, S., Yusoff, U. K., Ding, P., &Wahab, P. E. M. (2012).Nitrate, ascorbic acid, mineral and antioxidant activities of *Cosmos caudatus* in response to organic and mineral-based fertilizer rates.*Molecules*, *17*(7), 7843-7853.

Hunt, R.1990. Basic growth analysis. London, Unwin Hyman.

Heng, N. (2014, 28 May). Untapped treasures in herbal industry products.

Jumat, F.,. (2006.). Kesan kadar pembajaan nitrogen terhadap pertumbuhan hempedu bumi (*Andrographis paniculata*) [Abstract].

Kanokwan, J., & Nobuo, N.,. (2008). Pharmacological aspects of *Andrographis paniculata* on health and its major diterpenoid constitute andrographolide. *Journal of Health Science, 54*, 370-381.

Kataky, A., &Handique, P. (2010). A brief overview on *Andrographis paniculata* (burm. f) nees., a high valued medicinal plant: Better over synthetic drugs. *Asian J SciTechnol, 6,* 113-118.

Krishna, A., Patil, C., Raghavendra, S., &Jakati, M. (2010).Effect of bio-fertilizers on seed germination and seedling quality of medicinal plants. *Karnataka Journal of Agricultural Sciences, 21*(4) 588-590

Kumar, B., Verma, S. K., & Singh, H. P. (2011).Effect of temperature on seed germination parameters in kalmegh (*Andrographis paniculata* wall. ex nees.). *Industrial Crops and Products, 34*(1), 1241-1244. doi:http://dx.doi.org/10.1016/j.indcrop.2011.04.008

Marinova, D., Ribarova, F.andAtanassova, M. 2005. Total phenolics and total flavonoids in Bulgaria fruits and vegetables. Journal of the University of Chemical Technology and Metallurgy 40:255-260.

Mengel, K., Kosegarten, H., Kirkby, E. A., &Appel, T. (2001).*Principles of plant nutrition* Springer.

Mishra, S., & Jain, A.,(2014). Effect of INM on vegetative growth, flowering and fruiting of *Andrographis paniculata*.

Mishra,S. K., Sangwan, N.S.&Sangwan, R.S. (2007). *Andrographis paniculata* (kalmegh): A review.*Pharmalogy review.1*, 283-289.

Misra P, Paul NL,Guru PY, Katiyar JC, SrivastavaV,Tandon JS. (1992). Anti-malarial activity of *Andrographis paniculata* (kalmegh) against plasmodium berghei NK 65 in *mastomysnatatensis*.*IntJ.Pharmacogenomics, 30*, 369-378.

Mohanty, S., Paikaray, N. K., &Rajan, A. R. (2006).Availability and uptake of phosphorus from organic manures in groundnut (*Arachis hypogea* L.)–corn (*Zea mays* L.) sequence using radio tracer technique. *Geoderma, 133*(3–4), 225-230. doi:http://dx.doi.org/10.1016/j.geoderma.2005.07.009

Mohammed, R., Olorukooba, M. M., Akinyaju, J. A., &Kambai, E. A.,.(2013). Evaluation of different concentrations and frequency of foliar application of moringa extract on growth & yield of onion, *Allium cepa* lam.*Agrosearch, 13*(3), 196-205. doi:Http://dx.doi.org/10.4314/agrosh.v13i3.3S

Organic gardening.(2014)Retrieved from http://www.organicgardening.com/learn-and-grow/organic-fertilizers

Panda, M., Mosier, A., Mohanty, S., Chakravorti, S., Chalam, A., & Reddy, M. (1994).Nitrogen utilization by lowland rice as affected by fertilization with urea and green manure. *Fertilizer Research, 40*(3), 215-223.

Pietta, P. G.,.(2000). Flavonoids as antioxidant. *Journal of Natural Product, 63*(7), 1035-1042.

Poole, W., Randall, G., & Ham, G. (1983).Foliar fertilization of soybeans. I. effect of fertilizer sources, rates, and frequency of application. *Agronomy Journal, 75*(2), 195-200.

Prakash, D., Suri, S., Upadhyay, G., & Singh, B. N. (2007). Total phenol, antioxidant and free radical scavenging activities of some medicinal plants. *International Journal of Food Sciences and Nutrition,58*, 18-28.

Rajpar, I., Yusop, M., Ul-hassan, Z., Shah, A. N., Arshad, M., &Galani, S. (2011).Growth, herb yield and phytochemical contents in a medicinal herb *Andrographis paniculata* under saline irrigation. *Journal of Medicinal Plants Research, 5*(23), 5528-5533.

Robert, C. H., Lei Lani, L. D., Wanda, L. L., Eric, H. S., & Richard, K. S.,. (2004). Developing a production system for growing organic herbs using soilless culture in a greenhouse.4, 1-8.

Sangalungkarn, V., Thummauppakorn, P., Kittiyanee, U., &Chaichantipyuth, C.,. (1990). The effect of andrographolide, neoandrographolide and 14-deoxy-11, 12-dedehydro-andrographolide on the intestinal motility of white rat. *The Journal of Pharmacology Science, 15*, 5-7.

Sanjutha, S., Subramanian, S., Rani, C. I., &Maheswari, J. (2008).Integrated nutrient management in *Andrographis paniculata*. *Research Journal of Agriculture and Biological Sciences, 4*(2), 141-145.

Selvam, G. G., &Sivakumar, K. (2014). Influence of seaweed extract as an organic fertilizer on the growth and yield of *Arachis hypogea* L. and their elemental composition using SEM–Energy dispersive spectroscopic analysis. *Asian Pacific Journal of Reproduction, 3*(1), 18-22. doi:http://dx.doi.org/10.1016/S2305-0500(13)60179-7

Shaedin, S.,.(2012/2013).Effects of organic fertilizer rates on growth physiological and phytochemical of *Andrographis paniculata*.

Shafar, J. M., Noordin, D., &Nursyazwina, M. Z.,. (2011). Evaluation of *Hevea brasiliensis* (latex timber clone: RRIM 2001 and RRIM 3001) in relation to different water stress. *American Journal of Agriculture and Biological Sceinces, 6*, 66-67.

Sharma, A., Krishan, L., &Handa, S. S.,. (1992). Standardization of the indian crude drug kalmegh by high pressure liquid chromatographic determination of andrographolide.*Phytochem. Anal, 3*, 129-131.

Sharmilla, G.,. (2011, 5 December). Growing our herbal industry. *The Star*

Singh Man, A., Singh, R.S., Tripathi, R.K., Verma, M.M.,Gupta, H.O., Mishra, H.P., Singh A.K.,. (2011). Growth behavior, biomass and diterpenoid lactones production in kalmegh (*Andrographis paniculata* Nees.) strains at different population densities *6*(3), 115-118. doi:10.3923/aj.2011.115.118

Subba, A. R., &Sammi, K. R.,(2000). *Intergrated nutrient management vis-a-vis crop production/productivity, nutrient balance, farmer livehood and environment: India.*(No. 2).Regional Office Asia and Pacific.

Tackenberg, O. 2007. A new method for non-destructive measurement of biomass, growth rates, vertical biomass distribution and dry matter content based on digital image analysis. Ann Bot 99:777–783.

Talei, D., Valdiani, A., Puad Abdullah, M., & Hassan, S. A.,.(2012). A rapid and effective method for dormancy breakage and germination of king of bitters (*Andrographis paniculata* nees.) seeds.*Maydica*, *57*(2), 98-105.

Valdiani, A., Talei, D., Tan, S. G., Kadir, M. A., Maziah, M., Rafii, M. Y., &Sagineedu, S. R.,. (2014). A classical genetic solution to enhance the biosyntesis of anticancer phytochemicals in *Andrographis panicutala*. *9*(2), 1-17.

Whitbread, G. J. B. (1999). Integrated nutrient management in farming systems in southeast Asia and australia. *Nutrient and Organic Matter Management in Cash Poor, Rice-Based Cropping Systems of Cambodia: Research and Extension Needs*, (No. 93. 91 p.) 58.

Wong, S.P., Lai, P.L. and Jen, H.W.K. 2006.Antioxidant activities of aqueous extracts of selected plants. Food Chemistry 99:775-783.

Xu, H. L.,.(2001). Effects of a microbial inoculant and organic fertilizer on the growth, photosynthesis and yield of sweet corn. *Journal of Crop Production*, *3*(1), 183-214. doi:10.1300/J144v03n01_16

Zhang, G., Chen, J., & David, A. B.,. (2001). The effects of timing of N application and plant growth regulators on morphogenesis and yield formation in wheat. *Plant Growth Regulation, 35*, 239.doi:10.1023/A:1014411316780

Zhao, Y., Kao, C., Wu, K., Liao, C., Ho, Y., & Chang, Y. (2014).Chemical compositions, chromatographic fingerprints and antioxidant activities of andrographis herba. *Molecules, 19*(11), 18332-18350.

Zhu, Z., Zhang, F., Wang, C., Ran, W., &Shen, Q. (2013). Treating fermentative residues as liquid fertilizer and its efficacy on the tomato growth. *Scientia Horticulturae, 164*(0), 492-498. doi:http://dx.doi.org/10.1016/j.scienta.2013.10.008