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Influence of nitrogen rates and harvesting time on growth performance of *Eclipta alba* grown on mineral soil

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Abstract
A two planting cycles study evaluated the effects of five nitrogen rates (0, 100, 200, 300 and 400 kg/ha) and four harvesting times (1, 2, 3 and 4 months after planting) on growth and yield of *Eclipta alba* at MARDI Headquarters (mineral soil). *Eclipta alba* showed optimum plant height, stem diameter, stem dry weight and leaf dry weight with application of 200 N kg/ha while 300 N kg/ha for dry root weight between 3 and 4 month after planting. Overall, optimum total plant dry weight achieved with application of 200 N kg/ha. Harvesting at three months after planting is recommended.

Keywords: *Eclipta alba*, urang aring, nitrogen, harvesting time, fertiliser

Introduction

Eclipta alba (L.) Hassk (*E. alba*) which locally known as urang aring is an annual herb of the Asteraceae family. This plant can grow either erect or prostrate condition and the leaves are normally densely arranged on both sides of the stem, able to root at the nodes and had white flowers (Arunachalam et al. 2009). This plant is able to survive through wet and moist conditions. In India, *E. alba* comes in three different types which are white-flowering, yellow-flowering, and black-fruiting grew by marshes, rivers, and lakes or on the foothills of the Himalayas (Satish et al. 2013). *E. alba* in its natural condition is a broadleaf weed and was considered as one of the worst weed in agricultural areas. *E. alba* has been reported among the broadleaf weeds found in rice cultivation (Sridevi et al. 2013) and other crops, including sugarcane, taro, papaya, banana, soybean, and cotton which is also an alternate host for root-knot nematodes (*Meloidogyne* spp.) and host for rice sheath blight *Rhizoctonia solani* (Bhawandeep et al. 2014).

Traditionally, the leaves have been used in Ayurveda, Chinese and Arabian medicines. The plant has been claimed to be able to treat kidney and liver problem, inflammatory conditions and digestive disorders (Arunachalam et al. 2009). The extract of the plant is also said to be the best remedy for hair treatment, effective for darkening the hair and helps to promote hair growth (Noraida 2005). This plant also provides a bluish black dye (Wasule 2011). Besides, the plant has high therapeutic and medicinal values from its varied composition such as wedelolactone, demethylwedelolactone, 14-hepatocosanol, luteolin-7-0-glucoside, alkaloids and polypeptides. Clinical studies showed wedololactone possessed anti-inflammatory

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property and can be used effectively to treat *Salmonella epidermidis* and *Salmonella typhimurium* infections (Neeraja et al. 2011).

In India, the plant has been reported to produce yield up to 6 t/ha of dried herbage with the use of 20 tons organic and additional of 50:75:30 NPK kg/ha and price for the dried whole plant was equivalent to RM0.80 – RM2.00/kg (Ved et al. 2002). Another study on *E. alba* grown under seasonal water logged ecosystem showed the yield could only be obtained at 1.46 t/ha and provides a net profit of RM 500/ha (Brahmanand et al.). Priya (2012) reported that application of poultry manure showed high total plant dry weight (g/plant) as compared to farmyard manure which was 32.34 g/plant and 21.11 g/plant, respectively.

E. alba has been identified as one of the potential herbs that can be utilised for commercial purposes due to the increase demand for natural product to substitute synthetic colour and its medicinal values. However, there is no study done to exploit the agronomic of *E. alba* in Malaysia. Hence, this study has been conducted to evaluate the effect of nitrogen and harvesting time for optimum growth and yield of domesticated *E. alba* on mineral soil.

Materials and methods

This experiment was conducted on mineral soil at MARDI, Serdang and evaluated at four harvesting time with five different nitrogen rates. The layout trials were in split plot design with two replications. The four harvesting times (1, 2, 3 and 4 months after planting), were assigned to main plots, while the five nitrogen rates (0, 100, 200, 300 and 400 N kg/ha) were assigned to sub plots. Urea (46 % N) was used as the source of nitrogen and no phosphorous (P) and potassium (K) applied. The seedlings were raised in nursery. Seed were germinated on the surface of Holland peat medium. The germinated seeds were transplanted into 104 holes plastic pot tray. Plastic trays were filled with Holland mixture as planting medium. After two months seedlings were transplanted at a spacing of 20 cm between plants and 20 cm between rows. Each plot size was 1.2 m by 1.2 m. Plants were watered using sprinkler twice daily. The yield of root, stem and leaves were obtained from all plants in the experimental plot (central plant) excluding the outer plants which served as border rows. Plant height and stem diameter were measured at fixed number of plant set at early stage of planting in each plot treatments. Plant stem diameter was measured 10 cm above ground. Experiment was repeated in two planting cycles at the same area.

The data was analysed using the General Linear Model (GLM) procedure of Statistical Analysis System (SAS 9.3). Combined analysis of variance over two planting cycles followed Gomez and Gomez (1984) to identify the interaction between treatments and over planting cycles. Log transformation was used to improve normality of a distribution and equalizing variance to meet assumptions and improve effect sizes. The means separation was determined by using Duncan's Multiple Range Test (DMRT) at $p < 0.05$.

Results and discussion

Results from combined analyses of two planting cycles showed that there were interactions of planting cycles, harvesting time and nitrogen rates on plant height, root dry weight and total plant dry weight (*Table 1*). The results also showed interactions of planting cycle and harvesting time on stem dried weight and leaf dried weight. The main effect of harvesting time was observed on stem diameter while, the main effect of nitrogen rates was observed on stem and dry leaf weight.

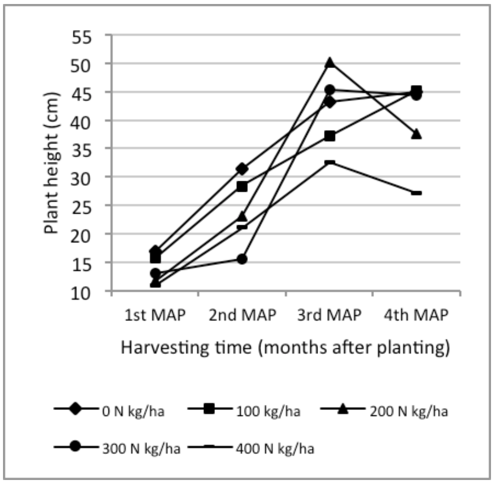
Table 1. Analysis of variance of the effect of planting cycle, harvesting month and fertiliser rates on growth and yield parameters of *Eclipta alba*

Source of variation	Mean square					
	Plant height (cm)	Plant stem diameter (mm)	Root dry weight (kg/ha)	Stem dry weight (kg/ha)	Leaf dry weight (kg/ha)	Total plant dry weight (kg/ha)
Planting cycle	*	ns	ns	*	ns	*
First planting	29.77	4.61	92.70	183.74	117.68	394.11
Second planting	48.66	6.35	135.33	375.35	178.68	689.19
Harvesting time	*	*	**	**	**	**
One MAP	23.98c	3.98d	35.97c	48.98c	106.01b	190.95c
Two MAP	36.07b	5.33c	116.20b	260.31b	209.40a	585.91b
Three MAP	46.92a	6.56a	154.40a	389.83a	173.69a	717.86a
Four MAP	49.90a	6.06b	149.48a	419.08a	103.31b	671.87a
Nitrogen rate	**	*	**	*	*	**
0 kg N/ha	41.51a	5.71a	124.28a	298.14a	155.39a	577.80a
100	41.06a	5.50a	111.93ab	261.98a	139.81ab	513.72a
200	40.12ab	5.74a	124.77a	321.92a	169.33a	616.02a
300	37.88bc	5.24ab	115.24b	302.74a	155.51ab	573.50a
400	35.52c	5.00b	93.83c	212.96b	124.42b	427.21b
C x H	*	ns	*	*	*	*
C x N	*	ns	*	ns	ns	*
H x N	*	ns	ns	ns	ns	ns
C x H x N	*	ns	*	ns	ns	*
CV	3.35	7.22	5.06	7.53	8.10	4.56
Mean	39.22	5.48	114.01	279.55	148.09	541.65

*,** : Significant at <0.05 and <0.001 probability level respectively; ns : not significant at 0.05 probability level. Log 10 transformation was used
MAP = month after planting

Plant height: Significant interaction between planting cycle, harvesting time and nitrogen showed on plant height (*Figure 1*). Plant height was taller in second planting cycle compared to first planting cycle. Plant height increased with time at any rates of nitrogen given. The highest plant height was at three and four months after planting in first and second cycle, 50.20 cm and 65.60 cm respectively. The increment of plant weight was 30 % in second planting cycle and both were applied with 200 N kg/ha. Although methodologies differ by Priya (2012), application of farmyard or poultry manure showed the plant height was 45.74 cm and 49.53 cm respectively. Priya (2012) explained better plant height might be contributed by organic manure breakdown which released nutrients in the soil. The plant height was also reported elsewhere with range of height, between 20 cm to 90 cm in Bulgaria (Rossen 2007) and 30 cm to 100 cm in Jammu district, India (Bhawandeep 2014).

Stem diameter: Harvesting time and nitrogen rates showed significantly different on stem diameter (*Table 1*). Generally, stem diameter was bigger in second planting cycle than the first which were 6.35 mm and 4.61 mm, respectively but was not significantly different. Harvesting at three months after planting relatively gave the biggest stem diameter which was 6.56 mm and slightly decreased at four months after planting which was 6.06 mm. Plant grown with 200 N kg/ha showed better stem diameter of 5.74 mm. No different observed with the rates of 0 N kg/ha, 100 N kg/ha and 300 N kg/ha. The highest rate of nitrogen at 400 kg/ha tends to suppress growth of stem diameter.



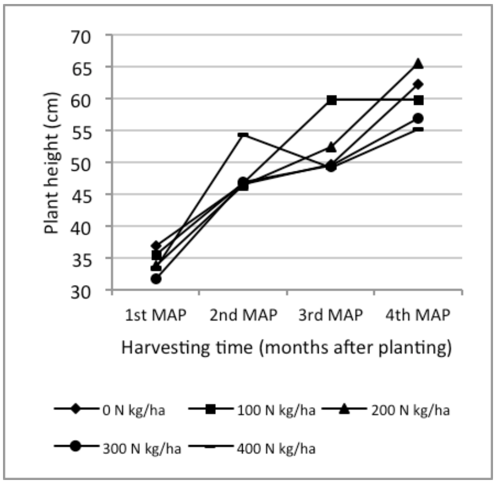


Figure 1. Interaction effect between planting cycle, harvesting time and nitrogen rates on plant height (cm). First planting cycle (left) and second planting cycle (right)

Root dry weight: Significant interaction between planting cycle, harvesting time and nitrogen showed on root dry weight (*Figure 2*). Generally, root weight in the second cycle was considerable higher than in the first cycle. Root dry weight was 135.33 kg/ha in second planting cycle as compared to first planting cycle which was 92.70 kg/ha (*Table 1*). Application of nitrogen at any rates in both planting cycles showed no effect on root dry weight in first month old. However, root dry weight was observed maximum at 3 months and 2 months in first and second planting cycle, which was 199.14 kg/ha and 205.31 kg/ha, respectively. The maximum root dry weight achieved when applied at 300 N kg/ha. In first planting cycle, the applied nitrogen at 0 kg/ha and 100 kg/ha showed better root weight at two months after planting compared to other treatments. This may indicate the root growth was vigorous when nitrogen source was limited that caused it bigger and longer in order to increase nitrogen uptake. At three months after planting, the effect of control (0 N kg/ha) and other fertiliser rates were almost similar except at 300 kg/ha, which was the highest. In second planting cycle, application of nitrogen at 0 kg/ha and 100 kg/ha showed the lowest root dry weight at two months after planting compared to other treatments. However, the weight was comparable as obtained in first planting cycle. This might be because of nitrogen residue in the first planting cycle. In both planting, root dry gained weight with time despite of nitrogen supply. Sridevi (2013) reported that weeds are able to grow faster and absorb nutrients efficiently and in larger quantities. Kevin (2011) reported after 50 days of planting on dry condition (no-standing water but watered twice daily), *E. alba* can produce root length up to 400 cm. This may explain the ability of *E. alba* to have greater root development albeit of low nutrient availability.

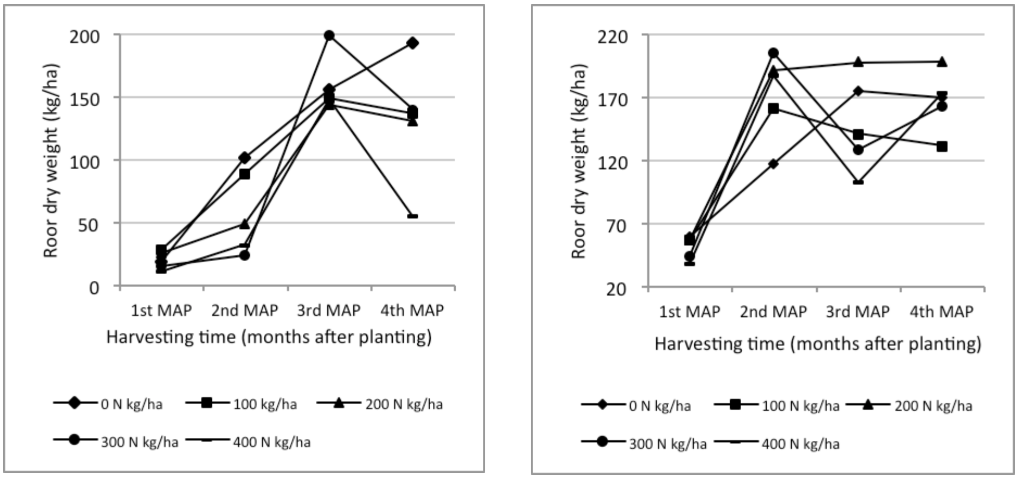


Figure 2. Interaction effect between planting cycle, harvesting time and nitrogen rates on root dry weight (kg/ha). First planting cycle (left) and second planting cycle (right)

Stem dry weight: The highest stem dry weight was in second planting cycle compared to the first cycle which were 375.35 kg/ha and 183.74 kg/ha respectively. Data depicted in *Table 1*, indicated the interaction effects of planting cycle and harvesting time on stem dry weight as illustrated in *Figure 3*. In first and second planting cycle the stem dry weight was almost similar at one month after planting. However, in second planting cycle weight of dried stem was considerably better than in the first cycle after two month of planting. The stem dry weight was inconsiderably difference at three months after planting in both cycles, but at four months after planting different trend of weight observed which increased in second but decreased in first planting cycle. Overall, the highest stem dry weight was recorded at four month after planting in second planting cycle. Data in *Table 1* showed the main effect of nitrogen rates on stem dry weight. The nitrogen rates significantly affected the dried stem weight. The highest stem dry weight was obtained with the application of 200 N kg/ha, but was not different with nitrogen rates of 0 N kg/ha, 100 N kg/ha and 300 N kg/ha. The application at the highest rates (400 N kg/ha) showed the lowest stem dry weight (*Figure 4*). Correlation analysis showed significantly strong positive relationship between plant height, plant stem diameter and dry root weight, which the increased of any of these will increase the stem dry weight (*Table 2*). This information suggested that application of nitrogen fertiliser in planting *E. alba* did not have much effect on stem dry weight but due to growth stages.

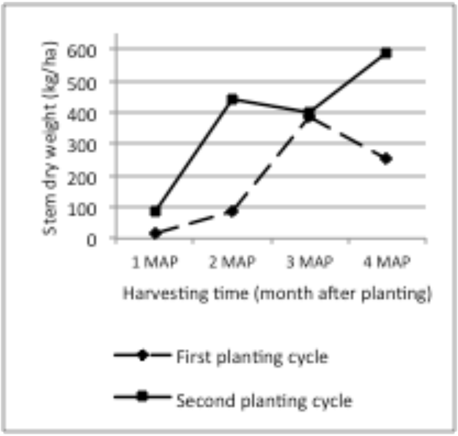


Figure 3. Interaction effect of planting cycles and harvesting time on stem dry weight

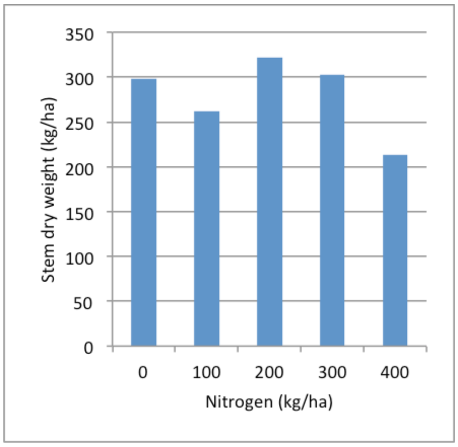


Figure 4. The effect of nitrogen rates on stem dry weight

Table 2. Correlations between variables in *Eclipta alba* growth and yield perfomance

	Pearson correlation coefficients					
	Plant height (cm)	Plant stem diameter (mm)	Dry root weight (kg/ha)	Dry stem weight (kg/ha)	Dry leaf weight (kg/ha)	Total plant dry weight (kg/ha)
Plant height (cm)	1	0.89547	0.78979	0.88009	0.4254	0.8462
		<.0001	<.0001	<.0001	<.0001	<.0001
Plant stem diameter (mm)	0.89547	1	0.73432	0.80689	0.41794	0.78572
	<.0001		<.0001	<.0001	0.0001	<.0001
Dry root weight (kg/ha)	0.78979	0.73432	1	0.82008	0.55248	0.88364
	<.0001	<.0001		<.0001	<.0001	<.0001
Dry stem weight (kg/ha)	0.88009	0.80689	0.82008	1	0.51805	0.95648
	<.0001	<.0001	<.0001		<.0001	<.0001
Dry leaf weight (kg/ha)	0.4254	0.41794	0.55248	0.51805	1	0.72797
	<.0001	0.0001	<.0001	<.0001		<.0001
Total plant dry weight (kg/ha)	0.8462	0.78572	0.88364	0.95648	0.72797	1
	<.0001	<.0001	<.0001	<.0001	<.0001	

Leaf dry weight: Significant interaction between planting cycle and harvesting time on leaf dry weight was showed in *Figure 5*. In second planting cycle, leaf dry weight was higher, contributed by better yield at all harvesting months excluding after three months of planting which was lower than in first planting cycle. This also demonstrated that the best harvesting time to get higher yield of *E. alba* on mineral soil was between 2 – 3 months after planting. Data provided in Table 1 showed leaf dry weight was significantly affected by nitrogen rates. The highest leaf dry weight was obtained with the application of 200 N kg/ha however, was not different with the rates of 0 N kg/ha, 100 N kg/ha and 300 N kg/ha. The application of 400 N kg/ha showed the lowest leaf dry weight obtained (*Figure 6*). Correlation between plant height, plant stem diameter, root and leaf dry weight with dry leaf weight was showed significant but with moderate relationship. However, significant strong relationship between total plant dry weights with dry leaf weight was found (*Table 2*). As nitrogen rates showed not much effect in leaf dry yield, it may suggest taller plant height and sizeable stem diameter will contribute to leaf production.

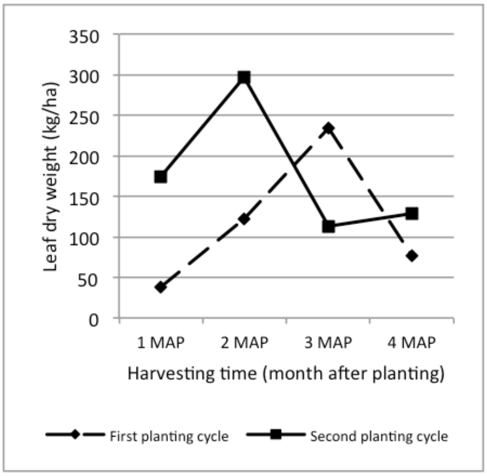


Figure 5. The effects of planting cycles and harvesting time on leaf dry weight

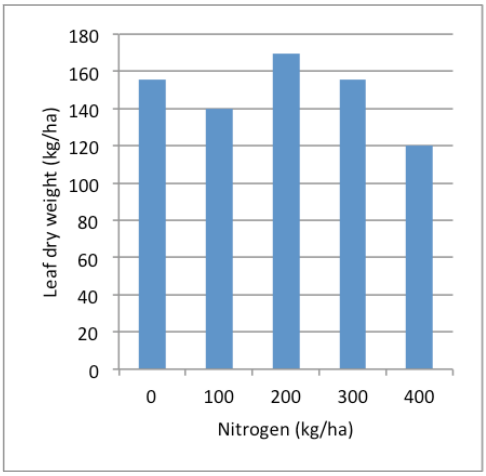


Figure 6. The effect of nitrogen rates on leaf dry weight

Total plant dry weight: Significant interaction between planting cycles, harvesting time and nitrogen rates on total plant dry weight was presented in *Figure 7*. Generally, total plant dry weight was lower in first planting cycle compared to the second cycle which were 394.11 kg/ha and 689.19 kg/ha, respectively. The weight of total plant dry weight was significantly correlated with plant height, stem diameter, root, stem and leaf dry weight (*Table 2*). In first planting cycle the yield components were optimum after three month of planting, before declining at four months. Application of nitrogen at the rate of 300 kg showed the highest total plant dry weight but almost equal to 200 N kg/ha which were 1114.10 kg/ha and 990.18 kg/ha respectively. The nitrogen rate at 0 kg/ha, 400 kg/ha and 100 kg/ha showed reduction of total plant dry weight. In second planting cycle, the weight of yield components varied along growth period. Plant height was recorded tallest at the end of cycle. Similar pattern showed in root dry weight, which highest at four months after planting. Stem diameter achieved maximum after three months of planting, while leaf and stem dry weights were highest at the second month. Application of nitrogen fertiliser at

200 kg/ha and 300 kg/ha showed the highest total plant dry weight in two different months of planting. The weights recorded were 1102.99 kg/ha after two months and 1136.39 kg/ha at the end of growth observed. Though application of nitrogen at 300 kg/ha in both planting cycles produced the highest total plant dry weight, application of nitrogen at lesser amount which 200 kg/ha showed promising yield. Ved (2002) reported that the plant could produce dry yield up to 6 t/ha with the use of 20 tons organic with additional of 50:75:30 NPK kg/ha which the total nitrogen content estimated about 250 kg (consideration of 1 percent of nitrogen in organic fertiliser). High yield in India as compared to this study at average of 541.65 kg/ha might be because of phosphorous, potassium applied and organic matter synergistic effects.

Conclusion

Eclipta alba yield components showed optimum response with 200 N kg/ha for plant height, stem diameter, stem dry weight and leaf dry weight while 300 N kg/ha contributed for high dry root weight in both planting cycles. Generally, the plant yield was also contributed by the growth period of plant which highest at 3 to 4 month as well as the plant matured. Overall, to achieve optimum total plant dry weight application of 200 N kg/ha and harvesting at three months after planting is recommended.

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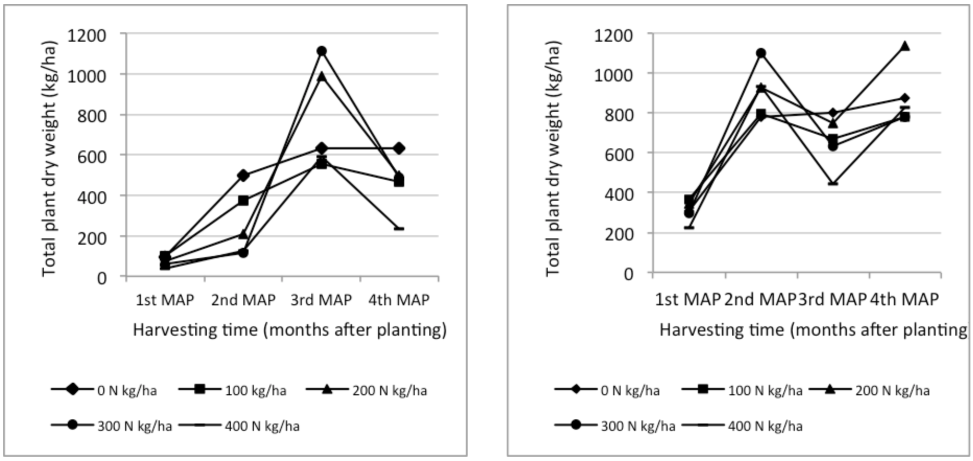

Figure 7. Interaction effect between planting cycle, harvesting time and nitrogen rates on total plant dry weight. First planting cycle (left) and second planting cycle (right)

References

Arunachalam, G., Subramaniam, N., Pazhani, G.P. and Ravichandran, V. (2009). Anti-inflammatory activity of methanolic extract of *Eclipta prostrate L*. (Astearaceae). *African Journal Of Pharmacy And Pharmacology* 3(3): 7 – 100

Bhawandeep, K., Sanjay, B. and Kuldeep K. S. (2014). Diversity and impact of invasive alien plant species of family Asteraceae in Jammu District (Jammu and Kashmir, India). *International Journal of Interdisciplinary and Multidisciplinary Studies* 1(8): 51 – 62

Brahmanand, P.S., Kumar, A., Chowdhury, S. Roy., Sahoo, N., Kundu, D.K.,Mohanty S. and Behera, M.S. (n.d.). Growth, yield and water productivity of medicinal plants under seasonal waterlogged ecosystem. *E-Planet* 9(2): 38 – 41

Gomez, A. and Gomez, A. (1984). *Statistical Procedures For Agricultural Research*. 2nd ed. Canada: John Wiley & Sons

Kevin, J.S., Christopher, B.W. and Joel, A.J. (2011). Effect of arbuscular mycorrhizal fungi on seedling growth and development of two wetland plants, *Bidens frondosa* L. and *Eclipta prostrate* (L) L. grown under three levels of water availability. *Mycorrhiza* 21: 279 – 288

Neeraja, P.V. and Elizabeth. M. (2011). *Eclipta alba* (L.) Hassk: A valuable medicinal herb. *International Journal of Current Pharmaceutical Review and Research* 2(4): 188 – 197

Noraida, A. (2005). *Penyembuhan semula jadi dengan herba*, p. 249 – 250. Malaysia: Millenia Sdn. Bhd.

Priya, S. and Elakkiya, R. (2012). Effect of organic and biofertilizers on gowth and yield of *Eclipta Alba* (L.). *International Journal of PharmTech Research* 4(4): 1703 – 1705

Rossen, T. (2007). *Eclipta prostrata* (Asteraceae): A new alien species for the Bulgarian flora. *Phytologia Balcanica* 13(1): 79 – 80

Satish, A. B., Deepa, R.V., Nikhil, C.T. and Vaibhav, R.M. (2013). *Eclipta alba* (L.): An overview. *International Journal of Bioassays* 2(11): 1443 – 1447

Sridevi, V., Jeyaraman, S.,C. Chinnusamy, C. and Chellamuthu, V. (2013). Weed management in lowland rice (*Oryza Sativa* L.) ecosystem. A review. *International Journal of Agricultural Science and Research* 3(3): 13 – 22

Wasule D.D. (2011). Hair dyeing activity of eclipta species. *Journal Of Pharmaceutical Research And Opinion* 1(5): 159 – 160.

Ved, D.K., Oommen, S. and Singh, A. (2002). *Propagation and agrotechnology status of commercially important medicinal plant species of the project area of Andhra Pradesh community forest management* project, 160p. India: Andhra Pradesh Forest Department

Abstrak

Satu kajian mengenai dua kitaran penanaman untuk menilai kesan pemberian lima kadar nitrogen (0, 100, 200, 300 dan 400 kg/ha) dan empat masa penuian (1, 2, 3 dan 4 bulan selepas ditanam) terhadap pertumbuhan dan hasil *Eclipta alba* di Ibu Pejabat MARDI (tanah mineral). *Eclipta alba* menunjukkan tinggi pokok, diameter batang, berat kering batang dan daun yang optimum dengan pemberian 200 N kg/ha manakala 300 N kg/ha untuk berat akar kering selepas 3 – 4 bulan ditanam. Secara umumnya, berat kering pokok yang optimum dicapai dengan pemberian 200 N kg/ha. Penuaian 3 bulan selepas pokok ditanam adalah disyorkan.