VOL. 2, NO. 3, MAY 2007 ISSN 1990-6145
Journal of Agricultural and Biological Science

www.arpnjournals.com

EFFECTS OF LIGHT ON SEED GERMINATION, GROWTH PATTERN OF STRAITS RHODODENDRON (*Melastoma malabathricum L.*)

Mahdi Faravani[1] and Baki Bin Bakar[1]
[1]Institute of Biological Sciences, University of Malaya, 50603 Kuala Lumpur, Malaysia
E-mail: faravani@yahoo.com

ABSTRACT

The effects of media on seed germination and general growth patterns of *M. malabathricum* under different light and temperature regimes were studied in the laboratory and insect-proof house conditions in University of Malaya. 50 fresh or dried seeds of *M. malabathricum* were placed in each petri-dish and moistened with water or solutions of the chemical media, KNO_3, H_2O_2 and HNO_3 and placed either in darkness or fully exposed to fluorescence light at temperatures of 15, 20, 25, 30, and 35 ^oC in growth chambers. Seed germination of *M. malabathricum* was positively photoblastic. The highest rate of germination of 40-37% were observed at 25-30^oC for oven dried seeds in distilled H_2O. No seed germination prevailed in darkness, or when exposed to chemical media, and at temperature regimes less than 20 ^oC. Uniform two-month seedlings were exposed to two light regimes, *viz*. full sunlight (FSP) in an open (at midday, mean photosynthetically active radiation, PAR = 622 µ mole photon m^{-2} s^{-1}) or 20% of full sunlight within the greenhouse (Partial exposed plants) (PEP) (at midday, PAR =125 µ mole photon m^{-2} s^{-1}). Light regime strongly influenced both clonal and reproductive growths of *M. malabathricum.* Floral initiation in *M. malabathricum* requires exposure to no less than 400 µ mole photon m^{-2} s^{-1} for 15-20 days. The FSP displayed higher rate of growth in terms of number of berries, seeds, 2^o branch, leaves /2^o branch, leaves /1^o branch, berries/2^o branch and total number of leaves/plant .Exposure to full sunlight led to higher reproductive and clonal growths with higher number of leaves/plant and number of 1^o branch/plant, number of flowers/plant, number of seeds/plant for the FSP plants, but the PEP had more secondary and tertiary branches and internode's length. The regression analysis generated model for plant height data in relation to days after planting (x) were y = 56.2Ln(x) - 209.3, r = 0.96 for the PEP plants, and y = 15.99Ln(x) - 2.65, r = 0.92 for the FEP counterparts.

Keywords: *Melastoma malabathricum*, growth, phenology.

INTRODUCTION

Melastoma malabathricum is a serious weed in many crops, derelict and abandoned farmlands, and arable lands in Malaysia (Ridley 1922; Maxwell 1989, Baki 2004; 2006; Faravani and Baki 2007), and else where in the tropics and subtropics (Renner and Meyer 2001; Clausing and Renner 2001). The weed has a propensity to become invasive with adaptive life strategies including robust clonal and reproductive growths coupled with efficient seed dispersal, often aided by ants and birds, and are attracted by copious production of fruits. This opportunity rarely arises in the native habitat of a species as there tends to be a higher rate of competition from other natives. They are primary colonizers of secondary areas, disturbed habitats, pastures, roadsides, landslides, light gaps and rivers. This species is fast growing, shade tolerant, devoid of natural pests, and sets an abundance seeds with a high rate of germination leading to monospecific stands-easily out-competing native flora putting them at great risk (Penneys 2004).

Plants are influenced by sunlight reduction in a different ways. The main limitation of leaf net photosynthetic carbon assimilation at high photon flux density is the concentration of CO_2. When photon flux density decreases to approximately 40% of that a full sunlight, then carbon assimilation become light-limited (Cohen *et al.* 2005). However, plants have considerable ability to acclimatize to different light regimes through changes in leaf properties, as well as canopy structure (Syvertsen *et al.* 1984). Plants responses to light include a variety of adaptations at physiological and biochemical levels like as alteration of growth rate and plant architecture and finally on morphological characteristics and distribution and also the architecture of plant canopy influences the interception, absorption and scattering of solar radiation as passes through the atmosphere of earth to the soil surface (Christopher *et al.* 1998, Nasrullahzadeh *et al.* 2007). These photo-morphological responses are mediated by the phytochrome system under dense canopy. Generally branching is more inhibited by vegetation shade than by natural shade (Wan *et al.* 1998). Shade imposes a limitation to biological productivity in plant, although the extent of the limitation varies with shade tolerance of the species and the nitrogen supply (Wong 1991). Knowledge on the effects of light for some pioneer photoblastic species like *M. malabathricum* would have a practical value in designing the degree of canopy opening to stimulate the establishment of these seedlings. Interestingly, variation in specific leaf mass, the trait considered to be important in adaptive shade-avoidance responses, was only partially attributable to ontogenetic plasticity (environmentally-induced adjustments of ontogeny).

This paper describes some of the results on the response of *M. malabathricum* to one or two environmental stimuli or factors, and their interactions on seed germination, and clonal and reproductive growths, and phenology of the weed.

MATERIALS AND METHODS

Effects of chemical media, light and temperature regimes on seed germination and seedling growth of *Melastoma malabathricum*

Mature seeds of *M. malabathricum* were stored with silica gel in darkness at 4ºC before use. A series of germination experiments and growth performance studies on the weed was conducted in the laboratories of Institute of Biological Sciences, University of Malaya. Fifty fresh seeds were placed in each petri-dish, previously lined with 9cm diameter Whatman No. 2 filter paper were treated with distilled water (pH = 7) for 24 h as control; seeds soaked in distilled H_2O in 24 h + 0.2 M KNO_3 (pH = 2.5); seeds soaked in distilled H_2O in 24 h + 5% H_2O_2 (pH = 2.8); seeds soaked in distilled H_2O in 24 h + 0.01 M HNO_3 (pH = 2.5); and seeds soaked in distilled H_2O in 24h + 0.01 M HNO_3 (pH = 2.5). Four replications were allocated for each treatment. A similar set of treatments were replicated but with seeds of *M. malabathricum* previously oven-dried at 35^{o}C for a week and stored in a refrigerator at 4^{o}C until use. The petri-dishes were placed in growth chamber with different temperature regimes of 15, 25, 30 and 35^{o}C, and exposed to fluorescent light with intensity of 630 Em^{-2} s^{-1}. Another set of petri-dishes, wrapped in a double layer of aluminum foil and with the same treatment combination media and temperature regimes, were also maintained to assess seed germination in darkness. Seed germination was recorded at three-day intervals and the germination percentages were determined 18 days after sowing. All petri-dishes in the light treatment were augmented with 6 ml of deionized water at 3 day-intervals in order to maintain moisture condition. Seedlings and obviously dead seeds were then counted and removed. Germinated seeds were counted and removed every 3 days until no germination were recorded, root and shoot lengths of seedlings were recorded. The rate of germination was estimated from the reciprocal of the time taken to reach 50% of the final cumulative germination. Differences in germination were subjected to analyses of variance. Data transformations were done prior to the achieve homogeneity of variances.

Effects of light regimes on clonal and reproductive growth of two biotypes of *Melastoma malabathriucm*

Six young uniform seedlings of the pink- and white-flower biotypes) of *M. malabathricum* were selected from a commercial nursery in Genting Highlands, Pahang, Malaysia (3^o 8’ N; 101^o 42’ E) in December 2005. These were then transplanted into clay pots measuring 35cm in diameter, and 40cm high, previously filled with garden soils of Malacca series. The physico-chemical characteristics of the soil have been presented elsewhere (Faravani and Baki 2007). The plants were watered twice in the morning and in the evening from above with fine rose. The plants were divided in two groups outdoor (FEP = full exposed to sunlight) (mean midday radiation of 622 µ mole photon m^{-2} s^{-1}) and inside in insect-proof house (PEP = partially exposed to sunlight) with 12h of natural sunlight (mean midday radiation of 125 µ mole photon m^{-2} s^{-1}) and mean ambient temperatures of 33^{o}C (day) and 25^{o}C (night) at Rimba Ilmu, University of Malaya, Kuala Lumpur. Growth parameters, namely, plant height; number and lengths of primary, secondary, and tertiary branches, leaf numbers in each category of branches; and phenological traits (time and duration of flowering, number of flowers/branch or number of flowers/plant) were recorded. The growth data were analyzed with ANOVA and regression analyses were performed where appropriate. The process of finding the best fit was done by CurveExpert 1.3 by comparing the data to each model to choose the best curve. The XY data can be modeled using a toolbox of linear regression models, nonlinear regression models, interpolation, or-splines.

RESULTS AND DISCUSSION

Germination and seedling growth

Germination of *M. malabathricum* seeds was significantly (p =0.05) affected by temperature but this was not manifested in fresh and dry seed treatments (Table-1). No seed germination prevailed in darkness, or when exposed to chemical media, and at temperature regimes less than 20 ^{o}C. The seed viability tests with 2,3,5-triphenyltetra-zolium chloride test showed the seed embryos were killed by chemical media. Seed germination of *M. malabathricum* was positively photoblastic. The highest rate of germination of 40-37 % were observed at 25-30 ^{o}C for oven dried seeds in distilled H_2O.Uniform two-month seedlings were exposed to two light regimes, *viz*. full sunlight (FSP) in an open (at midday, mean photosynthetically active radiation, PAR = 622 µ mole photon m^{-2} s^{-1}) or 20% of full sunlight within the greenhouse (Partial exposed plants) (PEP) (at midday, PAR = 125 µ mole photon m^{-2} s^{-1}). Light regime strongly influenced both clonal and reproductive growths of *M. malabathricum.* Germination of the light-mediated *M. malabathricum* seeds is expected to take place near the soil surface. This is beneficial for the survival of the species as germinated seeding prevailing too deeply in the soil where it may not be able to reach the soil surface (Egley, 1995). Germination capacity declined at 35ºC and thereafter, revealing that 28ºC as the optimum germination temperature for this unsorted seed lot. The length of radicle was affected by different temperatures (Table-1) and root and radicle lengths were increasing in high temperatures, but higher shoot lengths were observed in low temperatures. The root/shoot ratio was significantly affected by different temperatures and it was increasing with high temperatures (Table-1). The lower and upper temperature thresholds for germination of *M. malabathricum* were not encountered in this study, but no germination prevailed at temperatures lower than 20 ^{o}C, and germination declined at temperatures higher than 30 ^{o}C. However, effect of low and high temperatures among seeds in a population or in germination sensitivity were observed by others (Orozco-Segovia *et al.* 1996; Kebreab & Murdoch 2000; Grundy *et al.* 2000), and changes in

both the upper and lower temperature limits for germination are often associated with the imposition and release of dormancy (Kruk and Benech 2000). We did not observe strong dormancy in *M. malabathricum*. The dormancy level of seeds can change on a presumably continuous scale for example in dark area. Seeds of many species can react on the environment and adjust the level of dormancy by deepening or weakening it (Vleeshouwers *et al.* 1995; Baskin and Baskin 1998). Knowledge on seed dormancy and germination helps to explain the occurrence of weeds, and can be important when developing, or foreseeing the effect of various weed-control methods.

General growth and branching patterns

Table-2 displayed the regression models representing the best fitted models for different plant characters as the functions of days after planting in PEP and FEP plants. These models describe the growth for different parameters such as plant height, branch number, leaf number/plant or leaf number/branch, and flowers per branch or flowers/plant.

Table-1. Comparison of means of seed germination and seedling growths of *Melastoma malabathricum* in different temperatures and seed treatments*

		Germination (%)	Shoot (mm)	Root (mm)	R:S
Temperature °C	**35**	26..3 b	2.36 b	8.45a	3.718 a
	30	37..3 a	2.66 ab	5.31b	1.813 b
	25	39. 8 a	2.89 a	3.23 b	1.119 c
	15	0.0 c	0.00 c	0.00 c	0.00 d
Seed treatment	**Fresh seed**	1.82 a	3.83b	1.63 b	1.82 a
	Fresh seed + 24 h distilled water	1.74 a	3.29 b	1.49 b	1.74 a
	Oven-dried seed	2.28 a	5.96a	2.06 a	2.28 a
	Oven-dried seed + 24 h distilled water	2.06 a	3.91ab	1.464b	2.06 a

* Figures followed by the similar letters in a column for each parameter for different temperature regimes and seed treatments are not significantly different at $p < 0.05$ (Tukey's HSD tests).

Table-2. Model summaries and parameter estimates of the regression relationships between selected growth parameters of *Melastoma malabathricum* as function of time after transplanting exposed to full and partial sunlight in insect-proof house, University of Malaya.

Dependent variables	Partial sunlight		Full sunlight	
	Regression model	r	Regression model	r
Number of 2^Obranch/plant	$y = -13.2x /(-79.7 + x)$	0.99	$y = 2.2 + 0.3*\text{Cos}(0.1x - 3.3)$	0.90
Number of leaves /2^obranch/plant	$y = 0.001x^{2.008}$	0.99	$y = -55.3 + 0.5x$	0.92
Number of leaves /1^obranch/plant	$y = 36.4 + 12.4*\text{Cos}(0.02x + 0.55)$	0.99	$y = 1/(-0.0002x + 0.05)$	0.95
The length of 1^o branch/plant	$y = -50.5 + 1.08x - 0.002x^2$	0.99	$y = -31.9 + 1.03x - 0.003x^2$	0.99
Plant height (cm)	$y = 56.2\text{Ln}(x) - 209.3$	0.96	$y = 15.99\text{Ln}(x) - 2.6491$	0.92
Number of leaves/plant	$y = 12.4 + 0.5*\text{Cos}(0.2x - 5.02)$	0.80	$y = (-2995.9*80.569 + 197.6*x^{2.2}) /(80.6+x^{2.2})$	0.79
Number of 3^o branch/plant	$y = 0.42 - 0.007x - 0.0003x^2$	0.89	No analysis done, 3^o absent	-
Number of leaves /3^obranch/plant	$y = (-700072 + 6005x)/(1 + 13368.775x - 53.2x^2)$	0.98	No analysis done, 3^o absent	-
Number of 1^obranch/plant	constant equal 4.3**		$y = 1/(-0.001x + 0.2761)$	0.96

** No variations were observed on the number of 1^o branches during period of study, and this was nearly constant equal to 4.3. As each pot had just one plant and no more competition, thus devoid of light competition.

The regression analysis generated respective models for plant height data in relation to days after planting (x) were y = 56.2Ln(x) - 209.3, r = 0.96 for the PEP plants, and y = 15.99Ln(x) - 2.65, r = 0.92 for the FEP counterparts (Figure-1). Figure-1 shows PEP plants grow more rapidly in height and with bigger leaf sizes than FEP plants. Apparently, the low production costs albeit more efficient photosynthetic capacity enabled these PEP plants to produce new metamers (leaf modules, branches) quickly vis-à-vis the FEP counterparts. Such robust growths were also translated in greater plant height, a good character for this species as a better competitors as they compete for space and light**.** The regression analysis generated growth models for length of plant branch 1^o per plant in relation to days after planting is shown in Figure-2. Accordingly, there were more and early branch death in PEP than FEP plants arguably that some death of old branches prevailed inside within the PEP and FEP populations especially at the bottom and inside of canopy possibly due to the reduction in substrate production capacity and light availability. It can be argued that some death of old branches prevailed inside within the PEP and FEP especially at the bottom and inside of canopy due to the reduction in substrate production capacity and light availability (Figure-2).

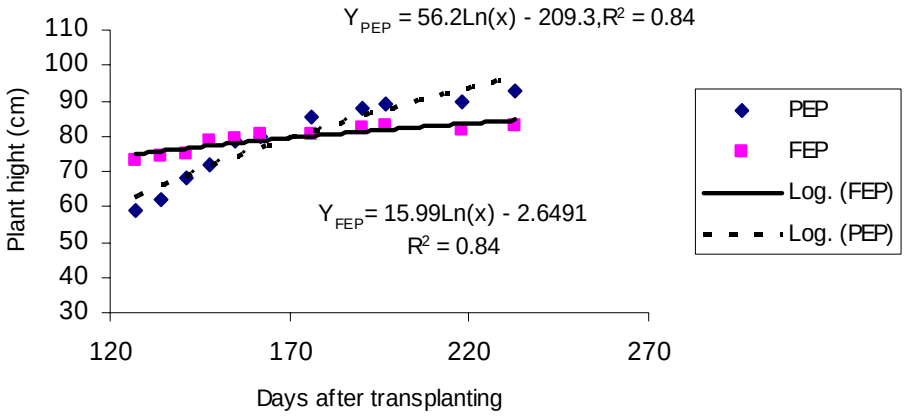

Figure-1. Plant heights of *Melastoma malabatricum* plants as influenced by light regimes. FEP, Fully exposed plants; PEP, Partially exposed plants.

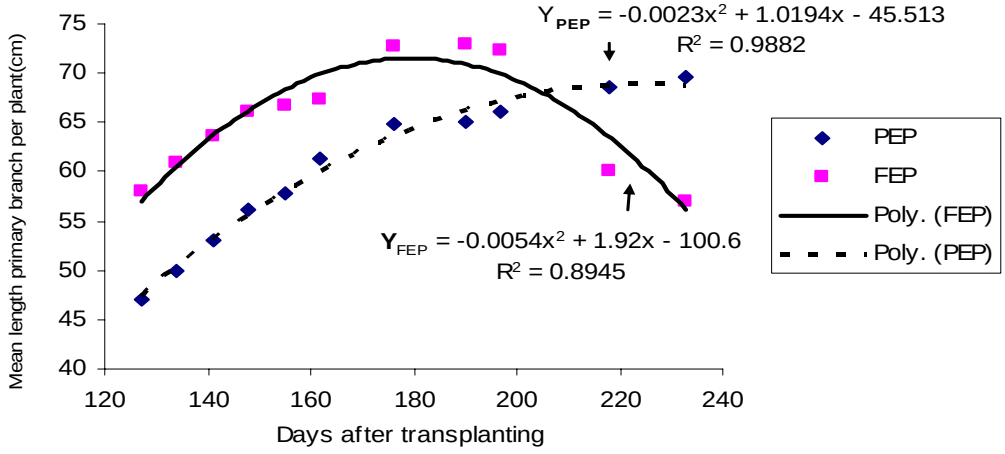

Figure-2. The lengths of primary branch per plant of *Melastoma malabathricum* as influenced by light regimes. FEP, Fully exposed plants; PEP, Partially exposed plants.

Holeman *et al.* (1990) reported for *Pinus taeda* trees that the average number of flushes on branch shoots decreased with crown depth. Rook *et al. (*1987) showed the same results for *Pinus radiata* and reported that the number of flushes on a branch is controlled by hormones and the environmental conditions or substrate availability is largely unknown. The equations for other discrete variables like as the number of leaves, branches are mentioned in Table-2.

A number of phenological and morphological stages are represented by nonlinear regression models. The FEP displayed higher rate of growth in terms of number of berries, seeds, 2^o branch, leaves/2^o branch, leaves/1^o branch, berries/2^o branch and total leaves in each. The PEP had a higher mean 100 seed weight than the FSP. Two biotypes (pink flower and white flower) showed different rates of biomass and plant height. Sunlight caused a higher rate of seed production, number of leaves and 1^o branch

and flower but the PEP had more second and third branches and internode's length. The regression analysis generated these models for plant height and branch 1^{o} per plant in relation to days after planting are shown in Figures 1 and 2.

An early death of some branches within the plant canopy was observed because of light and internal growth competition between different plant parts (Figure-2). In these experiments, the phenological variations of *Melastoma malabathricum* and the environmental conditions that the plants have been subjected to have largely been empirical and for a predictive understanding growth strategies and carbon allocation in relation to light regimes, more information on the mechanisms of phenology is needed.

REFERENCES

Baki H.B. 2004. Malaysian J. of Science. Vol. 23: 1-23.

Baki H.B. 2006. Weed Ecology and Management in Rice Ecosystems. University of Malaya Press. p. 363.

Baskin C.C. and Baskin J.M. 1998. Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination. Academic Press, San Diego, CA, USA.

Christopher J. K., John M. N. and Smith, T.G. 1998. Measurement of leaf orientation, light distribution and sunlit leaf area in a boreal aspen forest. Agriculture and Forest Meteorology. Vol. 91: 127-148.

Clausing, G. and Renner S.S. 2001. Molecular phylogenetics of *Melastomataceae* (including *Memecylaceae*): implications for character evolution. American Journal of Botany. Vol. 88: 486-498.

Cohen, S., Raveh E.Y., Grava A. and Goldschmit E. 2005. Physiological responses of leaves, tree growth and fruit yield of grapefruit trees under reflective shade screens. Scientia Horticulturae. Vol. 107: 25-35.

Egley G.H. 1995. Seed germination in soil dormancy cycles. In: Seed Development and Germination (J. Kigle and G. Galili, Eds.). Cambridge Univ. Press. p. 332.

Faravani, M. and Baki H.B. 2007. Descriptive analysis on the morphology, growth and branching patterns of Princess-flower (Tibouchina urvilleana Cogn.) in Peninsular Malaysia. Journal of Food, Agriculture and Environment. Vol. 5: 234-238.

Grundy A.C., Phelps K., Reader R.J. and Burston S. 2000. The germination of Stellaria media using the concept of hydrothermal time. New Phytologist. Vol. 148: 433-444.

Holeman, R., Hennessey T.C. and Dougherty P. M. 1990. Shoot and foliage phenology of main branch terminals of 15-year-old loblolly pine. Proc. 11^{th} North American Forest Biology Workshop (Athens, GA). pp. 32-33.

Kebreab E. and Murdoch A.J. 2000. The effect of water stress on the temperature range for germination of Orobanche aegyptiaca seeds. Seed Sci. Res. 10: 127-133.

Kruk B.C. and Benech-Arnold R.L. 2000. Evaluation of dormancy and germination responses to temperature in (*Carduus acanthoides*) and (*Anagallis arvensis*) using a screening system, and relationship with field-observed emergence patterns. Seed Science Research. 10: 77-88.

Maxwell, J.F. 1989. Melastomataceae. In: Tree Flora of Malaya (Ng, F.S.P., Ed.). Forest Res. Institute Malaysia, Ministry of Primary Industries, Malaysia. pp. 179-198.

Nasrullahzadeh, S., Ghassemi-Golezani K, Javanshir A., Valizade M. and Shakiba MR. 2007. Effects of shade stress on ground cover and grain yield of faba bean. J. of Food, Agriculture and Environment. Vol. 5: 337-340.

Orozco-Segovia A., González-Zertuche L., Mendoza A. and Orozco S. 1996. A mathematical model that uses Gaussian distribution to analyze the germination of Manfreda brachystachya (Agavaceae) in a thermogradient. Physiologia Plantarum. Vol. 98: 431-438.

Penneys D.S. 2004. Melastomaceae of the world. http://www.flmnh.ufl.edu/ (accessed in Feb. 2007).
Renner S.S. and Meyer K. 2001. Melastomacea come full circle : biogeographic reconstruction and molecular cloack dating. Society for the Study of Evolution. 55: 1315-1324.

Ridley H. N. 1922. The Flora of the Malaya Peninsula. Reeve, London. 1: 763-766.

Rook D., Bollmann M.P. and Hong S.O. 1987. Foliage development within the crowns of Finns radiata trees at two spacing. New Zealand J. of Forestry. 17: 297-314.

Syvertsen J. P. and Smith Jr. M. L. 1984. Light acclimation in Citrus leaves. I. Changes in physical characteristics, chlorophyll, and nitrogen content. J. of American Society of Horticultural Sciences. 109: 807-812.

Vleeshouwers L. M H. J, Bouwmeester C., Karssen M. 1995. Redefining seed dormancy: an attempt to integrate physiology and ecology. J. of Ecology. 83: 1031-1037.

Wan C. and Ronald E. S. 1998. Tillering responses to red: far-red light ratio during different phenological stages in (Eragrostis curvula). Environmental and Experimental Botany. Vol. 40: 247-254.

Wong G. 1991. Shade tolerance of tropical forages: A review. In: Forages for Plantation Crops (Shelton, H. M. and Stuart, W.W., Eds.). ACIAR, Canberra. pp. 64-69.