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RESEARCH ARTICLE

Early growth and plant performance of *molineria* colla species grown under different shade levels and media compositions

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Abstract

Molineria or locally known as lemba is a wild herbaceaous plant that is found abundantly in the shade areas and under rubber plantations. Main interest on this plant lies on the curculin, the sweet protein that is contained in its fruits which is known to have antidiabetic properties and is a good source of alternative sweetener. The importance of curculin found in the fruit has been discussed but cultivation of lemba was never reported. A study was carried out with the aim of obtaining the optimum growing conditions of Molineria species in nurseries, in relation to different media ratio and light requirement. The specific objectives of this study were to obtain the optimum media composition and shade requirement for M. latifolia and M. rubriclavata grown under nursery condition. Analysis were based on the selected growth parameters such ass plant height, number of leaves, fresh and dry weights of shoots and roots. Plants were grown under two shade structures providing 50% and 70%. The treatment combinations of two species and 10 soil mixtures were randomly assigned in a split plot design with four blocks in each shade structure. The media and species were the main and sub plots respectively. The experimental units were the potted plants, which were arranged in a square pattern of 15cm x 15cm. The potted plants were placed on the floor of black plastic sheets in each shade structure. Plants were harvested 16 weeks after planting (WAP). Data collected were plant height and fresh and dry weight of shoots and roots. Data were analysed using SAS version 9.2 package, and the mean separations was determined by the Duncan's New Multiple Range Test (DNMRT) at $\rho = 0.05$. Result show that the best shade level for both varieties was 70%. It is concluded that the best media for maintaining Molineria species under nursery condition was 1:3:1(top soil:peat grow:sand) combination for M. latifolia var. megacarpa and 2:3:1 for M. rubriclavata.

Introduction:-

The genus Molineria Cola of the Hypoxidaceae family is found abundantly wild in the secondary and primary forests. This genus is mainly distributed in the tropical regions of Africa and South East Asia. It is locally known as Lemba, Lumbar or Lumbah (Malay) and is a perennial rhizomous herb. The plants were found growing in shaded area typically in rubber plantations but some are found to be successful under full sun and disturbed areas particularly on clay soil. In 1990, Yamashita et al. patented a new sweet protein found from the fruits of Molineria named curculin and neoculin. These proteins are taste bud modifier and were proposed as a good source for alternative sweeteners. According to Ismail et al. (2011), curculin is 9000 times sweeter than sucrose and can be developed as low calorie food product and put in line with other plant sources of sweeteness such as Synsephylum dulficum (miracle fruit) and Stevia rebaudiana (stevia). A survey conducted by the National Health and Morbidity Survey (NHMS) in 2011 showed that 2.6 million Malaysians are diabetic or at risk with diabetes. These statistics indicate that incidence of diabetes in Malaysia has increased by 31% in the past five years. To date, there are numerous avaiable alternatine sweetener products from sugar cane and stevia and with the discovery of curculin, Molineria was reagarded as one of the important herbal plants in Malaysia. Due to that knowledge on agronomic practices and planting requirements for this plant is necessary for its cultivation. To date, no such reports were found and these plants are still considered as wild or forest species.

A pioneer study was carried out with collections from various populations in Peninsular Malaysia showed the presence of narrow genetic distance diversity among accessions (Ranjabarfard, 2010) and taxonomic revisions revealed that new species were found (Rozilawati et al., 2015). One particular species was found growing well under full sun, with big plant size and numerous inflorescence simultaneously bearing fruits (Table 1). The rest were often found growing under the shades of shrubs or tree.

Shade tolerance, environmental factors and growth conditions such as growing media, nutrients, light and water play important roles in plant growth and development (Salisbury & Ross, 1992). Plants growing at high intensities have a different leaf morphology and growth performance from those grown at low intensities (Boardman, 1977), where high light intensity causes stronger development of the palisade and sponge mesophyll regions, resulting in thicken leaves. Different growing media mixtures or soil types such as peat moss give different plant growth responses that are effective to varieties or species (Tsakaldimi, 2005). Optimization of media and light are important since roots are forced to obtain nutrient in a confined and limited area of the pot. Domestication of wild plants indirectly will alter the growing condition and plants would have higher capability for their survival and adaptation. However, in agriculture adaptation is less of worry since plants with high yielding traits are more desirable for selection and this can be obtains by manipulation and optimizing the growth factors. In order to obtain high yield the optimization of the growth factors are usually manipulated. Although the 3:2:1 mixture of media media (top soil: organic matter: sand) is known as the standard media type, some monocotyledonous plants may prefer different ratio or different type of media. Ratna et al. in 2006 reported that banana cv. Raja Serai reached the highest value for shoot and leaf growth in media containing mixture of soil and sand. Ni et al., 2011 reported that growing media containing mixture of soil and manure is the best for growth of pineapple seedlings. Media types such as vermicompost, vermiculite, organic matter and the current biochar provide wider range of growing media that lead or resemble the organic and soilless culture for plant growth. However, not all plants are able to perform better in different media as was seen in mangosteen (Nurul Ain, 2011). Lower percentage and slow seedlings growth of mangosteen were seen when seeds were sown in media with higher composition of biochar as compared to when seed was sown in sands. Above findings however was not consistent with various reports on the recommendations and the advantages of using biochar as part of planting media as the requirement on biochar ratio may differ according to different plant species or varieties (Sohi et al., 2010). Thus, optimization of the media composition and ratio are often required to reduce the pressure towards low growth rate which will subsequently produced low yielding crop, weak and susceptible to pests and diseases (Mustafa Kamal, 1989).

Plants that were collected by Ranjabarfard (2011) were initially maintained in the 3:2:1 soil mixture but their identification at species level were not determined. Preliminary observations revealed plants collected from higher altitude and with maroon leaf abaxial tend to have faster and higher death rate as compared to plant that are from lower altitude. Plants that were originally collected from shaded area also did not survive when left under full sun. On the other hand, plants collected from open area showed slow growth when kept under shade. From these observation, it seems that different Molineria species require different growth conditions and this will become problematic for cultivation. Therefore, prior knowledge of their species identity and growth requirement is needed prior to large scale cultivations. With this in mind, a study was carried out to determined the optimum media composition and shade requirements for Molineria species grown under nursery conditions. Two different species were compared, the sun loving M. rubriclavata and species found under semi shaded are M. latifolia var. megacarpa. The objectives of this study were to determine the optimum media composition and shade level required for the cultivation of two Molineria species under nursery condition.

Materials and methods:-

Two species of Molineria namely Molineria latifolia var. megacarpa and Molineria rubriclavata were used in this study. The former was collected from Sungai Jai, Selangor while the latter was from Lata Payung, Terengganu. The plants were grown under two shade levels (50% and 70% light intensity) with 10 soil mixture ratios of top soil:peat growth:sand (1:1:1, 1:2:1,1:3:1, 2:1:1, 2:2:1,2:3:1, 1:1:2, 1:2:2,1:3:2,3:2:1). The mixtures were placed in the planting pots with a diameter of 22.5 cm. This experiment was conducted at the Agronomy Research Farm, Field 2, Universiti Putra Malaysia. The treatment combinations of two species and 10 soil mixtures were randomly assigned in a split plot design with four blocks in each shade structure. The media and species were treated as the main and subplots respectively. The experimental units were potted plants, arranged in square pattern of 15cm x 15cm.

The potted plants were placed on the floor covered with black plastic sheets to control weeds and watering was done manually twice a day. Fertilization was applied at week four and week 12 after planting. Plants were harvested at 16 weeks after planting (WAP). Data collected were plant height, and fresh and dry weight of shoots and roots. Data were analysed using SAS version 9.2 package, and the mean separation was determined using the Duncan's New Multiple Range Test (DNMRT) at $\rho = 0.05$.

Results and discussion:-

There were significant effects of shade, media and species on growth parameters of both Molineria latifolia var. latifolia and Molineria rubriclavata in terms of plant height, shoot and root fresh weights, and shoot and root dry weights (Table 2). This study also indicate that there were interactions between species, media and shade which contributed to different plant growth performance. The difference in growth performance between the two Molineria species may be due to their differences in adaptation capacity. There were no significant effects of shade, media and species on number of leaves in both species (Table 2).

The heights of M. latifolia var. megacarpa and M. rubriclavata increased when the light intensity was increased from 50 % to 70 % (Table 3). Height of M. latifolia var. megacarpa increased by 37.67 % while that M. rubriclavata was only by 15.40 %. Howard (1992) indicated that plants under shading condition would grow longer towards light in order to obtain adequate sunlight. Molineria is the monocot plant that measurement of the plant height was also based on the leaf length. Leaf sizes are strongly influenced by light levels during development because light intensity affects plant growth, that is, in part by influencing the rate of photosynthetic activity. The leaves grow longer at the low light intensity (Hartmann et al., 1988). Based on Lockhart (1960), excessive stem elongation occurs in plants when grown in darkness and then exposing them to high intensity will cause the plant to grow and achieved a minimum height. Besides that, under physiological stress condition (which is low of light intensity level), plant were probably promote stem elongation. The maize height increase when grown in shade area as compared to those in exposed area (McColla et al., 1939). In term of species, height M. rubriclavata was higher than M. latifolia in all factor tested.

Plants growns in soil containing mixtures of 20 % top soil: 60 % peat growth: 20 % sand (1:3:1) gave better plant height for M. latifolia var. megacarpa, while 34% top soil, 49% peatgro and 17% sand (2:3:1) was for M. rubriclavata when grown under 50% and 70% shade (Table 2). According to Bugbee and Frinck (2002), plant height is increased significantly by increasing the organic matter. In term of species, height M. rubriclavata was higher than M. latifolia in all factor tested.

Figures 1 and 2 show that plant height of Molineria latifolia var. megacarpa and Molineria rubriclavata versus weeks became well fitted to the logistic growth model in the form of $y = a/(1+be^{-cx})$, where y = plant height, x = weeks after planting where a, b, and c are constants. Both species attain the optimum growth when grown in the same shade level but showed differences among different media compositions. The height of Molineria latifolia var. megacarpa and M. rubriclavata were 38.5 cm and 59.5 cm, respectively. Molineria latifolia var. megacarpa achieved optimum growth in media composition of 1:3:1 (Top soil:Peat grow:sand) while the composition of 2:3:1 for M. rubriclavata.

The growth rate of Molineria in term of height are shown in Figures 3 and 4, and the growth rate (height rate) is shown in Table 5 and Table 6. It was observed that the maximum growth rates for M. latifolia var. megacarpa grown under 50% and 70% shade were 3.8 and 6 week^{-1} cm at weeks, respectively. The maximum growth rates for M.

rubriclavata grown under 50% and 70% shade were 6.4 cm week^{-1} at weeks 5 and 6.9 week^{-1} cm at weeks 6, respectively. The growth rate increase until weeks five when grown under 50 shade and weeks six under 70 % shade. The reduction in plant height might be attributed to the fact that plants had archived the optimum growth rate at about 6 weeks after planting. M. latifolia var. megacarpa and M. rubriclavata had maximum the optimum growth rates in media containing mixture of 1:3:1 and 2:3:1, respectively as compared to those grown under other media compositions.

Light intensity and media composition did not give any significant effect on number of leaves of both M. latifolia var. megacarpa and M. rubriclavata (Table 3). According to George et al., (2012), the number of leaves for Salvia officinalis L. were not affected by light intensity. The number of leaves for both species ranged from five to six leaves per plant in all factors tested. Some plants such as Labisia pumila develops leaf at very slow rates and some monocots species experience the same thing. It was observed during sampling of Molineria spp., most of the plant specimens bears 5-7 leafs.

The fresh and dry weight of roots of M. latifolia var. megacarpa and M. rubriclavata increased when light intensity was increased from 50 % to 70 % (Table 4). Plants grown in soil containing mixtures of 20 % top soil: 60 % peatgro: 20 % sand gave highest fresh and dry weight of roots for M. latifolia var. megacarpa, while the media with 34% top soil, 49% peatgro and 17% sand was for M. rubriclavata. These media compositions provided the optimum condition for root development which make nutrient and water absorption more effectives to achieve optimum height. According to Resh (1991), media must support the growth and development of plant roots. It was shown that when total dry weight increased the internal substance of plant will be are produced from mineral absorption and photosynthesis. The increase in dry mass also showed that the plant had increase in size by cell division and enlargement, including synthesis of new cellular materials and subcellular organels (Salisbury and Ross, 1992). In term of species, fresh and dry weight of root of M. rubriclavata was higher than M. latifolia in all factors tested.

The fresh and dry leaf weight of M. latifolia var. megacarpa and M. rubriclavata increased with the reduction of light intensity (Table 4). Reduction of light was reduced when the shading percentage was increased from 50% to 70%. According to Shelly and David (2000), reduced light intensity would increase the leaves weight of Eucalyptus globulus ssp. Globul, while leaves dry weight of Beta vulgaris l. var. crassa increase with decreasing light intensity (Sebahatin and Necdet, 2007). Plants grown in soil containing mixtures of 20 % top soil: 60 % peatgro: 20 % sand gave highest fresh and dry weights of leaves for M. latifolia var. megacarpa and 34% top soil: 49% peatgro: :17% sand for M. rubriclavata. In term of species, fresh and dry weight of leaves of M. rubriclavata was higher than M. latifolia in all factors tested.

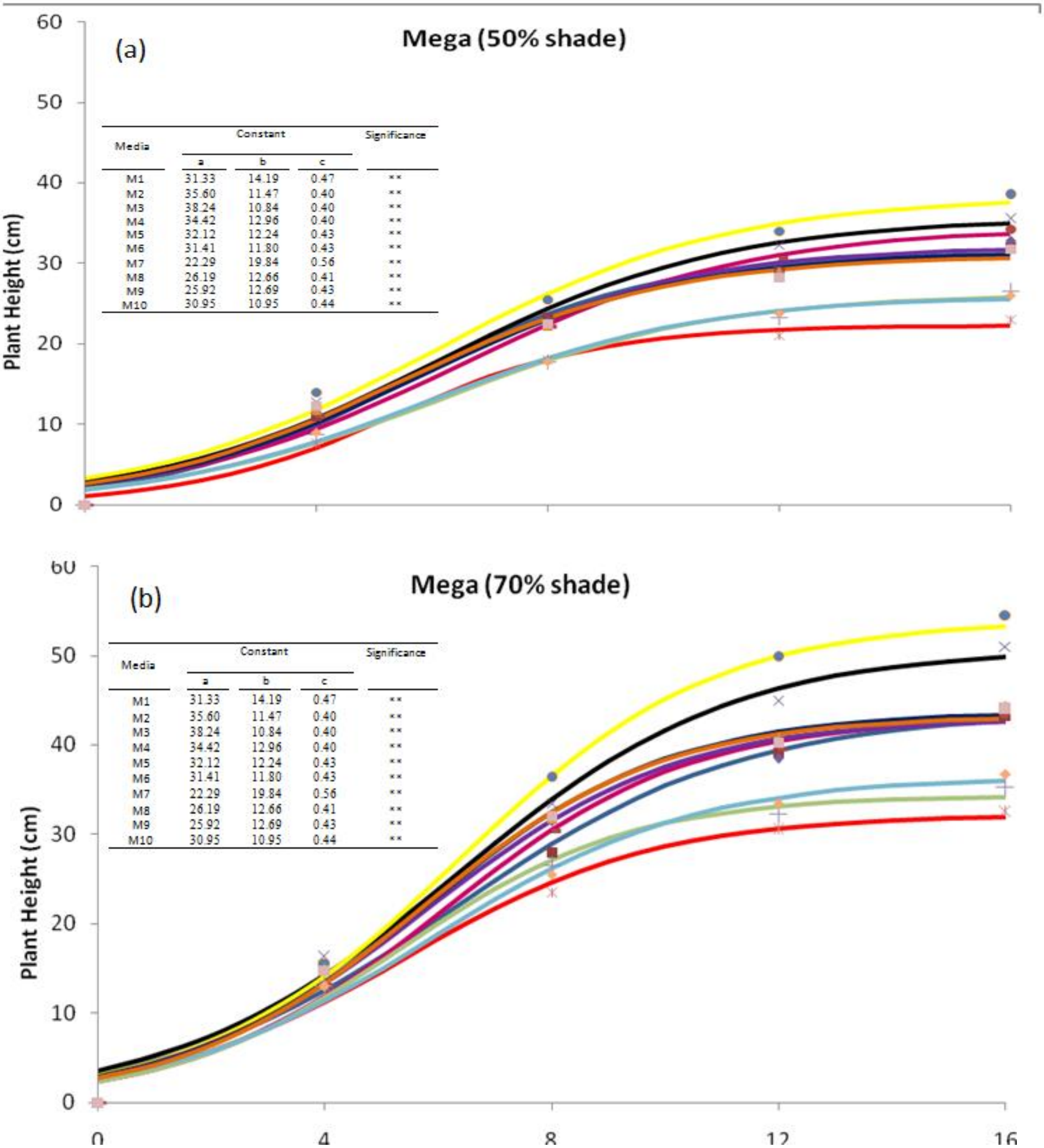
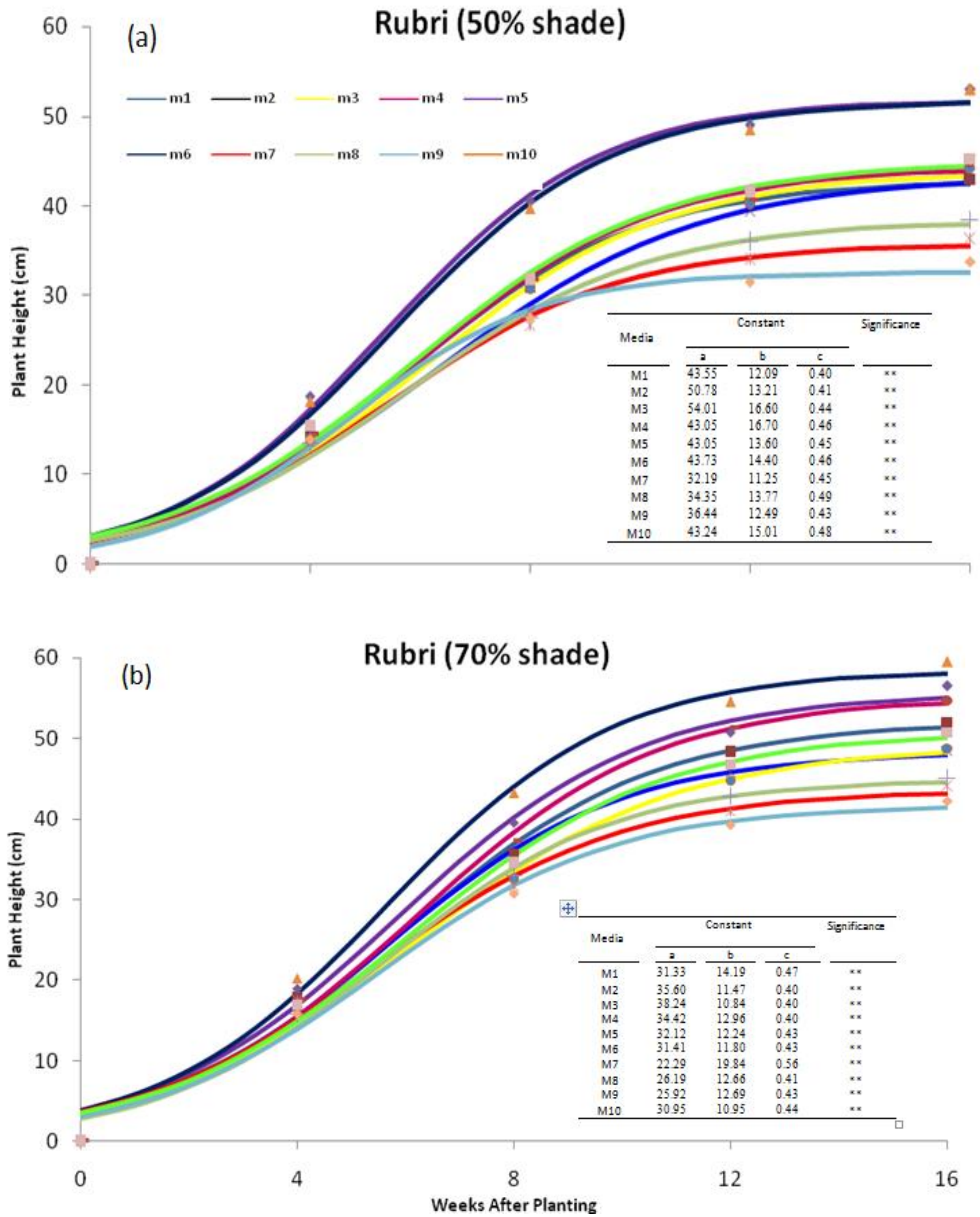


Figure 1: Plant height growth of *M. megacarpa* var. *latifolia* in (a) 50% shade and (b) 70% shade grown in 10 types of media ratio The media in the form of formula $Y=a/1+be^{-cx}$ where Y=plant height, x=WAP, while a,b,c are regression constant. The * and ** are significant at p≤5% and 1% respectively, where ns is not significant at p=5%.



Media	Constant			Significance
	a	b	c	
M1	43.55	12.09	0.40	**
M2	50.78	13.21	0.41	**
M3	54.01	16.60	0.44	**
M4	43.05	16.70	0.46	**
M5	43.05	13.60	0.45	**
M6	43.73	14.40	0.46	**
M7	32.19	11.25	0.45	**
M8	34.35	13.77	0.49	**
M9	36.44	12.49	0.43	**
M10	43.24	15.01	0.48	**

Media	Constant			Significance
	a	b	c	
M1	31.33	14.19	0.47	**
M2	35.60	11.47	0.40	**
M3	38.24	10.84	0.40	**
M4	34.42	12.96	0.40	**
M5	32.12	12.24	0.43	**
M6	31.41	11.80	0.43	**
M7	22.29	19.84	0.56	**
M8	26.19	12.66	0.41	**
M9	25.92	12.69	0.43	**
M10	30.95	10.95	0.44	**

Figure 2: Plant height growth of *M. rubriclavata* in (a) 50% shade and (b) 70% shade grown in 10 types of media ratio The media in the form of formula $Y=a/1+be^{-cx}$ where Y=plant height, x=WAP, while a,b,c are regression constant. The * and ** are significant at p≤5% and 1% respectively, where ns is not significant at p=5%.

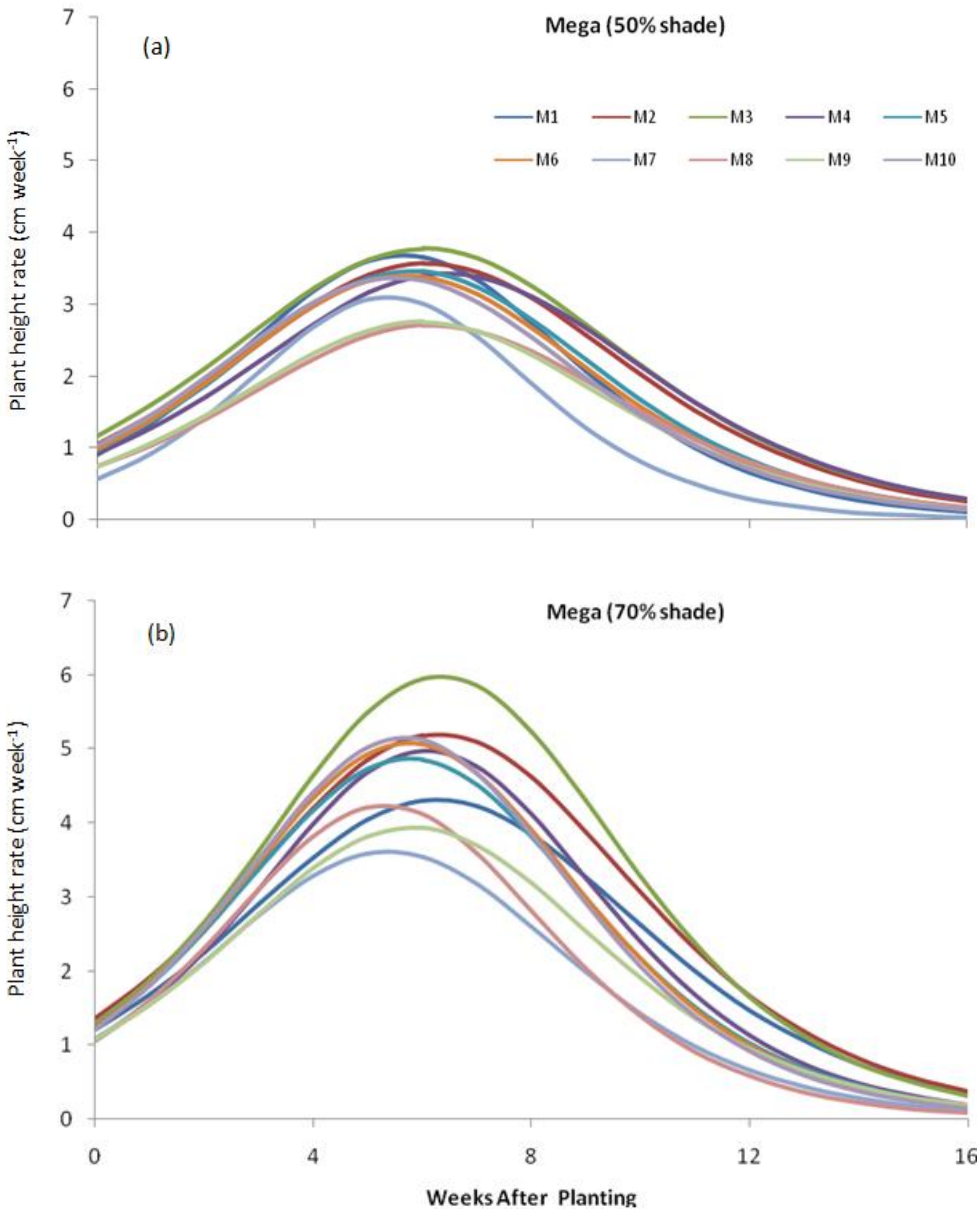


Figure 3: Plant height increase rate of *M. latifolia* var. *megacarpa* in (a) 50% shade and (b) 70% shade in 10 types of media ratio (Top soil:Peat:Sand).M1= 1:1:1, M2=1:2:1, M3=1:3:1, M4=2:1:1, M5=2:2:1, M6=2:3:1, M7=1:1:2, M8=1:2:2, M9=1:3:1, M10=3:2:1.

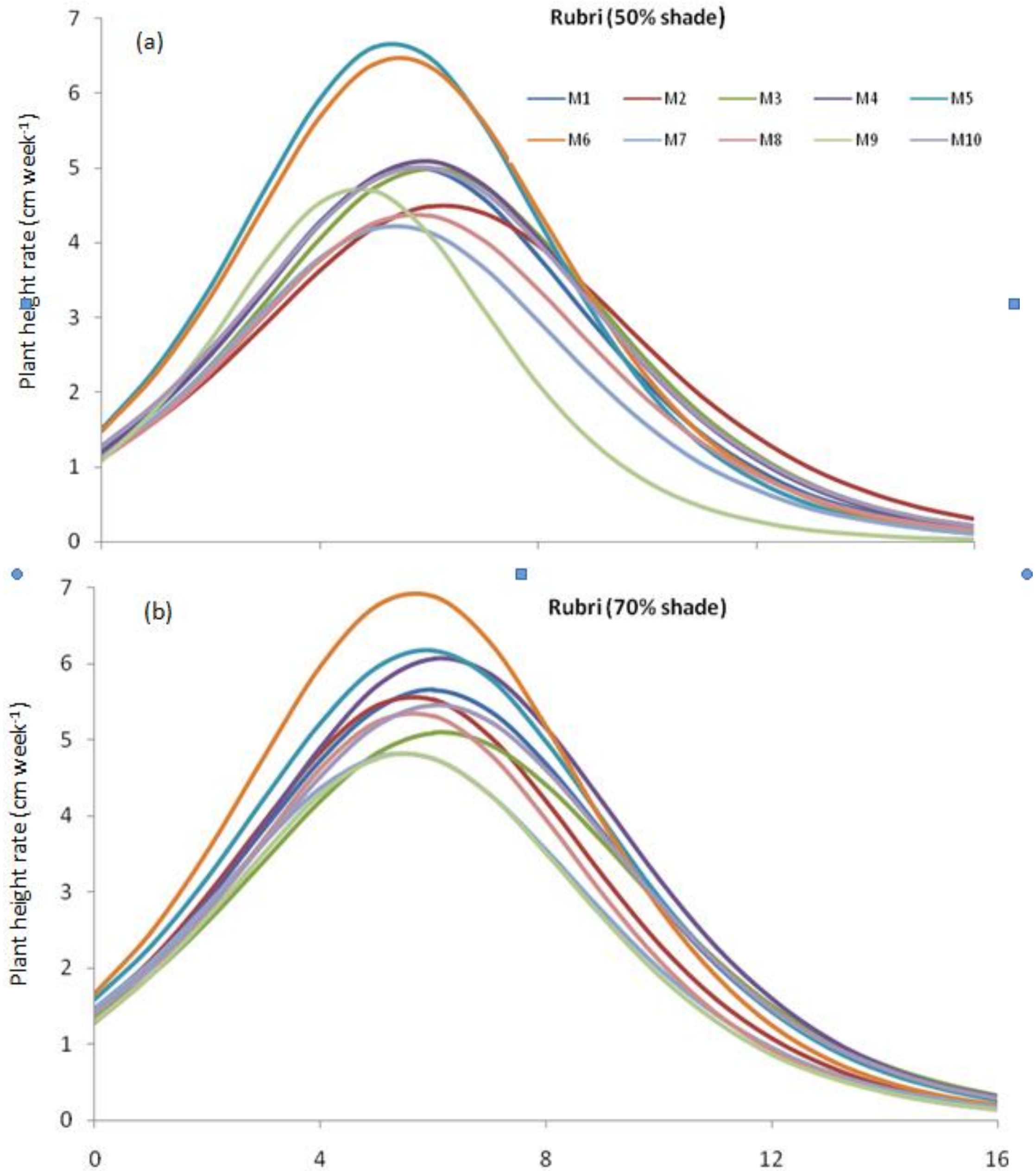


Figure 4: Plant height increase rate of *M. rubriclavata* in (a) 50% shade and (b) 70% shade in 10 types of media ratio (Top soil:Peat:Sand).M1= 1:1:1, M2=1:2:1, M3=1:3:1, M4=2:1:1, M5=2:2:1, M6=2:3:1, M7=1:1:2, M8=1:2:2, M9=1:3:1, M10=3:2:1.

Table 1: Molineria species found in Peninsular Malaysia:-

No.	Species
1.	Molineria latifolia (Dryand.) Herb. ex Kurz var. latifolia
2.	Molineria latifolia (Dryand.) Herb. ex Kurz var. megacarpa (Ridl.) I.M.Turner
3.	Molineria latifolia var. rutilovenis Psyquay & Ghazali
4.	Molineria erythrofolia Psyquay & Thohirah
5.	Molineria nitida Psyquay & Rozilawati
6.	Molineria capitulata (Lour.) Herb
7.	Molineria atropurpurea Psyquay & R.Go
8.	Molineria trichobunda Psyquay & Kaslamiah
9.	Molineria rubriclavata Psyquay & Ghizan

Table 2: Mean square of plant growth parameters of M. latifolia var. megacarpa and M. rubriclavata species as affected by light intensity and media composition

Source of Variation	DF	Plant height	No. of Leaf	Shoot Fresh Weight	Root Fresh Weight	Shoot Dry Weight	Root Dry Weight
		-- Mean square --					
Shade	1	3404.03**	0.63	1226.22**	175.77**	89.25**	12.75**
Rep(shade)	6	2.67	0.03	5.45*	0.54	0.08	0.01
Media	9	413.12**	0.29	126.48**	61.37**	22.42**	4.84**
Media*Shade	9	4.17	0.33	1.85	4.08**	0.48**	0.33**
Media*Shade*Rep(shade)	54	6.23	0.18	1.48	0.53	0.05	0.01
Species	1	3822.03**	0	18156.12**	3247.92**	855.26**	270.48**
Species*Shade	1	255.03**	0.4	147.23**	28.58**	7.62**	2.45**
Species*Media	9	124.51**	0.07	178.28**	79.90**	26.93**	6.80**
Species*Media*Shade	9	16.15*	0.19	4.55*	5.15**	1.06**	0.41**
Error	60	6.67	0.17	1.81	0.53	0.05	0.02

Note: * and ** are significant at p=5% and 1%, respectively, ns is not significant at p=0.05. DF=degree of freedom

Table 3: Mean values for plant height and number of leaf) of two Molineria species as affected by media and shade under nursery condition.
Means followed by same letter within a column are not significantly different at p= 0.05 by Duncan New Multiple Range Test (DNMRT); Mega=M.latifolia var. megacarpa , Rubri= M. rubriclavata:-

	Plant height				No. of leaf			
	Shade 50%		Shade 70%		Shade 50%		Shade 70%	
Media	Mega	Rubri	Mega	Rubri	Mega	Rubri	Mega	Rubri
M1	32.00b	43.00b	43.25c	52.00bcd	5.00a	5.00a	5.00a	5.00a
M2	35.50ab	43.00b	51.00b	48.5de	5.00a	5.50a	5.50a	5.00a
M3	38.50a	44.25b	54.5a	48.75de	5.00a	5.00a	5.50a	5.75a
M4	34.25b	45.00b	43.5c	54.75bc	5.50a	5.25a	5.00a	5.00a
M5	32.75b	53.00b	44.5c	56.5ab	5.00a	5.50a	5.75a	5.50a
M6	31.75b	53.00b	44.25c	59.5a	5.00a	5.25a	5.50a	5.50a
M7	23.00b	36.25cd	32.5e	44.00ef	5.25a	5.00a	5.00a	5.00a
M8	26.5c	38.5c	35.25de	45.00ef	5.00a	5.25a	5.25a	5.25a
M9	26.00c	33.75b	36.75d	42.259	5.00a	5.25a	5.5a	5.25a
M10	31.75c	45.25b	44.00c	50.75cd	5.50a	5.25a	5.50a	5.25a

Table 4: Means values of shoot and root of two Molineria species as affected by media and shade under nursery condition:-

	Shoot fresh weight				Root fresh weight				Shoot dry weight				Root dry weight			
	Shade 50%		Shade 70%		Shade 50%		Shade 70%		Shade 50%		Shade 70%		Shade 50%		Shade 50%	
Media	Mega	Rubri	Mega	Rubri	Mega	Rubri	Mega	Rubri	Mega	Rubri	Mega	Rubri	Mega	Rubri	Mega	Rubri
M1	8.59c	28.13b	12.38b	37.05b	3.19cde	12.00bc	4.65	15.30cd	2.10c	6.14c	3.14b	8.35cd	1.16bc	3.62d	1.43b	4.58bc
M2	10.24b	22.11cd	16.13a	26.52c	4.02b	6.79e	6.11a	10.29e	2.67a	4.35f	4.51a	5.50f	1.26ab	1.99e	1.84a	3.09d
M3	11.21a	22.77cd	16.05a	28.28c	4.49a	7.32e	6.29a	7.13f	2.71a	4.11f	4.45a	4.88g	1.35a	2.20e	1.91a	2.17e
M4	8.62c	27.03b	12.36b	35.35b	3.54c	13.04	4.70b	16.08cd	2.23b	5.92cd	3.17b	8.05de	1.12bc	4.13c	1.41b	4.83b
M5	8.45c	37.54a	11.61b	46.01a	3.34cd	18.67a	4.30b	18.60b	2.15bc	9.46b	3.30b	11.89b	1.05cd	5.68b	1.34b	5.59a
M6	8.49c	37.84a	12.13b	45.74a	3.31cd	18.54a	4.65b	20.62a	2.17bc	1.75a	3.29b	13.55a	1.04cd	5.67a	1.40b	5.78a
M7	7.51d	25.59b	9.07d	34.59b	3.00def	10.76cd	3.50c	14.85d	1.75d	5.51d	2.09d	7.89e	1.04cd	3.32e	1.23c	4.46c
M8	7.34d	26.81b	9.81cd	35.29b	2.87ef	9.64d	3.80c	16.61c	1.71d	6.08c	2.33cd	8.13de	2.91d	1.19f	1.34c	4.83b
M9	6.94d	23.90c	10.12c	28.97c	2.79f	7.07e	3.83c	9.51e	1.77d	4.91e	2.45c	5.77f	0.93bc	2.91e	1.28c	2.85d
M10	8.65c	28.11b	12.56b	34.65b	3.47c	11.83bc	4.70b	16.12cd	2.09c	6.05c	3.20b	8.54c	1.15bc	3.58d	1.46b	4.78b

Means followed by same letter within a column are not significantly different at p= 0.05 by Duncan New Multiple Range Test (DNMRT); Mega=M.latifolia var. megacarpa , Rubri= M. rubriclavata.

Table 5: Height rate of plant height in 10 media with two shading levels with functions of $dy/dx = abce^{-cx}/(1+be^{-cx})^2$ for M. latifolia var. megacarpa, where y = plant height, x = week and a, b, and c are constants as indicated in Figure 4.1.

	50 % shade		70 % shade	
Treatment	Plant growth rate (Plant height)		Plant growth rate (Plant height)	
	Week	cm week^{-1}	Week	cm week^{-1}
M1	2	1.92	2	2.25
	6	3.67	6	4.30
	10	1.48	10	2.62
M2	2	1.95	2	2.60
	6	3.58	6	5.18
	10	2.03	10	3.07
M3	2	2.12	2	2.67
	6	3.78	6	5.96
	10	2.15	10	3.29
M4	2	1.71	2	2.27
	6	3.41	6	4.98
	10	2.14	10	2.40
M5	2	1.88	2	2.54
	6	3.46	6	4.86
	10	1.67	10	2.18
M6	2	1.90	2	2.58
	6	3.39	6	5.06
	10	1.58	10	2.17
M7	2	1.43	2	2.13
	6	3.01	6	3.55
	10	0.81	10	1.43
M8	2	1.41	2	2.31
	6	2.71	6	4.12
	10	1.51	10	1.39
M9	2	1.45	2	2.12
	6	2.76	6	3.94
	10	1.42	10	1.91
M10	2	1.98	2	2.59
	6	3.33	6	5.13
	10	1.45	10	2.07

Table 6: Height rate of plant height in 10 media with two shading levels with functions of $dy/dx = abce^{-cx}/(1+be^{-cx})^2$ for *M. rubriclavata*, where y = plant height, x = week and a, b, and c are constants as indicated in Figure 4.2.

	50 % shade		70 % shade	
Treatment	Plant growth rate (Plant height)		Plant growth rate (Plant height)	
	Week	cm $week^{-1}$	Week	cm $week^{-1}$
M1	2	2.54	2	2.90
	6	4.99	6	5.66
	10	2.11	10	2.85
M2	2	2.22	2	2.96
	6	4.48	6	5.52
	10	2.61	10	2.31
M3	2	2.37	2	2.62
	6	4.99	6	5.09
	10	2.42	10	2.84
M4	2	2.50	2	2.91
	6	5.09	6	6.07
	10	2.33	10	3.17
M5	2	3.43	2	3.19
	6	6.48	6	6.17
	10	2.04	10	2.93
M6	2	3.30	2	3.54
	6	6.36	6	6.89
	10	2.20	10	2.78
M7	2	2.36	2	2.84
	6	4.14	6	4.74
	10	1.55	10	1.99
M8	2	2.28	2	2.74
	6	4.36	6	5.31
	10	1.90	10	2.10
M9	2	2.71	2	2.67
	6	4.11	6	4.76
	10	0.80	10	1.90
M10	2	2.59	2	2.77
	6	5.00	6	5.46
	10	2.34	10	2.86

Conclusion:-

In most cases, when collecting plants from the wild they are usually subjected to nursery condition for hardening before replanted as field crops. This study succeeded to identify suitable nursery condition for *M. latifolia* var. *megacarpa* and *M. rubriclavata* before they are being used for field cultivations. Shade and soil mixture have an impact on growth of both species. Based on this study, the best shade level for both varieties was 70%. This study concluded that the best media for maintaining *Molineria* species under nursery condition is 1:3:1(Top soil:Peat grow:Sand) media combination for *M. latifolia* var. *megacarpa* and 2:3:1 for *M. rubriclavata.*

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