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Formulation of properties and proportion of constituents in growing media for Pot (tube) and Analysis on identification of sizes of Pot (tube) based on root penetrating pattern and growth of commercial tree species

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LIST OF ABBREVIATION

Br. P	Brick Powder
CEC	Cation Exchange Capacity
CD	Cow Dung
CCP	Charcoal Powder
EDP	Elephant Dung Powder
EM	EM Bocashi manure compost
RH	Rice Hull
CRH	Carbonized Rice Husk
N:P:K	Nitrogen: Phosphorus : Potassium
FD	Forest Department
CF	Community Forestry
SPM	Sugar Press Mud
S soil	Sticky soil
F soil	Forest soil
RP (f)	Rice Powder (fine)
RP (c)	Rice Powder (coarse)
SRP	Sticky Rice Powder
SD	Sawdust
SFC	Sugarcane Filter Cake

Pot (Tube) အတွင်း ထည့်သွင်းမည့် စပ်မြေ (Growing Media)များ တွင် ပါဝင်မည့် ပစ္စည်းအမျိုးအစားနှင့် အချိုးအစားများကို စမ်းသပ် ဖော်ထုတ်ခြင်းနှင့် Pot (Tube) အရွယ်အစား ရွေးချယ်နိုင်ရန် အမြစ်များ၏ ထိုးဖောက်မှု ပုံသဏ္ဌာန်များနှင့် အမြစ်များ ကြီးထွားမှုကို လေ့လာခြင်း

လှမျိုးအောင်၊ လက်ထောက်ညွှန်ကြားရေးမှူး
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စာတမ်းအကျဉ်း

ဤစာတမ်းတွင် မြန်မာနိုင်ငံသစ်တောများ ပြန်လည်ပြုစုပျိုးထောင်ခြင်း စီမံကိန်းကို အထောက်အကူဖြစ်စေရန် နှင့် စီမံကိန်းတွင် ပျိုးထောင်ရာ၌ အသုံးပြုနေသော ပလတ် စတစ်အိတ်များအစား ခေတ်မီသော ပြန်ချောင်း Pot(Tube) များဖြင့် အစားထိုးသုံးစွဲပြီးနောက် ပလတ် စတစ်အိတ် များသုံးစွဲမှု လျော့ချသွားရန်၊ ပလတ်စတစ်အိတ်များညစ်ညမ်းမှုမှကာကွယ်ရန်၊ သယ်ယူပို့ဆောင်ခစရိတ် သက်သာစေပြီး စိုက်ပျိုးနည်းအသစ်ဖြင့် အချိန်တိုတိုအတွင်း စရိတ်သက်သာစွာဖြင့် အမြန်ဆုံး စိုက်ပျိုးနိုင်ရေး လေ့လာစမ်းသပ်ခြင်း ဖြစ်ပါသည်။ ပျိုးပင်များကို ပြန်ချောင်းဗန်း များဖြင့် ပျိုးထောင်ရာတွင် မြန်မာနိုင်ငံအတွင်း၌သာ အလွယ်တကူ ရရှိနိုင်သည့် အော်ဂဲနစ် ပစ္စည်းများကို အသုံးပြု၍ ဖော်စပ်ခဲ့သည့် စပ်မြေပေါင်း ၅ဂကျော်တွင် ပါဝင်နေသော ပစ္စည်းအမျိုးအစားနှင့် အချိုးအစားများကို ဖော်ထုပ်ခြင်းနှင့် ပါဝင်သော ပစ္စည်းများ၏ ရုပ်ဂုဏ်သတ္တိနှင့် ဓါတ်ဂုဏ်သတ္တိတို့ကို ဖော်ထုတ်လေ့လာသောသုတေသနဖြစ်ပါသည်။ ထိုအပြင် ဖော်ထုတ်လေ့လာခြင်းနှင့်အတူ ဖောစပ်ခဲ့သော စပ်မြေများနှင့်အတူ ထည့်သွင်းစမ်းသပ်ခဲ့သည့် သစ်မျိုးများအလိုက် သင့်လျော်မှုရှိမည့် Pot (Tube) များ၏ အရွယ်အစားကို ခွဲခြားသတ်မှတ်၍ ရွေးချယ်ပေးရန်လည်း ပါဝင်ပါသည်။ မြန်မာ နိုင်ငံရှိ သစ်မျိုးများနှင့် ကိုက်ညီမှုရှိသော စပ်မြေ အစားထိုး အဟာရ(Growing Medium) ဖော်စပ်ပုံ အမျိုးအစားနှင့် အချိုးအစား တို့ကို စမ်းသပ်ဖော်ထုပ်ခဲ့ပြီးနှင့် စီးပွားရေး စိုက်ခင်းများ တည်ထောင်ရန် အတွက် သစ်မျိုးများအလိုက်ကိုက်ညီမည့် ပြန်ချောင်း အရွယ်အစားကို ရွေးချယ် သတ်မှတ် နိုင်ခဲ့ပါသည်။ မြန်မာနိုင်ငံအတွင်း သစ်တောစိုက်ခင်းများ တည်ထောင်ရာတွင် သက်တမ်း ကြာရှည် ခံ၍ ကြိမ်ဖန်များစွာ ပြန်လည်အသုံးပြုနိုင်သည့် Pot (Tube) များဖြင့် ပျိုးထောင်ရာတွင် စိတ်ချစွာ အသုံးပြုနိုင်သည့် စပ်မြေ (Growing medium) ပေါင်း (၈၀) ကျော်နှင့် အစားထိုးအဟာရ (Peat) (၄)မျိုးကို စမ်းသပ် ခဲ့ပြီးနောက် စပ်မြေများ အတွင်း ပါဝင်သည့် အော်ဂဲနစ် ပစ္စည်း အမျိုးအစားများ၊ အချိုးအစားများ၊ ရုပ်ဂုဏ်သတ္တိများ နှင့် ဓါတ်ဂုဏ်သတ္တိများကို ဖော်ထုတ် တင်ပြပေးနိုင်ခြင်း နှင့် သစ်မျိုးများအလိုက် အသုံးပြုသင့်သည့် Pot (Tube)၏ အရွယ်အစား (၂၁) မျိုးကို သုတေသနပြု ဖော်ထုတ်ခဲ့ခြင်း ဖြစ်ပါသည်။

Formulation of properties and proportion of constituents in growing media for Pot (tube) andAnalysis on identification of sizes of Pot (tube) based on root penetrating pattern and growth of commercial tree species

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Abstract

The aims of this study were to substitute pot (tube) seedlings instead of using of traditional plastic bags in order to reduce plastic waste, transportation and planting cost and to find out applicable formulae for appropriate growing media through searching of constituents, physical and chemical properties and proportion for conferring tree seedlings of Myanmar. With created growing medium, appropriate pot (tube) sizes were determined for containerized tree species seedling production in future.The analytical method for physical and chemical properties of growing medium were used such as 5:25 soil–water suspension method with pH meter (F-51, HORIBA), Kjeldahl method with Kjedahl digestion and distillation unit, Molybivanado phosphoric acid method with UV-VIS Spectrophotometer JENWAY 6305 and Hitachi108-80 atomic adsorption spectrometer (Hitachi Ltd., Tokyo, Japan). Organic matter in the growing media was measured by Loss of weight in ignition with temperature controlled oven, Muffle furnace. Moreover, seven sizes of plastic containers were used in this study to determine appropriate pot (tube) size based on formulated growing medium. This study found that locally available organic materials should be consisted of coconut coir, carbonized rice husk, rice hull, cow dung and sugar press mud with the range of volume 4:2:1:1:1 to 4:2:1:1:1:1 if coco peat or freshwater aquatic plant (*hydrilla verticilata*) with 5 to 10%) can be substituted for part of the sugar press mud if a more nutrient medium is preferred.This study also found that F-1, M-3, G-12 and H-5 were the best in each group among created 45 kinds of growing media. The pH was between 5.66 and 6.53, while the highest appeared in the M-3 formula while bulk density increases from 9.9 to 20.8 kg cm^3 with increasing of water holding capacity 4.9 to 6.8 when the air porosity decreased from 27 to 47% in each group.The results of study suggested that the depth should be range from 5.0" to 7" and 5 inches and 7 inches diameter of pot (tube) was not significant linking of root penetrating pattern and growth while different depth from 5 to 7 inches of pots (tubes) were necessary for different kinds of tree species production in nursery for 6 month age in the containers.This study concluded that selection of a growing media is one of the most important decisions in the production of pot (tube) tree seedlings. The physical and chemical characteristics of growing medium affect not only seedling growth, but also other aspects of nursery operations as well. With the precise size selection of container, pot (tube) should be replaced and recommended instead of plastic bags using to reduce plastic wastes in forests, transportation cost and planting cost. These findings of created growing medium and precise pot (tube) can be used as a technical renovation from traditional nursery practice revolution to new era of mechanized silviculture through using of precise pot (tube) seedlings and planting instruments.

Keywords: Growing medium, Pot (tube), Coconut coir, Rice hull, Carbonized rice husk, Sawdust, Sugar press mud, Cow dung powder, Coco peat

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1. Introduction

Myanmar Forest Department has been campaigning tree planting program by distributing about 15-18 million seedlings to the citizens annually since 1970s. Moreover, Forest Department (FD) has been establishing different types of forest plantations in line with the Myanmar Reforestation and Rehabilitation Programs (MRRP), such as commercial plantation, watershed plantation, local supply plantation, industrial plantation within it limited manpower and budget. In addition, private plantation program was launched in 2006 with the aim to promoting private investment in plantation forestry. So far, the total area of private plantation has accomplished 297,004 acres. At the same time, community forestry program has been promoting since 1995, by 2016, a total of 282,432 acres of community forests have been established throughout the country (MRRP-FD, 2017).

During 10 year project period, 162,900 acres of commercial tree plantation, 34,585 acres of watershed plantation, 29,690 acres of mangrove plantation, 104,563 acres of village supply plantation, 8,000 acres of greening plantation, 12,700 acres of hill plantation, 285,104 acres of private plantation, 770,332 acres of community owned forests, 16,714 acres agroforestry plantation, 147,270 acres enrichment plantation, totally 1,571,860 acres of plantation will be established. Moreover, 97,098,889 seedlings distributed to general public during 10 year. At the same time, 5o lbs. plastic 2940 bags or plastic bag 147,000 lbs. will be used for tree seedlings multiplication in every year. During 10 year period, a total of 147,000 lbs. or 65.625 ton of plastic bags will be used for the production of tree seedlings in every year. Nowadays, the Forest Department is currently spending 200 million Kyats for purchasing of plastic bags in every fiscal year and 2000 million kyats must be used for purchasing of plastic bags for 10 year project period (MRRP-FD, 2017).

In order to reduce plastic bags and waste in plantation sites, long term use plastic containers (pot or tube) will be replaced instead of using of plastic bags. To use long term use plastic containers (pot or tube), growing soilless media will be used when seedlings production in the nursery. With the changing of long term use plastic containers, not only nursery shed but also nursery technique will be transformed in accordance with preferable technology. However, the Forest Department of Myanmar is still using old tree seedling production method and limited knowledge on growing media formulation due to lacking technology of soilless culture in the production of containerized seedlings since 1980s. Therefore, the containerized seedling production technology needs to be applied an organic suitable growing media to reduce weight transportation and planting cost as much as possible with the MRRP project period.

Soilless may serve as an alternative planting medium because it reduces incidence associated with soil borne diseases and pests which leads to reduced use of soil fumigant. It improves water use efficiency and fertilizer use due to its high water-holding and cation exchange capacity (Cantliffe et al., 2007). Soilless media with good physical and chemical properties gives forest tree seedlings opportunity where soil conditions are proficient to be detrimental to tree planting (Rodriguez et al., 2006).

The characteristic of growing media is one of the important factors that affect the growth performance of the seedlings (Maher, M.J. etal. 2008). Tree seedlings require sufficient nutrients and moisture from the medium in which they are grown in the plantation sites (Maronek, D.M.et al., 1986) Soilless growing media have several physical, chemical and biological functions (Yeager, T.H., et al. 2007). The physical function of soilless media is to provide support to the plant with good root aeration, gas exchange to and from the roots and sufficient water for the roost (Nelson, P. 2003). The chemical function of soilless media is to supply adequate oxygen and nutrients for proper root functions. Biologically, availability of soilless growing media is important for beneficial microorganisms as a host to release nutrients from the media (Thomas D. Landis & Nancy, M. 2009).

For the above mentioned requirement of containerized seedling production, this study was to investigate formulation of an organic growing media with locally available organic materials such as rice husk, coir, carbonized rice hull, bark, saw dusts, cow dungs, charcoal, and composted materials including Sugar Press Mud (SPM) for commercial tree seedling production.

2. Objectives

1. To substitute pot (tube) or containerized seedlings instead of using traditional plastic bags to reduce plastic wastes in forests, transportation and planting cost.
2. To substitute growing media instead of sand and forest soil in order to maintain forest soil ecosystem.
3. To find out suitable formulae of suitable growing media through searching of constituents, physical and chemical properties and proportion for conferring tree seedlings of Myanmar.
4. To determine appropriate pot (tube) sizes for tree species seedling production based on formulated growing medium.

3. Materials and Methods

Physical properties: The analysis focus on physical properties such as water holding capacity, porosity and bulk density of the formulated growing medium (Maronek and others 1986).

Chemical properties: The chemical properties such as pH, total nitrogen, total phosphorus, total potassium and total organic carbon were measured with the following analytical methods.

Table 1. Analytical method for physical and chemical properties of growing medium

Sr.	Analytical Item	Analytical Method	Apparatus Used
1.	pH	5:25 (Sample: water suspension method)	pH meter (F-51,HORIBA)
2.	Total N	Kjeldahl method	Kjedahl digestion and distillation unit
3.	Total P	Molybivanado phosphoric acid method	UV-VIS Spectrophotometer JENWAY 6305
4.	Total K	Wet digestion method	Atomic Absorption Spectrophotometer, Nov AA 400
5.	O.C	Loss of weight in ignition	Temperature controlled oven, Mufflefurnace

The locally available organic or inorganic materials were used in the research such as rice husk, coir, carbonized rice hull, bark, saw dusts, cow dungs, charcoal, sand, brick power, rice powder (coarse and fine), auger powder, eucalyptus pine bio composer, and freshwater grass *Hydrilla verticilata*. This study rejects peat moss, perlite, vermiculite, rock-woll which are available in foreign countries. There 40 kinds of tree seeds were used in this study and collected in March 2017 from the dominant trees which naturally located at the Taung Ngoo Township in the Bago Region of Myanmar.

The experiment was conducted in the nursery of Natural Resources Section, Forest Research Institute, Yezin, Naypyitaw. The experiment with 24,300 seedlings were tested in different growing media in an open-sided nursery shed with shading nets and auto-spray irrigation systems at the FRI, Yezin. There 40 kinds of tropical tree seeds were applied for 24,300 seedlings for the searching of growing media in every trial test with two month interval. Six group different types of soilless media such as F, M, G, H groups, F group plus M group, M group plus Peats were formulated and observed at the analysis.

4. Results and Discussion

4.1 First Experiment

In order to know the preparation of a growing media, 15 growing media with the following material and 10 teak tree seedling as a first of trial was investigated in 25th July 2017 and completed in 29th August in 2017.

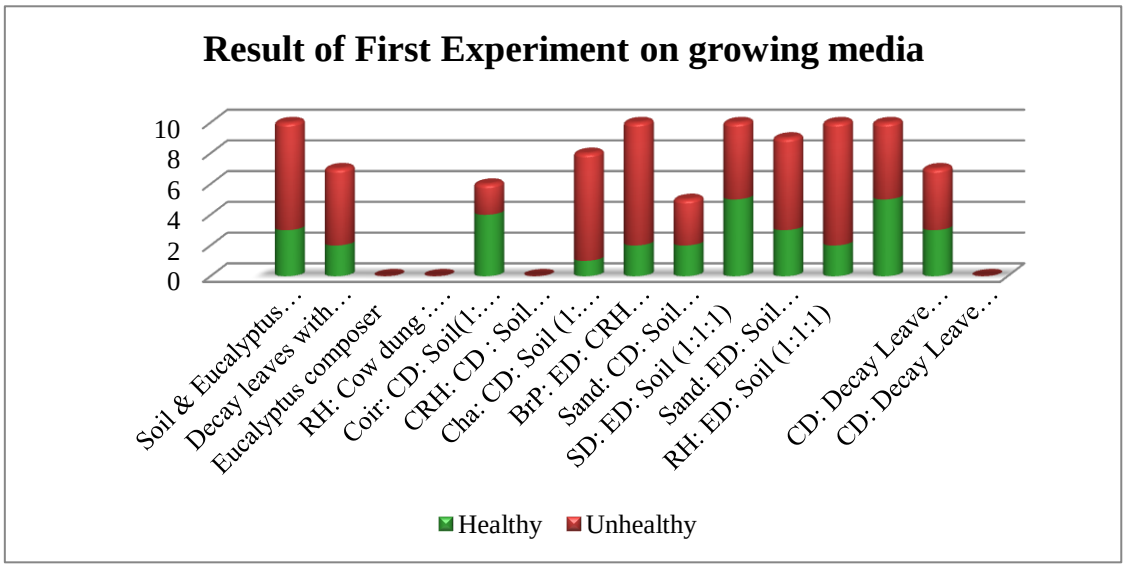


Figure 1. Result of first experiment on growing media constituents

Remark: RH- Rice Husk, CD- Cow Dung, Cha- Charcoal powder, Br P- Brick Powder, ED- Elephant Dung powder, CRH- Carbonized Rice Husk, EM- EM Bokashi method.

After two month, the findings of above mentioned table of first trial points toward that the weight of growing media is heavy due to the containing weight of sand and forest soil. Sand particles tend to be the biggest among containing materials of growing media. There 4 trees were survived in the decay soil with cow dung but weeds were growing, and seedlings could not pull out from plastic pot (tube). Although some of teak seedlings were died due to lack of nutrient, but growing media were compacting with roots which can be pull out easily from plastic pot (tube) after two month. Almost 10 seedlings were survived in the growing mixture

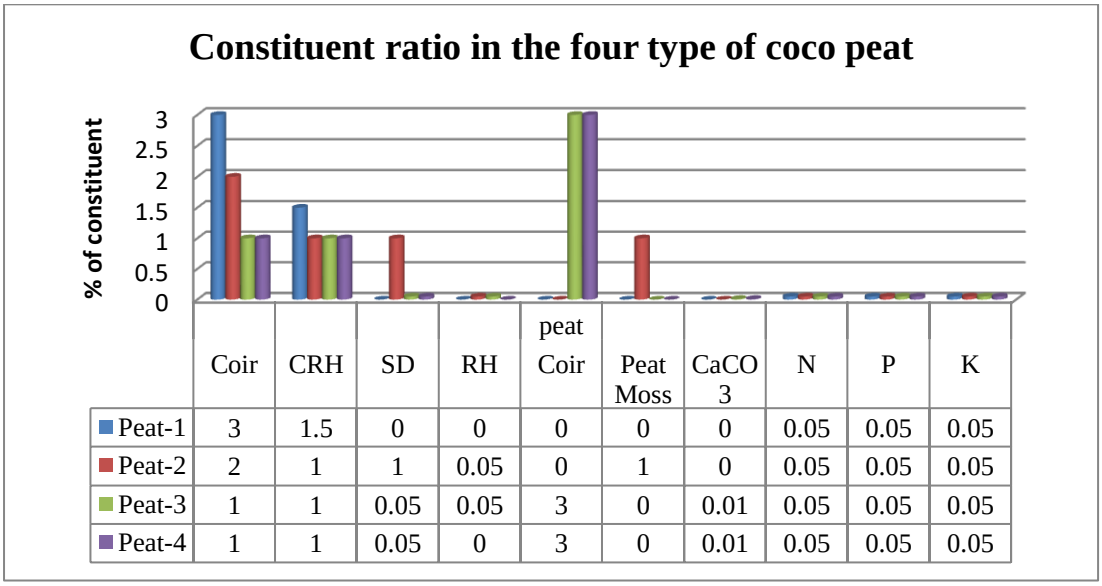
of elephant dung and rice husk, but all seedlings have fungus and growth is not well. Additionally 80 % of seedlings were survived at the growing mixture of charcoal and brick powder although they had slow growth. Although 70% to 80 % of teak seedlings were survived with a mixture of eucalyptus pine bio composer, seedlings could not pull out due to the porous and cracked mixture. The lessons learn from first trial shows sticky fluid are needed in some growing medium.

4.2 Second Experiment

Based on the findings of first experiment, further second experiment was carried out in 28th November 2017 to 28th January 2018. There were 10 growing media with the following material and 120 teak tree seedlings as a second of trial test.

After two month, the findings of second trial shows that above 12 tree species seedlings with a mixture of sticky rice power liquid were died while some of teak seedlings were survive at the growing media formula of F-1 to F-4, but 80% of teak seedlings were died in the formula growing media of M-1 and M-2 despite of 45% of Teak and fast growing tree species were live with slowly developing rate. At the same time 90% of seedlings with a mixture of rice powder (fine) were biked by ants, so growth was not good and 85 % of seedlings with a mixture of sticky soil were died due to the water logging. Although 95% of seedlings with a mixture of rice powder (coarse) were survived, their growth rate was not satisfied.

Additionally, all of seedlings with a mixture of coir, rice husk, and carbonized rice husk were survived with a upright growth, and all seedlings were pulled out from the pot (tube), and there is no weeds in the pot (tube). Most leaves were rotten in the mixture of saw dust, and growth of root was very weak. The result of second experiment indicated that 95% of seedlings were required nutrient in the mixture of coir, rice husk and carbonized rice husk. Therefore, researcher had strived hardly to input required nutrient into the growing media which a mixture of coir, rice husk and carbonized rice husk with the cooperation of Dr. Myat Thaint Ko who was a specialist of crop nutrient from Department of Agricultural Research, Yezin.



	Coir	CRH	SD	RH	peat Coir	Peat Moss	CaCO 3	N	P	K
Peat-1	3	1.5	0	0	0	0	0	0.05	0.05	0.05
Peat-2	2	1	1	0.05	0	1	0	0.05	0.05	0.05
Peat-3	1	1	0.05	0.05	3	0	0.01	0.05	0.05	0.05
Peat-4	1	1	0.05	0	3	0	0.01	0.05	0.05	0.05

Figure 2. Constituent ratio in the four type of coco peat production process

Continuously, the third trial of 8 growing media with 4 kinds of coco peat and 4 kinds of growing medium combined with the following material and 80 teak tree seedlings as a second of trial test in the current nursey site at Yezin on 18th January 2018. After two month, the findings of second trial as follow:

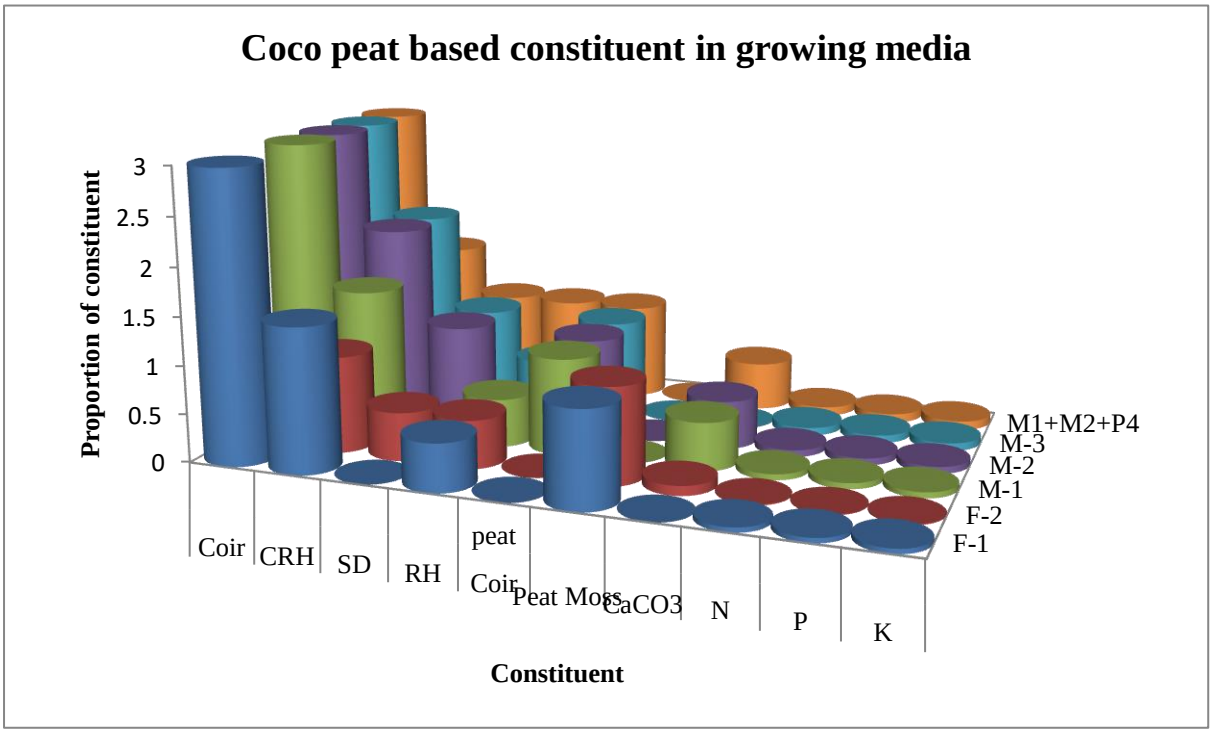


Figure 3. Coco peat based organic materials growing media

Likewise, the results of second experiment indicated that sawdust is commonly used in forestry growing media and is usually composted before use. Because of the inherent differences in chemical properties between different woods, however, the suitability of sawdust as an organic growing media component is extremely variable. Additionally, sawdust has characteristics that make it desirable for use in a growing mix.

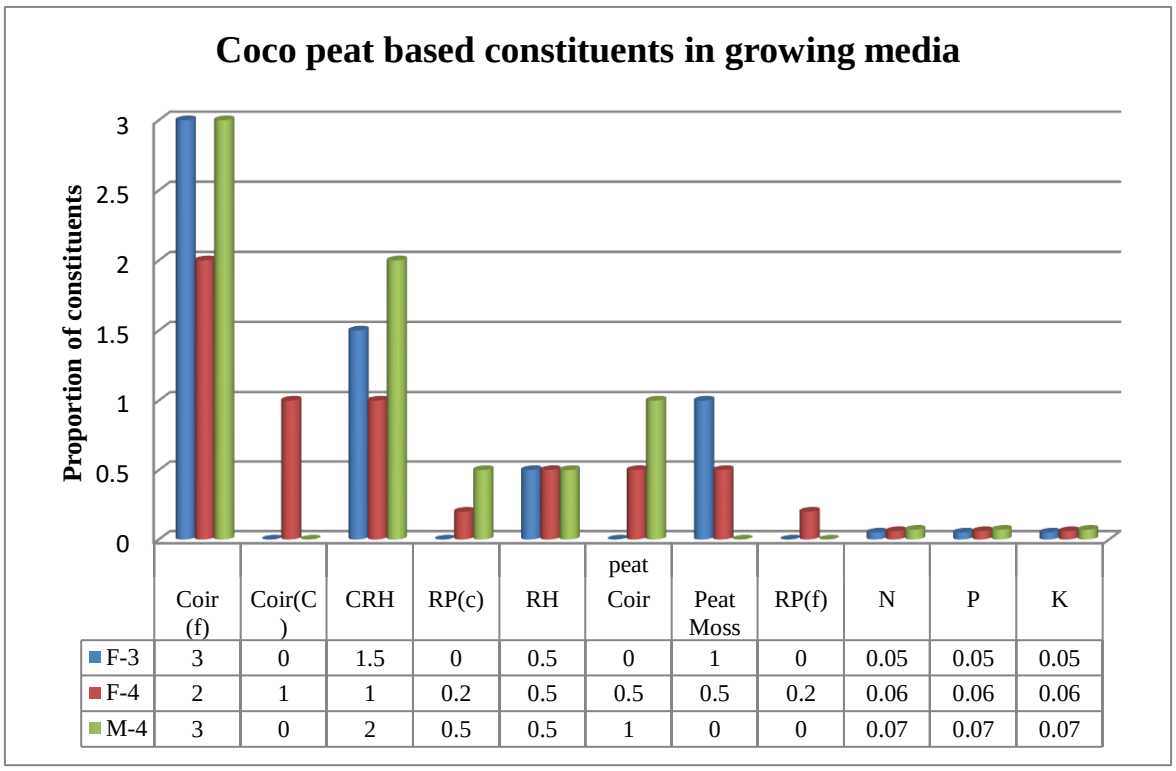
Large amounts of nitrogen must be added to compensate for nitrogen depletion of sawdust. Old sawdust has a lower nitrogen requirement than fresh sawdust but full decomposition cannot occur without the addition of nitrogen (Mastalerz, 1977).

When using of carbonized rice husk (CRH) and Rice Husk or Rice Hull (RH) in the formulation of growing media, Rice Hulls (RH) is a bi-product of the rice milling industry. Although they are extremely light in weight, rice hulls are very effective at improving drainage. The particle size and resistance to decomposition of rice hulls and sawdust are similar. However N depletion is not as serious of a problem in media amended with rice hulls (Maher, M.J. et.al,. 2008).

Moreover, Carbonized Rice Husks (CRH) consists of a very light material with a micro-porous structure and a bulk density (Marianthi, T. K., 2006).

CRH also used as a substrate in beds or recipients in the germination of seeds and formation of cuttings from higher vegetables, permitting the penetration and exchange of air at the base of the roots; and being sufficiently firm and dense to fix the seed or stake; it has a dark coloration, being opaque to the light at the base of the stake; it is light and porous ,

permitting good aeration and drainage; it has a constant volume whether dry or humid; it is free of weeds, nematodes and pathogens; it does not need chemical treatment for sterilization, the reason being that it has been sterilized by the carbonization (Handreck, K., & N. Black. 2010).



	Coir (f)	Coir(C)	CRH	RP(c)	RH	peat Coir	Peat Moss	RP(f)	N	P	K
F-3	3	0	1.5	0	0.5	0	1	0	0.05	0.05	0.05
F-4	2	1	1	0.2	0.5	0.5	0.5	0.2	0.06	0.06	0.06
M-4	3	0	2	0.5	0.5	1	0	0	0.07	0.07	0.07

Figure 4. Coco peat based growing media formulation

4.3 Third Experiment

After two month, the findings of third experiment confirmations that second results based growing media were right for third trial test. Due to the coco peat mixed in the growing media, it supported to grow seedlings for long term in the pot (tube). Likewise, the quality of coco peat was decreased acidity in terms of gypsum ($CaCO_3$) destroyed acidity of coco peat.

Coco peat is used for a wide range of soilless forestry seedling production throughout the world including: Teak (*Tectona grandis*), Pyinkado (*Xylia xylocarpa*), Padauk (*Pterocarpus macarpus*) and Mahogany etc. with no harmful environmental impact. The high water holding capacity of this substrate provides a buffer in high temperatures and high crop load demand without compromising air supply. The presence of organic compounds in coco peat can stimulate root growth and offer some natural resistance to plant disease.

Peat is a very good substrate, used successfully for many years, but now, due to environmental reasons other organic products are suggested for replacement, i.e. coconut coir, rice-husk, pine bark, straw from grass species (Cantliffe, D.J. et.al., 2007).

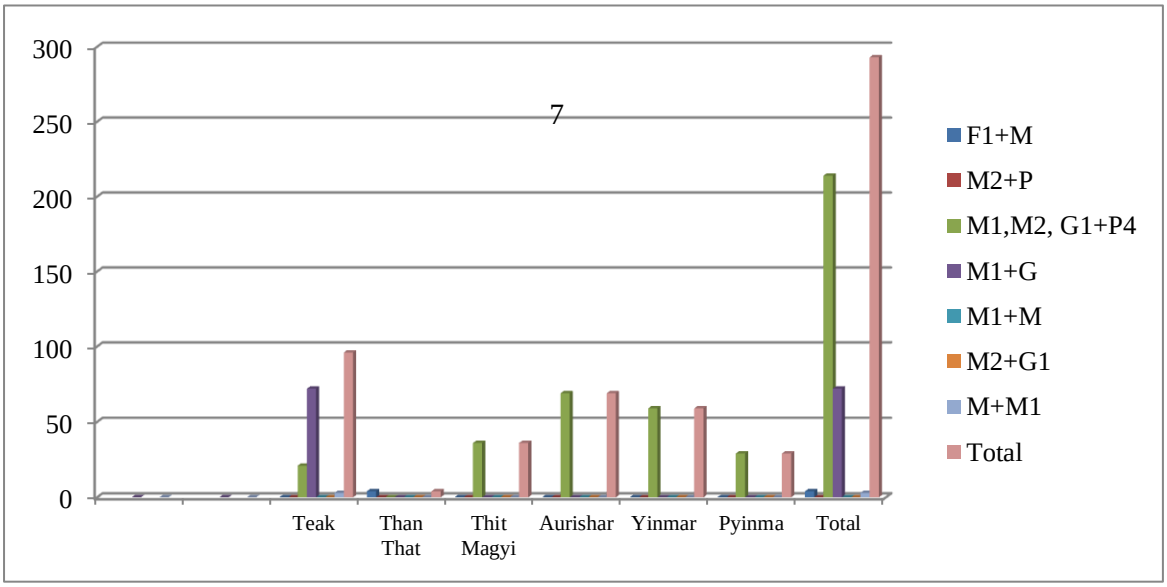


Figure 5. Proportion and constituents in the combination of M group growing medium

Significantly, the result of pounding of coir with pounding machine was effective to improve aeration of growing media. However, there was not necessity to pound carbonized rice husk. All rice husks must to wash with water and dry in sun light because it can be eaten by ants and rats if there are some remaining of rice residue. Nevertheless, fertilizer N: P: K (16:16:16) and gypsum ($CaCO_3$) is essential to mix in the coco peat making process. Moreover, root hormone (Fertistart) had sprayed in all pots (tubes) for two weeks after seedlings were transplanting from seed bed into containerized pots (tubes).

The result of third trial also shows that all of two month old seedlings could be pulled out from pots (tubes) easily when their roots were developed in the containerized pots (tubes). Based on results of third finding, different sizes of pots (tubes) were needed for different kinds of tree species due to the different developing pattern of roots. Besides, weight of each of trial seedlings has only 2 gram to 2.5 gram by weight with digital balance.

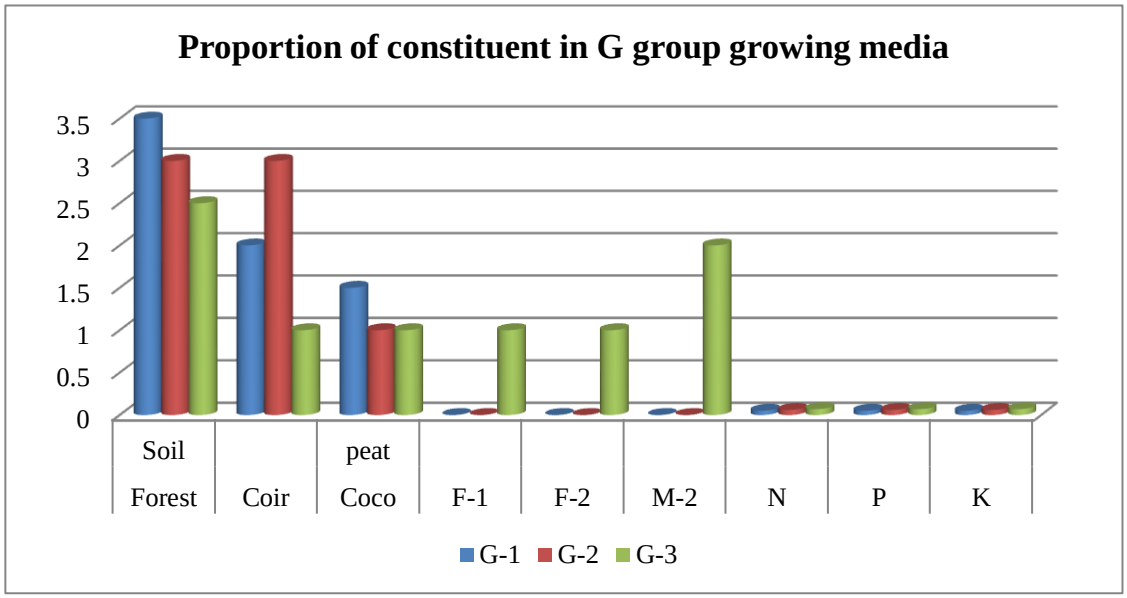


Figure 6. Proportion and constituents of G group growing medium

In these findings of third experiment, one of special interest is coconut coir. This material is presently a waste product in the Myanmar coconut industry. Coir is one of the most abundant plant-derived organic waste materials in many tropical and subtropical countries.

Coir dust has many desirable substrate characteristics such as high water holding capacity; excellent drainage; absence of weeds and pathogens; physically resilient; slow decomposition; acceptable pH, CEC, and EC; easily wettable, and a renewable resource with no known ecological drawbacks (Abad, et al., 2005; Cresswell, 1992; Lennartsson, 1997; Martinez et al., 1997; Pill and Ridley, 1998; Verdonck et al., 1983). Due to these favorable characteristics, coir has been extensively used as an environmentally safe substitute for natural peat in container substrates.

Similarly, the results of physical properties of growing media shows that the capacity of the media to supply sufficient amounts of water for plant growth can be indicated by the percentage of available water present in the field capacity. There was a great difference in the physical properties of the coco coir growing media. The water holding capacity is 88.35 while air porosity is retaining 23.5. There is speculation that the combination of high water holding capacity and low air porosity can be detrimental during periods of high air temperature, which can influence higher nutrient temperature in the bags, therefore possibly lower oxygen content in the solution(Abad, M., P. et., al. 2002).

4.4 Fourth experiment

After implementing of the third trial with 8 growing media with 4 kinds of coco peat and 4 kinds of growing medium combined with the following material and 80 teak tree seedlings, the fourth trial were conducted in the current nursery site at Yezin on 19th March 2018 to 20th May, 2018. After two month, the findings of fourth trial as follow:

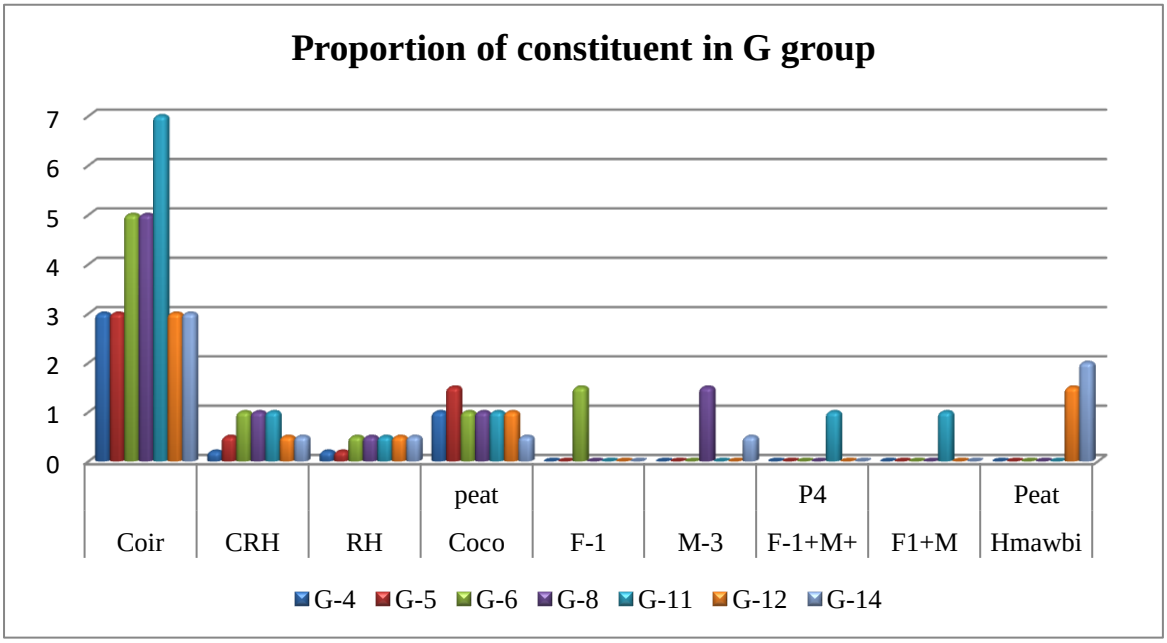


Figure 7. Proportion of constituents in G group

The results of fourth experiment indicated that seedling survival rate is very important to identify the best formula of G generation of 12 growing media with 12 tree species seedlings. Among of 12 tree species seedlings, survival rate of teak seedlings had occupied the most population compare to other 11 tree species seedlings. Moreover, teak seedlings had already survived at 6 growing media formula of G-4, G-6, G-7, G-8, G-11, and G-12 respectively while Auricularformis seedlings are surviving in 9 formula of growing medium as a second position and Pyinkado (*Xylia xylocarpa*) seedlings are growing in 7 formula of growing medium as a third status.

4.4.1 Planting of Seedlings at the trial plots in the plantation site

According to the decision of meeting number 16/2018 of Forest Department Executive Committee which held at the Office of the Director General, Forest Department on 20th June 2018, 1200 teak containerized seedlings had been planted at the trial plots in the 1/2018 Teak commercial plantation (150) acre which is located in the No. 2 Compartment of Nga Lite Reserve Forest, Ottarathiri Township, Ottarathiri District, Naypyitaw on 7th July 2018. 1200 teak containerized seedlings were planted with planting instrument "Pottiputki" between original spacing 6'×6' lines as a line trial. All stakes were painted yellow color in order to distinct amongst original white color stakes. Moreover, 17 ASEAN senior forestry officers who were attended 21st ASOF meeting had been planted 520 pot (tube) seedlings with 9'×9' spacing in the Moeswe Forest Research Institute campus on 14th July 2018.

As a final endeavor, survival counting of five month old 1200 teak trees had been measured in the No. 2 Compartment of Nga Like Reserve Forest, Ottarathiri Township, Ottarathiri District, Naypyitaw on 8th December 2018. The field observation shows that there were no dead teak trees amongst of planted trees since 7th July 2018. Most of heights of teak trees were stand-up from 2 feet to 5 feet and average height of teak trees were 2 feet and 6

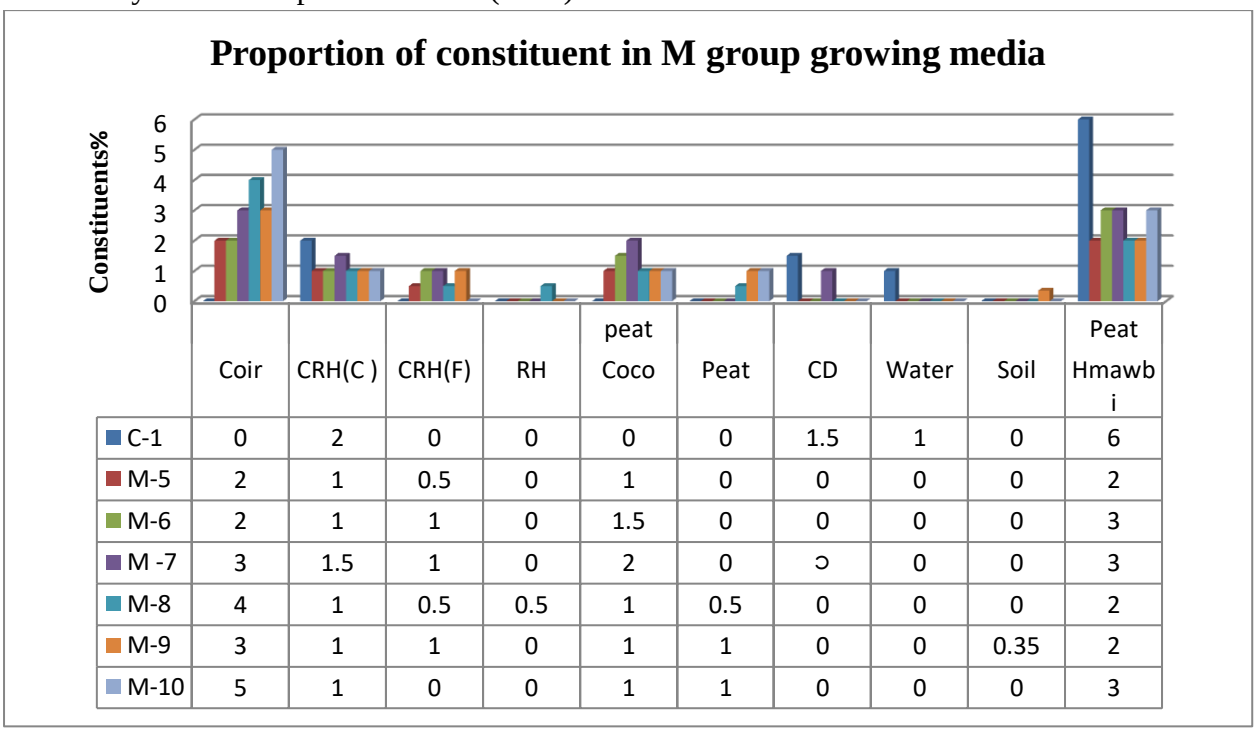
inches. This result also indicated that containerized pot (tube) seedlings could contest survival rate and growth as well with traditional plastic bags seedlings.

4.5 Fifth Experiment

Based on the previous results of experiment, the next experiment will be necessarily carried out in order to find out require nutrient material due to inadequate nutrient in the most of pots (tubes) when testing growth rate among seedlings. That is why, 5th trial had been started on 4th July 2018.

After two month, the findings of fifth experiment confirmations that 95% of seedlings were growing with brighter green color and good survival rate due to the Sugar Press Mud (SPM) or the Sugarcane Filter-Cake (SFC). SPM is the residue of sugarcane is used as a suitable fertilizing agent which is available abundantly in the Pyinmana Sugar Factory since it is rich in micro and macro nutrients along with organic carbon.

It is eco-friendly and protects the plants from various soil borne diseases. SPM contains almost all the required supplements for the growth of plants such as calcium, nitrogen, magnesium, traces of sugar and salts, fiber etc. Bacteria consume SPM which in-turn produces useful substances and thereby promotes decomposition of wastes to enhance the fertility of soil Bhupander Kumar (2008).



	Coir	CRH(C)	CRH(F)	RH	peat Coco	Peat	CD	Water	Soil	Peat Hmawbi
C-1	0	2	0	0	0	0	1.5	1	0	6
M-5	2	1	0.5	0	1	0	0	0	0	2
M-6	2	1	1	0	1.5	0	0	0	0	3
M -7	3	1.5	1	0	2	0	ɔ	0	0	3
M-8	4	1	0.5	0.5	1	0.5	0	0	0	2
M-9	3	1	1	0	1	1	0	0	0.35	2
M-10	5	1	0	0	1	1	0	0	0	3

Figure 8. Proportion of constituent in M group growing media

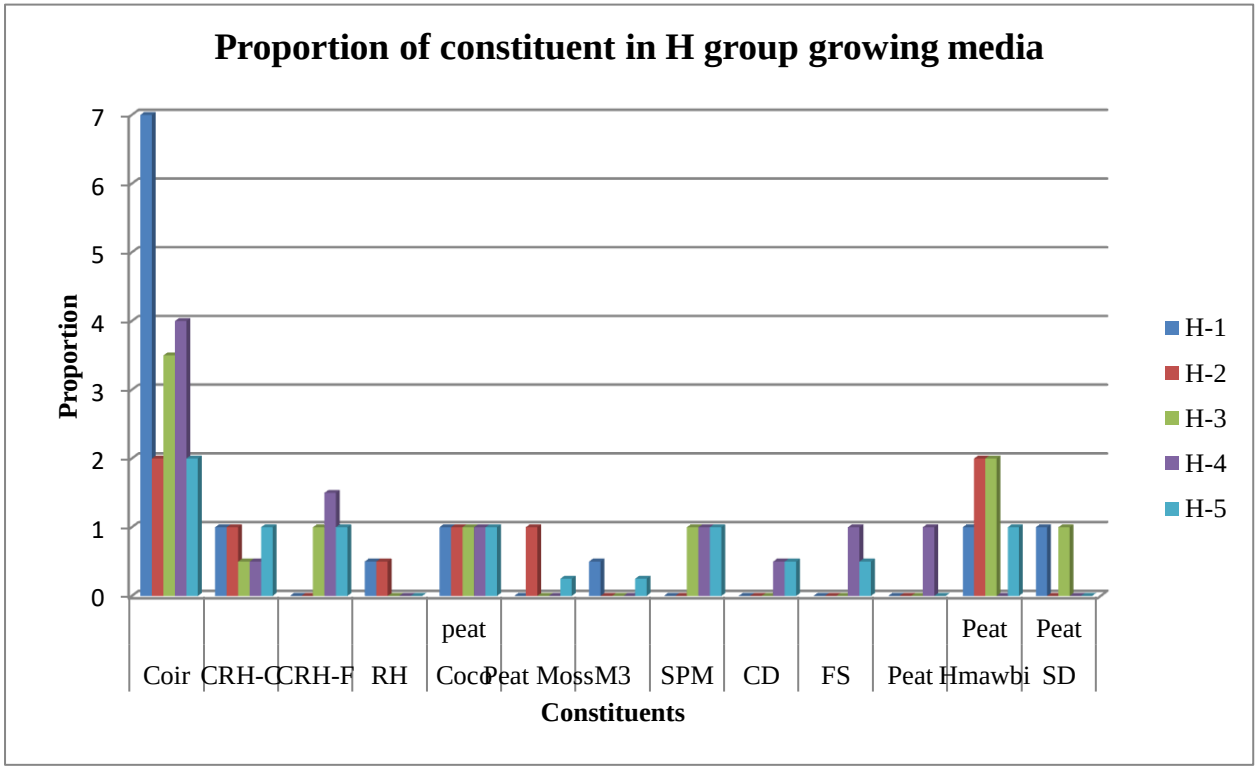


Figure 9. Proportion of constituents in H group growing media

During the period of teak root penetration pattern and root growth analysis, 15 kinds of growing media such as F group, G group and M group were applied by researcher on 27th May 2018. The results of analysis show that F-1, M-3 and G-12 were the best in each group. The significant finding is both tap root and lateral roots of teak were coiling from one to three coils at the bottom of pot (tube) during three month.

If teak seedlings become 5 month to 6 month long-standing in the pot (tube), their roots might be longer with 4 coils to 6 coils due to the length of pot (tube) which had 4.5 inch in length. Therefore, finding shows that length of the pot (tube) should be 5 inch to 7 inch which is more suitable for teak seedlings. Furthermore, diameter of pot (tube) was not significant of root penetrating pattern and development to seedlings of Teak or Pyinkado because of the 1.5 inch diameter it was quite appropriate for those.

In order to identify size of pot (tube) based on different types of tree seedlings, root pattern and growth analysis had been implemented by researcher on 26th May 2018. The results of analysis indicated that size and depth of containerized pot (tube) directly relate to root penetrating pattern and development of root of different commercial tree species seedlings at the containers.

The result showed that both formulation of growing media and container types, size and depth are significantly related growth and root development pattern of seedling, but slightly significant influence on diameter of pot (tube) was observed.

Based on the analysis, size of pot (tube) had larger effects on seedling growth and root development of Teak (*Tectona grandis*) than the Pyinkado (*Xylia xylocarpa*). Meanwhile, a significant interaction between formulation ratio of growing media and container types was detected for seedling height and physical appearance whereas significant interaction was observed for the root development pattern of the seedlings. . It is always best, therefore, to

test any new growing medium before full operational use following the results of (Spomer, L.A. 1974).

4.6 A summary result of five experiments

An overall of this study shows that testing plants growth in pots (tubes) response to all the different media appeared different survival rate. There was a great difference in physical properties of the growing media. The water holding capacity and air porosity is vastly different. This is speculation that the combinations of high water holding capacity and low air porosity, which can influence high nutrient in pot (tube), therefore possibly lower oxygen content in the growing media.

Table: 2. Physical properties of growing media

Growing media	Dry weight g/L	Wet weight g/L	Bulk density kg cm^3	Water holding %	Air porosity %
F-1	110.6	130.1	9.9	4.9	47
F-2	112.8	131.8	16.4	3.7	63
F-3	115.8	136.6	11.9	4.5	54
F-4	119.8	94.9	4.4	3.9	60
M-1	107.5	102.5	14.3	3.5	62
M-2	107.3	125.3	11.9	3.2	60
M-3	83.6	115	10.9	5.9	27
M-4	116.3	88.3	12.7	3.8	62
M-5	119.3	111.7	14.6	3.9	60
G-6	107.4	95.3	13.4	3.3	56
G-7	118.1	115.6	37.4	5.1	49
G-8	88.3	86.7	13.8	5.6	44
G-9	116.3	113.7	37.1	3.8	62
G-11	86.9	108	17.6	6.8	40
G-12	81.8	94	12	3.8	69
H-3	87.6	94.9	12.6	3.9	60
H-4	97	122.9	19.6	5.9	42
H-5	89.7	107.6	20.8	5.4	39
H-6	80.8	95.9	16.2	3.8	67

The results of Table 2 show that the bulk density of growing media increases with the water holding capacity, decreasing in air porosity of growing medium F-1, M-3, G-11, G-12, H-4 and H-5. The bulk density increases from 9.9 to 20.8 kg cm^3 with increasing of water holding capacity 4.9 to 6.8 when the air porosity decreased from 27 to 47 % in each group.

With reference to the water holding capacity, it ranged from 3.2 to 6.8 g water/g dry sample for different types of growing medium. The lowest value of water holding capacity 3.2 g water/g was found for M-2 and the highest value of water holding capacity 6.8 g water/g was found for G-11.

The porosity values ranged from 27 to 69 % for different types of growing medium. The lowest value of the porosity 27.0 % was found for M-3 and the highest value of the porosity 69 % was found for G-12. The porosity depends on bulk density of growing medium. The porosity decreased with increasing bulk density. The results indicate that the

porosity of growing medium decreased from 69 to 27 % when the bulk density increased with from 9.9 to 20.8 % gradually. Moreover, total result of the macronutrient contents N, P, K, of the soilless media are shown in Table No.3. The pH value for each growing medium composition was measured in The Department of Agricultural Research, Yezin and is shown in the following Table.3.

Table 3. Chemical properties of constituents of formulated growing medium

Growing medium	pH Value (5:25)	Total O.C%	Total N%	Total P_2O_5%	Total K_2O%
F-1	5.06	24.03	1.17	3.52	0.56
F-2	4.93	30.58	0.79	0.94	0.08
F-3	5.71	36.53	1.23	0.77	0.13
M-1	7.10	30.12	0.66	0.12	0.07
M-2	7.39	31.87	1.68	0.34	0.26
M-3	6.53	39.55	0.69	0.45	0.62
M-4	6.34	33.80	1.01	0.18	0.11
G-6	5.78	41.68	0.63	0.47	0.50
G-7	5.66	11.85	0.52	0.83	0.68
G-8	5.81	41.69	0.60	0.45	0.54
G-9	5.88	11.08	0.52	0.96	0.48
G-11	6.03	42.02	0.71	0.95	0.52
H-3	6.64	35.1	0.99	1.94	0.58
H-4	7.17	23.3	0.90	0.90	0.84
H-5	7.43	22.6	0.67	0.92	0.78
H-6	7.01	18.3	0.62	0.62	0.88
Coco peat	6.32	30.54	0.98	2.14	0.50

Source: Department of Agricultural Research, Yezin (2018)

The above table No. 3 shows the chemical properties (pH, total organic carbon, total nitrogen, total phosphorus, total potassium and) of different types of soilless growing media. There are significant differences in the chemical properties among the eleven growing medium, except for coco peat. The pH is between 5.66 and 6.53, while the highest appeared in the M-3 formula. The initial pH of the growing medium has 5.78 and 7.41 although general guideline for pH value is from 5.8 to 6.0. Because most components of media are acidic, dolomitic limestone (calcium and magnesium carbonates) is added to start at an acceptable pH range and provide Ca and Mg for plant growth.

It could be seen that the pH value ranged from 5.06 to 7.43 for different growing media types. The highest value of pH 7.8 was found for H-5, while, the lowest value of pH 5.06 was obtained for F-1. This pH range is in the optimum range for growing media as mentioned by Bunt (1988).

Regarding the total organic carbon results, it was found that it ranged from 18.3 to 42.02 % for different growing medium types in this study. The total organic carbon ranged 24.03% in the F group, 39.55 % in M group, from 11.08 to 42.02% in G group, from 18.3 to 35.1 in H group respectively.

The total nitrogen values ranged from 0.00 to 0.68 % for different growing medium groups in this study. The total nitrogen values ranged 1.17 in F group, 0.69 in M group, from 0.52 to 0.71 in G group, from 0.62 to 0.99 in H group respectively.

The highest value of phosphorus was 3.52 in F-1 while potassium low level value was 0.56. However, the potassium value was 0.62% and value of phosphorus is lowest level with 0.45 in M-3. Obviously, the phosphorus values ranged from 0.45 to 0.96 %, the lowest value of total potassium was found in G-9 of G group. The lowest value of total potassium 0.58 % was found for H-3 and the highest value of total potassium (0.88%) was found for H-6 growing medium. The value of total phosphorus 2.14 % was found while the nearly value level of potassium 0.50% was for coco peat.

The H group growing medium contains low levels of organic carbon, but significant levels of phosphorus and potassium. However, the bulk density weight ranged from 23.2 to 62.4 gram, and the highest bulk density (62.4 gram) was observed in the G-9 formula. Generally, when the proportion of the cow dung powder, it increased and peat proportion decreased, the total nutrient contents of N, P, and K as well as pH values significantly increased, and organic carbon content was increased in G-11 formula while H group is occupying 18.3 to 35.1. When compared with the G-6 and G-8 formula, the total content of N is occupying 41.68%, 41.69%, and 42.02% in the G-11 respectively.

Table 4. A Comparison of some characteristics of growing media components

	Coir	**RH**	**CRH**	**Coco peat**	**Cow Dung**	**SPM**	***H.v.***
Dry Bulk density	Low	Medium	Medium	High	Medium	High	Medium
Wet Bulk density	High	Medium	Medium	High	High	High	Medium
Influence on air porosity	High	Low	Low	Variable	Variable	Medium	High
Water holding capacity	High	Low	Low	Variable	Variable	Medium	High
Nutrient holding capacity	High	Low	Low	Variable	Variable	Medium	Low

Growing media consist of mixtures of constituents that provide water, air, nutrient and support to seedlings. The media provide seedling support, while the nutrients are provided by added fertilizers. Water and air are provided in the pore spaces in the media. Four main factors affect air and water status in containers: the media components and ratios, height of the media in the container, media handling and watering practices (Thomas D. L., & Nancy M., 2009).

This study show that container types and size are significantly affected seedling growth and root development pattern of seedling, but slightly effect was observed for the diameter of pots (tubes) based on all formulated growing medium. The finding of suitable sizes of seedlings for pot (tube) is as follow:

Sr.	**Name of seedling**	**Scientific Name**	**Depth (inch)**	**Top Radius (Inch)**	**Bottom Radius (inch)**	**Volume ($Inches^3$)**
1	Teak	*Tectona grandis (Linn.)*	5	2	1.5	48.43
2	Pyinkado	*Xylia xylocarpa (Roxb.) Taub.*	5	1.5	1	29.84
3	Thit Padauk	*Pterocarpus macrocarpus*	6	2	1.6	61.32
4	Tamalan	*Dalbergia oliveri* Gamble.	5	2	1.5	48.43
5	Pyin Ma	*Lagerstroemia reginae* Roxb.	5	2	1.6	61.32
6	Yinmar	*Chukrasia tabularis* A. Juss.	6	1.5	1.0	29.84

7	Mahogany	*Swietenia mahogani* L.	6	2.2	1.8	75.65
8	Let Khote	*Sterculata alata* Roxb.	7	2.5	2.0	111.79
9	Myitzuthaka	*Madhuca longifolia* (Koen.)	6	2.2	1.8	75.65
10	Thit Magyi	Alibizia odoratissima Benth	5	2.2	1.8	63.04
11	Mangyan Shar	*Acacia mangium*	5	2.0	1.5	45.43
12	Panama Ngu	Cassia spectabilis DC.	6	2.2	1.8	75.65
13	Mazali	*Cassia siamea* Lam.	6	2.2	1.8	75.65
14	Kabwee	*Casuarina equisetifolia* A.DC.	5	1.5	1	29.84
15	Than That	*Alibizia lucida* Benth.	5	2.0	1.5	45.43
16	Seinban	*Caesalpinia pulcherrima* (L.)	6	2.2	1.8	75.65
17	Kokko	*Albizia lebbeck* (L.) Benth.	7	2.5	2.0	111.79
18	Eucalypt	*Eucalyptus camaldulensis* D.	6	2.2	1.8	75.65
19	Thin Win	*Millettia pendula* Benth.	5	2	1.6	61.32
20	Melaleuca	*Melaleuca leucadendra*	5	1.5	1	29.84
21	Yinhtike	*Dalbergia cultrata Grah.*	6	1.5	1.0	29.84

This finding shows that deeper containers are best for optimum aeration and drainage. Roots in deep containers do not grow laterally, quickly enough after planting. Often the deepest container is too dry and shallowest container may be too wet after watering. The diameter of the container has no bearing on drainage. Similar drainage patterns occur regardless of diameter in pots with the same depth (Spomer, L.A. 1974). Therefore, there are no advantages to using excessively wide pots. Growers often group together plants in similar size containers for more accurate irrigation and easier handling and maintenance.

Containers which provide drainage holes that straddle the bottom corner Quick and proper drainage is imperative for the health of most nursery stock. The suitable drainage holes area at the bottom of the pot is at least 20 percent. Roots also play a key ecological role supplying plants with water and nutrients. Therefore, to understand terrestrial ecosystem biogeochemistry and ecology it is necessary to record information about spatial and temporal patterns of root growth (Tsakaldimi, Met, al., 2005).

5. Conclusion

In conclusion, selection of a growing media is one of the most important decisions in the pot (tube) tree seedlings. The results of this study showed that the results of analysis show that physical and chemical characteristics of growing medium F-1, M-3, G-12 and H-5 were the best in each group compared to other groups for 25 seedlings growth including teak (*Tectona grandis*). Likewise, the results also clearly indicated that formula (M1) is the most suitable for growing pyinkado (*Xylia xylocarpa*) seedlings especially when seeds are considered for raising planting stocks.

All of growing medium were formulated constituent of coconut coir, carbonized rice husk, rice hull, cow dung powder, Sugar Press Mud (SPM) and freshwater plant *Hydrilla Verticilata* is recommended, if these materials are available and reasonable price in locally once pot (tube) tree seedlings producing in Myanmar.

The best proportion of growing media were mixed with coconut coir, carbonized rice husk, rice hull, cow dung and sugar press mud on a volume/ volume basis can range from 4:2:1:1:1 to 4:2:1:1:1:1 if coco peat or *Hydrilla Verticilata* peat are available as a proportion with 5 to 10% can be substituted for part of the sugar press mud if a more nutrient medium is preferred.

Moreover, the above mentioned growing media is recommended for use in nursery plantation especially in our country where some of the soils are certified to be acidic and negatively impact plant growth.

This study show that pot (tube) types and depth (from 5" to 7") are significantly related to root growth and root development pattern of seedlings, but slightly influence on diameter of most pot (tube) (from 1.0" to 1.5") was observed based on all formulated growing medium of G group and H group.

6. Recommendations

Recommendations presented in this section are formulated based on the study findings and conclusions from the previous sections of this chapter. The following recommendations are suggested to improve nursery technology and planting technique in Myanmar.

1. Pot (tube) seedlings should be used instead of plastic bag seedlings to reduce plastic wastes in forests, transportation and planting cost and to maintain forest soil ecosystem friendly.
2. Recommended sizes of containers should be used to improve seedling quality, but are varied among the tree species.
3. New techniques for pot (tube) nursery are needed on this formulation of growing media and selection of suitable pot (tube) size in forest tree nurseries.
4. Locally available growing media components, such as coir, rice hull, carbonized rice husk, cow dung, and sugar press mud and coco peat should be applied instead of imported growing medium from other countries.
5. At least 4 pot (tube) nurseries with concrete drainage, iron hollow pipe nursery shed, and an irrigation watering system should be established in 4 townships in every year during MRRP project period.
6. Forest Department should be prepared for initial investments for several years before realizing any positive returns due to the initial investments and production costs are much higher for container- grown plants.
7. Alternative composted organic materials for coconut coir, freshwater *Hydrilla verticilata* and sugar press mud should be should be considered without using of chemical fertilizers.
8. Incorporation of limestone, gypsum or other fertilizer materials into the growing media is not recommended unless conventional fertilization techniques are unavailable.
9. Once planting containerized trees in plantation sites, planting instrument “Pottiputki” should be used in order to reduce planting cost.
10. Standard growing media should be commercially produced in the Forest Research Institute through research commercialization mechanism.
11. By using of containerized seedlings and planting instruments or machines, Mechanized silvicultural should be created by Forest Department to improve old nursery techniques as a technical change.

7. Acknowledgements

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