J. Trop. Agric. and Fd. Sc. 35(1)(2007): 41–48

Effect of different potting media on growth of a hanging ornamental plant (*Tradescantia* sp.)

[Kesan pelbagai medium tanaman terhadap pertumbuhan pokok hiasan gantung (*Tradescantia* sp.)]

M.H. Khelikuzzaman*

Key words: hanging ornamental plant, cocopeat, growing medium, soil air-filled porosity, container moisture capacity

Abstract

Normal field soils are not suitable for container media unless the structure is modified by adding other forms of physical conditioners. A study was therefore conducted on different potting mixtures and their relation between their physical parameters i.e. AFP (air-filled porosity) and CMC (container moisture capacity) and to ascertain which factors are responsible for the growth of a hanging potted plant *Tradescantia.*

The five soil mixtures were 100% cocopeat, 100% topsoil, 1 part cocopeat : 1 part topsoil, 1 part cocopeat : 1 part sand, and 1 part cocopeat : 1 part topsoil : 1 part sand. The experiment proved that soil mixture 1 part cocopeat : 1 part topsoil : 1 part sand was significantly better than other soil mixtures. It gave significantly higher vegetative fresh weight (1,246 g), significantly more number of stems (98) and secondary branches (33) as well as number of leaves (321) per plant (p <0.005).

Introduction

In Malaysia amenity horticulture such as indoor landscaping using hanging ornamental plants in baskets or pots has become a popular hobby with garden lovers. Hanging baskets with trailing or cascading plants are normally suited for indoor as well as outdoor landscaping. Hanging plants when grown in containers, their roots are restricted to a small volume. The demands for water and air are, therefore, much more intense than plants planted in the soil on the ground. Soil medium should provide adequate drainage and aeration to the root zone for good plant growth.

Container medium in horticulture serves primarily as mechanical support for the plant. It has only small reservoir of water supply and short substrate columns that affect drainage of water. Physical study of substrates is necessary to evaluate percentage of solid material, water and air capacity. Physical measurements of substrates done under standardized conditions will be changed during the growing period as a consequence of root growth, swelling and shrinkage, and decomposition of organic material.

There is a great deal of interest in the use of coir as a growing medium (Wever et al. 1994) particularly as a substitute for peat, based on environmental concerns, which has been resulting in peat land exploitation (Robertson 1993). Cocopeat or coconut

*Horticulture Research Centre, MARDI Headquarters, Serdang, P.O. Box 12301, 50774 Kuala Lumpur, Malaysia
Author's full name: Khelikuzzaman Meera Hussain
E-mail: kheli@mardi.my

coir or coir pith has been recognized as an acceptable peat substitute and it is renewable resource with no ecological drawbacks to its use. Coconut coir processing leaves a large quantity of dust and short fibres as waste product (Noguera and Abad 1996). Published results using coir dust as a growing medium have reported good results (Reynolds 1973; Meerow 1994), although there are also reports of negative results (Radjaguguk et al. 1983).

Coconut coir is already being widely and successfully used in different parts of the world as an environmentally-sound peat substitute for growing plants in containers (Meerow 1994). Nevertheless, research into coir waste properties and its capability as a plant growing medium is scarce (Handreck 1993).

In an experiment on the effect of aeration on rooting and growth of roses, Gislerod et al. (1996) proved that when changed from well aerated to unaerated condition, the root growth was reduced by 50%. It was advocated that different plant species have different root systems which enable them to grow under different oxygen conditions (Laan et al. 1987).

Prasad (1979) discussed the physical properties of various media for container grown crops. De Boodt and Verdonck (1972), Abad et al. (2001) and Verdonck et al. (1973) also reviewed the physical properties of horticultural important substrates. Water retention characteristics measure the ability of substrates to store water (Fonteno 1993).

The determination methods to describe physical properties of horticultural substrates by Fonteno (1993) gave results of water content of substrates as available water capacity (AWC). Air volume or air-filled porosity (AFP) of the growing medium is commonly used to estimate the level of aeration and the availability of oxygen to plant roots (Glinski and Stepniewski 1985; Bunt 1988; Wall and Heiskenen 2003). Volume of air is generally considered as the quality determining factor for substrates. High water content in the growing medium reduces AFP and aeration, which in most plant species can eventually lead to water logging and hypoxia (Lotocki 1977; Heiskenen 1995; Humara et al. 2002). However, sufficient amount of water in growing medium is one of the most important factors for the plant development (Beardsell et al. 1979).

Soil mixtures must be heavy to support the plant which is often provided by using topsoil or sand in the basic soil mixture. Soil must be included in the potting mixture: 1) as addition of weight for container stability, 2) to provide a reservoir for the storage of moisture and nutrients. It is suggested that ‘potting media’ should include mineral soil and light weight potting mixtures. A good quality soil mixture for successful growing of a pot plant must sustain a long range production of vegetative growth in good quality and quantity.

Currently, little research information is available locally on the potting medium aspects of potted hanging plant cultivation especially when using cocopeat mixed with topsoil and sand. This information is of significant importance when these contituents are combined and used as potting medium in the limited volume of a plant container.

This study investigated the properties of five growing media with respect to its aeration (measured as AFP) and moisture availability (measured as CMC) and their effects on the growth of a cascading hanging plant (*Tradescantia* sp.). The influence of different combinations of potting mixtures and the changes of AFP and CMC on quality and growth of the ornamental plant were also studied.

Materials and methods

Stem cuttings of the plant species (*Tradescantia* sp.) not exceeding 10 cm long or with at least three internodes were used as planting materials. They were planted in 18 cm pots using various combinations of soil mixtures as follows:

1. 100% cocopeat
2. 100% topsoil
3. 1 part cocopeat : 1 part topsoil
4. 1 part cocopeat : 1 part sand
5. 1 part cocopeat : 1 part topsoil : 1 part sand

Each pot contained 1.2 litres of each soil medium. For the potting preparation, 1 kg of ground magnesium limestone and 5 kg of slow-release osmocote fertilizer 14:14: 14 ($N:P_2O_5:K_2O$) were mixed into every 0.5 m^3 of each potting medium. The treatments consisting of four pots/treatment were arranged in a RCBD with four replications. The potted plants were hanged from the roof of a 50% shade netted house.

The plants were watered once daily for 40 min using an automated irrigation system through an overhead microjet sprayer. Routine horticultural practices for pest, disease and weed control were followed. Insecticide *(Malathion)* and fungicide *(Benlate)* were applied once every 2 weeks. Hand weeding was carried out whenever necessary.

The CMC of the five different potting media was taken at two different times and was calculated using the formula: (saturated mass – dry mass)/dry volume. It was measured by weighing the container 1 h and 5 h after watering at one month after planting. The CMC is the amount of water present after the medium has been saturated and allowed to drain. Twenty-four hours after the determination of CMC, the AFP or air capacity of the five potting media was estimated whereby readings were also taken at similar time intervals (Bunt 1988). AFP can be difined as the proportion of the volume of medium that contains air after it has been saturated with water and allowed to drain.

Plant data on different growth parameters such as number of main stems, length of main stem, total foliage weight, numbers of primary and secondary branches, internode length and leaf number were taken after 6 months of growth. All data were analysed following the Analysis of Variance Method (ANOVA) using the DMRT to signify its mean values.

Correlation relationship between physical properties of potting media and growth parameters of the tested plant was carried out and its values were expressed at p = 0.05 and p = 0.01. A similar test was also conducted among the different growth parameters viz. number of main stems, length of main stem, total foliage weight, numbers of primary and secondary branches, internode length and leaf number.

Results and discussion

Air-filled porosity (AFP)

The AFP of five potting media at two different times after watering is shown in *Table 1,* whereby soil mixture 1 part cocopeat : 1 part sand had the highest initial and final porosity at both times after watering. The soil mixture 1 part cocopeat : 1 part sand : 1 part topsoil was second highest in terms of AFP values, also at both times after watering. This implies that

Table 1. Physical properties of 5 potting media at 2 different times after watering

Potting medium	Air-filled porosity (%)		Container moisture capacity (%)	
	1 h after watering	5 h after watering	1 h after watering	5 h after watering
100% cocopeat	9.1b	10.6b	48.1a	44.5a
100% topsoil	8.5c	9.8c	37.4c	33.6c
1 cocopeat : 1 topsoil	8.8bc	10.2bc	42.8b	38.8b
1 cocopeat : 1 sand	9.7a	12.1a	19.8e	15.5e
1 cocopeat : 1 topsoil : 1 sand	9.5a	11.7a	29.5d	25.5d

Mean values in the same column followed by the same letter are not significantly different at p <0.05

addition of topsoil, which is clayey, had reduced its AFP values. The soil mixture with 100% topsoil had the lowest AFP values which is probably due to its high compacted clay content.

The variation in the volume of air in the different soil mixtures was consistent whereby the AFP values increased with time after watering. The volume of air was decreased when topsoil was mixed into cocopeat as compared to mixing with sand. The difference in AFP values between 1 part cocopeat : 1 part sand and 1 part cocopeat : 1 part topsoil was 0.3–0.4% respectively in both times after watering.

Martinez et al. (1996) proved that coconut coir increased air capacity and decreased water contents of the mixtures more than linearly, but when clay-materials were added, increases in available water were observed. The volume percentage of the air of the substrate is an important parameter affecting the success of raising plants in containers (Aendekerk 1993, 1994).

Container moisture capacity (CMC)

The linear changes in CMC of five different potting media is given in *Table 1*. The variation on the CMC of the different soil mixtures was also consistent where the CMC values decreased with time after watering. The 100% cocopeat soil mixtures had the highest CMC values ranging from 48.1% to 44.5% over both times after watering. Soil mixtures 1 part cocopeat : 1 part topsoil also had higher CMC values and was followed by soil mixture 100% topsoil. Soil mixture 1 part cocopeat : 1 part sand, due to its high AFP, had the lowest CMC values in both times after watering. Soil mixture 1 part cocopeat : 1 part topsoil : 1 part sand also showed the opposite behaviour similar to soil mixture 1 part cocopeat : 1 part sand. The CMC measured for the former soil mixture was higher than the latter.

The AFP values for both times after watering between soil mixture 1 part cocopeat : 1 part sand and 1 part cocopeat : 1 part sand : 1 part topsoil were not significant to each other, but conversely the mean values for CMC in both soil mixtures were significant to each other *(Table 1)*. This proves the sudden significant increase in moisture content of the soil mixture 1 part cocopeat : 1 part sand when it was added with 1 part topsoil. These results are in trend with earlier findings by Heiskenen (1966).

From the physical viewpoint, the potting media can be regarded as comprising solid matter interspersed with voids or pores. This explains the media's main physical function which is to regulate the supply of water and air to the roots.

Correlation effect on plant growth

The AFP was positively and significantly correlated to all growth parameters except for internode length, number of leaves and leaf size *(Table 2)*. This explains that the physical properties of the soil do not influence the inherent quality of the plant.

It was also shown that the CMC was negatively and significantly correlated to all the growth parameters except for leaf width. This result clearly illustrates that the moisture level in the soil mixture greatly influences the growth parameters as compared to air porosity of the soil. These results concur with Noguera and Abad (1996) who found similar results with *Calendula* sp. and *Coleus* sp.

A correlation was carried out among the different growth parameters such as number of main stems, length of main stem, total foliage weight, number of primary and secondary branches, internode length and leaf number *(Table 3)*. These growth parameters were positively significant to each other which implies that plants with longer and more number of main stems have more primary and secondary branches. They were also heavier in terms of total vegetative weight and have longer internodes and more leaves.

Vegetative yield and plant growth

The vegetative data showed that plant growth was significantly better when soil

Table 2. Correlation interrelationships between physical properties of potting media and growth parameters of the *Tradescantia* plant

Potting medium (treatment)	No. of main stems	Stem length	Tot. vegetative fresh wt.	No. of primary branches per stem	No. of secondary branches per stem	Stem internode length	No. of leaves per stem	Leaf size	
								Leaf length	Leaf width
AFP% 1 h after watering	0.52*	0.41*	0.49*	0.46*	0.51*	0.23ns	0.42ns	0.36ns	0.35ns
AFP% 5 h after watering	0.57*	0.46*	0.60*	0.60**	0.58*	0.33ns	0.44ns	0.46ns	0.45ns
CMC% 1 h after watering	–0.65*	–0.59*	–0.65*	–0.74**	–0.67**	–0.61*	–0.59*	–0.70*	0.65*
CMC% 5 h after watering	–0.66**	–0.58*	–0.66**	–0.72**	–0.68**	–0.60*	–0.58*	–0.69*	0.65*

AFP = Air-filled porosity; CMC = Container moisture capacity
*Significant at 5% level; **Significant at 1% level; ns = Not significant

Table 3. Correlation interrelationships between different growth parameters

	No. of main stems	Stem length	Tot. vegetative fresh wt.	No. of primary branches per stem	No. of secondary branches per stem	Stem internode length	No. of leaves per stem	Leaf size	
								Leaf length	Leaf width
No. of main stems	1.00	0.51*	0.90**	0.78**	0.93**	0.45ns	0.93**	0.46ns	0.41ns
Main stem length		1.00	0.62*	0.67**	0.62*	0.81**	0.63*	0.42ns	0.43ns
Tot. vegetative fresh wt.			1.00	0.92**	0.97**	0.57*	0.97*	0.85**	0.78**
No. of primary branches per stem				1.00	0.90**	0.58*	0.88**	0.43ns	0.41ns
No. of secondary branches per stem					1.00	0.65*	0.96**	0.45ns	0.39ns
Stem internode length						1.00	0.65*	0.44ns	0.35ns
No. of leaves per stem							1.00	0.41ns	0.23ns
Leaf length								1.00	0.80**
Leaf width									1.00

*Significant at 5% level; **Significant at 1% level; ns = Not significant

Table 4. Effect of 5 potting media on vegetative growth of a *Tradescantia* plant

Potting medium (treatment)	No. of main stems	Stem length (cm)	Tot. vegetative fresh wt. (g)	No. of primary branches per stem	No. of secondary branches per stem	Stems internode length (cm)	No. of leaves per stem	Leaf size	
								Leaf length (cm)	Leaf width (cm)
100% cocopeat	65d	69.2c	425d	8d	9d	2.72c	110d	1.80c	0.70c
100% topsoil	74c	73.5c	607c	11c	14c	3.16b	163c	2.05b	0.80b
1 cocopeat : 1 topsoil	88b	87.4a	890b	13bc	24b	3.71a	256b	2.20a	0.85a
1 cocopeat : 1 sand	91b	90.5a	950b	15ab	26b	3.81a	242b	2.25a	0.90a
1 cocopeat : 1 topsoil : 1 sand	98a	80.6b	1,246a	17a	33a	3.28b	321a	2.30a	0.95a

Mean values in the same column followed by the same letter are not significantly different at $p < 0.05$

mixture 1 part cocopeat : 1 part topsoil : 1 part sand was used as the potting medium *(Table 4)*. This soil mixture gave significantly high vegetative fresh weight, significantly higher number of stems and secondary branches as well as number of leaves as compared to other soil mixtures. This shows that formation and branching of the stems as well as other vegetative parts were enhanced by the slightly lower moisture content, but greater air porosity in the soil mixture. A strong effect of the soil constituent such as cocopeat on plant growth was confirmed by Bugbee and Frink (1986).

The data also showed that soil mixtures 100% cocopeat and 100% topsoil separately had significantly the lowest number of main stems, total vegetative weight, number of leaves, number of primary and secondary branches. Both the soil mixtures 1 part cocopeat : 1 part topsoil and 1 part cocopeat : 1 part sand had also similar yield trends for all the growth parameters.

This explains that the adverse effects of growing plants in potting media with either poor aeration (too much water) or with high aeration (too little water) can be at least partially mitigated by adding appropriate physical parameters that have good air-water relations suitable for container potting media usage.

Conclusion

Although there is no universally accepted ‘optimal’ physical specification for potting media with respect to the varying demands of plant species, soil type and watering practices, it was found that this study showed that plant growth was significantly better when soil mixture 1 part cocopeat : 1 part topsoil : 1 part sand was used as the potting medium. The soil mixture gave significantly high vegetative fresh weight, significantly higher number of stems and secondary branches as well as number of leaves in comparison to other soil mixtures.

The research on hanging potted plants should be continued to clarify what other qualities affect the degree of decomposition of the potting mixture. Some of the areas considered worthy of investigations include using different species and types of hanging plants and different combination of soil mixtures. One important area is the study on lightweight, easy handling growing media that helps in the handling and transporting of potted plants. Also of interest is the area of complex multi-nutrient formulation in relation to the different potting media combination and its effect on growth of hanging plants. This is to find out at what nutrient level is needed by the plant in order to reach a balanced foliage coverage of its hanging pot in relation to growth period.

Acknowledgement

The author wishes to express sincere thanks to Mr Subramaniam for technical assistance and valuable help during the course of the experiment.

References

Abad, M., Noguera, P. and Bures, S. (2001). National inventory of organic wastes for use of growing media for ornamental potted plant production: case study in Spain. *Bioresource Technology 77(2):* 197–200

Aendekerk, T.G.L. (1993). Standard of physical properties for substrates for cuttings. *Acta Horticulture 342:* 273–8

—— (1994). Standard of physical properties for substrate used in ebb and flow systems. (Annual report 1994), p. 38–8. Research Station for Nursery Stock

Beardsell, D.V., Nichols, D.G. and Jones, D.L. (1979). Physical properties of nursery potting-mixture. *Scientia Horticulturae 11(1):* 1–8

Bugbee, G.J. and Frink, C.R. (1986). Aeration pf potting media and plant growth. *Soil Sci. 141:* 438–41

Bunt, A.C. (1988). *Media and mixes for container-grown plants*. 2nd ed., 309 p. London: Unwin Hyman

De Boodt, M. and Verdonck, O. (1972). The physical properties of the substrate in horticulture. *Acta Horticultural 26:* 37–44

Fonteno, W.C. (1993). Problems and considerations in determining physical properties of horticultural substrates. *Acta Hort. 34:* 197–204

Gislerod, H.R., Bass, R., Mary, W. and Dick, V.B. (1996). *Proc. of Symposium on growing media and plant nutrition in horticulture,* 2–7 Sept. 1996, Germany, p. 113–22. ISHS

Glinski, J. and Stepniewski, W. (1985). *Soil aeration and its role for plants* 229 p. Boca Raton, Fla: CRC Press

Handreck, K.A. (1993). Propertioes of coir dust, and its use in the formulation of soilless potting media. *Commun. Soil Sci. Plant Analysis 24:* 349–63

Heiskenen, J. (1995). Compaction of growth media based on sphagnum peat during one-year culture of container seedlings. *Suo 46:* 63–8

—— (1996). Air-filled porosity of eight growing media based on sphagnum peat during drying from container capacity. *Proc. of Symposium on growing media and plant nutrition in horticulture,* 2–7 Sept. 1996, Germany, p. 227–86. ISHS

Humara, I.M., Casares, A. and Majada, I. (2002). Effect of seed size and growing media water availability on early seedling growth in *Eucalyptus globulus*. *Forest-Ecology-and-Management 167(1/3):* 1–11

Laan, P., Smolders, A., Blom, C.W. and Amstrong, W. (1987). The anatomical characteristics of roots and plant response to soil flooding. *New Phytol. 106:* 465–95

Lotocki, A. (1977). Effect of not aeration and form of nitrogen on photosynthetic productivity of *Pinus sylvestris*. *Acta Societatis Botanicorum 46:* 303–16

Martinez, F.X., Sepo, N. and Valero, J. (1966). Physical and physicochemical properties of peat-coir mixes and the effects of clay-material addition. *Proc. of Symposium on growing media and plant nutrition in horticulture,* 2–7 Sept. 1996, Germany, p. 39–46. ISHS

Meerow, A.W. (1994). Growth of two subtropical ornamentals using coir (coconut mesocarp pith) as a peat substitute. *Hort. Sci. 29(12):* 1484–6

Noguera, R. and Abad, M. (1996). Physical and chemical properties of coir waste and their relation to plant growth. *Proc. of Symposium on growing media and plant nutrition in horticulture,* 2–7 Sept. 1996, Germany, p. 365–9. ISHS

Prasad, M. (1979). Physical properties of media for container grown crops. II peat mixes. *Scientia Horticultural 10:* 325–30

Radjagukuk, B., Sockotjo, B.O.H. and Santoso, H.S. (1983). A comparative study of peats and other media for containerized forest tree seedlings. *Acta Hortic. 150:* 449–58

Reynolds, S.G. (1973). Preliminary studies in Western Samoa using various parts of the coconut palm (*Cocos nucifera* L.) as a growing media. *Acta Hortic. 37:* 1983–91

Robertson, R.A. (1993). Peat, horticulture and environment. *Biodiversity Conservation 2:* 541–7

Verdonck, O., Carpenter, I. and Boodt, M. da (1973). The rooting of azalea cuttings in inert substrates. *IWOSC Proc. 3rd Int. Congr. on Soilless Culture*, Sassiri, Italy, p. 143–8

Wall, A. and Heiskenen, J. (2003). Effect of air-filled porosity and organic matter concentration of soil on growth of *Picea abies* seedlings after transplanting. *Scandinavian-Journal-of- Forest-Research 18(4):* 344–50

Wever G.C. de kreij and van Schie, W. (1994). Coir, as a new substrate makes a spectacular entry. *Vaklad von de Bloemisterij 29:* 42–5

Abstrak

Tanah biasa dari ladang adalah tidak sesuai sebagai tanah campuran untuk tanaman berpasu melainkan campurannya diubah suai dengan bahan-bahan fizikal lain. Pelbagai campuran tanah telah dikaji untuk mengetahui faktor-faktor yang menentukan kadar pertumbuhan pokok bunga gantung (*Tradescantia* sp.) di dalam pasu dan hubung kaitnya dengan AFP (air-filled porosity) dan CMC (container moisture capacity) yang terkandung di dalam campuran tanah.

Lima jenis campuran tanah iaitu 100% cocopeat, 100% tanah atas, 1 bahagian cocopeat : 1 bahagian tanah atas, 1 bahagian cocopeat : 1 bahagian pasir dan 1 bahagian cocopeat : 1 bahagian tanah atas : 1 bahagian pasir. Kajian membuktikan bahawa campuran 1 bahagian cocopeat : 1 bahagian tanah atas : 1 bahagian pasir adalah lebih baik daripada campuran tanah lain. Campuran tanah ini memberi kesan yang baik terhadap pertumbuhan vegetatif pokok dari segi berat pokok (1,246 g), jumlah batang (98) dan cabang (33) serta jumlah daun (321) bagi setiap pokok ($p < 0.05$).

Accepted for publication on 24 July 2006