EFFECT OF CATTLE MANURE, COIR DUST AND PADDY HUSK ASH ON PHYSICAL AND CHEMICAL PROPERTIES OF POTTING MEDIA

Suthamathy.N[1] and Seran.T.H[2]

ABSTRACT

An experiment was carried out at the Agronomy farm of the Eastern University, Sri Lanka to study the effect of organic manures on physical and chemical properties of media used in pot culture technique. Three different types of organic manures (cattle manure, coir dust and paddy husk ash) were tested and soil type used for this experiment is sandy regosol. The experiment was laid out in a Complete Randomized Design (CRD) with five treatments and four replications. Different types of potting media were prepared by mixing of potting materials at different ratio (v/v) such as such as medium 1(T_1) used as control contained sandy soil only, medium - 2 (T_2) contained sandy soil: cattle manure at ratio of 3:1, medium - 3 (T_3) contained sandy soil: cattle manure: coir dust at ratio of 6:2:1, medium - 4 (T_4) contained sandy soil: cattle manure: paddy husk ash at ratio of 6:2:1 and medium - 5 (T_5) contained sandysoil: cattle manure: coir dust : paddy husk ash at ratio of 12:4:1:1. Soil testing was done in two stages i.e day on media preparation and four weeks after media preparation. Disturbed soil sample was collected from each medium and its both physical and chemical properties were estimated. The results indicated that organic manures have significant effect on the properties of potting media. Addition of organic manures resulted in the improvement of physical properties such as water holding capacity, particle density, bulk density and porosity and chemical propertiessuch as pH, nutrients content (P and K), organic matter content and electrical conductivity of potting media. Among tested materials, paddy husk ash increased pH and nutrients content (P and K) of media distinctly and improved other properties such water holding capacity, electrical conductivity and porosity to optimum level. Medium (T_4) contained sandy soil, cattle manure and paddy husk ash at ratio of 6:2:1 showed highest soil pH (7.4), P content (77 mg/kg) and K content (88 mg/kg). Usage of paddy husk ash as a potting material with sandy soil and cattle manure for media preparation in pot culture technique would improve both physical and chemical properties of medium and provide favourable condition for root establishment and crop growth.

INTRODUCTION

Soil is the key component of natural ecosystem because environment sustainability depends largely on sustainable soil eco system (Adedokun *et al*., 2007 and Adenipekun, 2008). Increasing food production is closely related with the productivity of soil. This productivity of soil in turns can be enhanced by improving soil properties. Organic matter influences the physical, chemical and biological properties of soil. It has nutritional function in that it serves as a source of N, P and K for plant growth, a biological function in that profoundly affects the activity of microflora and macroflora organism and physical function in that it promotes good soil structure, thereby improving tilth, aeration and retention of moisture. Soil organic matter also improves the chemical properties of soil such as cation exchange capacity and buffer action.

Pot culture technique is one of the recent method to control the environmentfor maximizingcrop productivity and increasing the quality of vegetable produces. Pot technique is an open system of vegetable cultivation; crops are grown in pots or poly bags. Potting medium depends on the crop requirement and the medium should provide suitable condition for the crop growth. Mixture of organic manures with soil is a good medium for cultivating vegetable crops. Organic manures serve as food for soil organism from bacteria to worms (Stephens *et al*., 1994). These organisms hold onto nutrients and release them in the available form to plants. In addition to N, P and K, manures can be a source of sulphur and micronutrients. Manures improve the structure of soil in potting medium, these structural improvement increases the amount of water useful to crops that soils can hold, improve aeration and drainage and also encourage good root growth by

[1 & 2] Department of Crop Science, Faculty of Agriculture, Eastern University, Sri Lanka. (nsuthamathy@yahoo.com)

providing enough pores of the right sizes and preventing the soil becoming too rigid when they dry or completely water logged and devoid of air when wet.

Cattle manure, paddy husk ash, coir dust, sand or gravel, peat, vermiculite, perlite, sawdust are the materials normally used for media preparation. Among these, cattle manure, coir dust and paddy husk ash are locally available organic manures. Cattle manure is the most commonly used organic manure in agriculture. Addition of cattle manure to potting medium improves the physical properties of soil, improves microbial activity and improves nutrient availability especially nitrogen to the crop in growing medium, it contains 0.35% N, 0.12% P_2O_5 and 0.17% K_2O (Tandon, 1999). Coir dust is the spongy, peat like residue from the processing of coconut husks (mesocarp) for coir fiber, also known as coco peat. Nowadays coir dust is used in growing medium for many crops such as fruits tree, vegetable and cut flowers. In Sri Lanka, it is used in growing medium for the seed potato production, potting medium for tomato under poly tunnel and it also used as medium for hydroponics production of leafy vegetable eg. Spinach. When applied to agricultural soil, coir dust can improve moisture retention capacity, increase nutrient content, infiltration rate, total porosity and hydraulic conductivity of that soil (Savithri *et al*., 1993). They are able to increase aeration in the basal mixture and reduce drying of the surface by lifting moisture higher in the pot. Coir dust contains 0.2% of N, 0.18% of P_2O_5 and 0.96% of K_2O (Tandon, 1999). The water holding capacity of the soil was increased in direct proportion to the amount of coir dust incorporated (Santhirasegaram, 1960).

In sandy soil of Sri Lanka where clay content ranges from 3% to 5% the cation exchange capacity is low as 4 meq/100 g soil (Mupa *et al*., 1995). This shows the ability of coir dust retain more plant nutrient, reducing leaching and show response to applied fertilizer when incorporated to soils in growing medium. Paddy husk is major byproduct obtained from paddy. This husk contains about 75% organic volatile matter and the balance 25% of the weight of this husk is converted into ash during the firing process, is known as paddy husk ash (PHA). When burned, paddy husk help to buildup of soil structure and aeration as they hold shape for a long time, have good water holding capacity, and are bacteria and fungus – free making them a good potting material (Aspinal, 2003). Paddy husk ash contains high percentage of potassium and phosphorus than nitrogen. Bronzeoak Ltd (2003) reported that potassium and phosphorus contents of paddy husk were 0.01- 2.69 % P_2O_5 and 0.1 – 2.54 % K_2O respectively. In Ampara and Batticaloa district, the paddy husk is more available material, which improves the water retention of sandy regosol effectively without any side effect. Therefore, this study was carried out to evaluate the improvement by in corporation of cow dung, coir dust and paddy husk ash to sandy soil on the physical and chemical properties of potting media used for vegetable cultivation in pots.

MATERIALS AND METHODS

An experiment was conducted during 'Maha' season 2008/2009 at the Agronomy farm, Eastern University, Sri Lanka. This experiment was laid out in Complete Randomized Design (CRD) with five treatments and four replicates. The soil type used for this experiment is sandy regosol which is the dominant soil type of Batticaloa district. In this study, organic manures such cattle manure, coir dust and paddy husk ashes were used as potting materials for media preparation. Treatments in this experiment are given in Table 1. Different types of potting media were prepared by mixing of materials at different ratio (v/v) according to the treatments. Soil testing was done in two stages i.e day on media preparation and four weeks after media preparation. Disturbed soil sample was collected from each and thoroughly mixed to get uniform sample for testing. There after samples were air-dried and ground to pass through 2 mm sieve and then used for soil analysis.

In stage -1 of testing some selected properties such as soil pH (soil: water, 1:2 solution) using Electrometric method (Tandon, 1993), soil organic matter content (wet digestion with potassium dichromate- Walkey and Black rapid titration method, 1934), total phosphorus (P) content [Bray and Kurtz, 1945, using spectrometer (Camspec M330BT, made in UK)] and total potassium (K) content (Schollenberger and Simon, 1945) using flame photometer (Jenway PFP-7, made in UK) were measured. In stage - 2 of soil testing, some selected properties of potting media such as soil pH (soil: water, 1:2 solution) and electrical conductivity (soil: water, 1:5 solution) using Electrometric method, particle density, bulk density and porosity using Laboratory method for disturbed soil (Gupta, 1999) and water holding capacity were measured. Measurements were

taken for each property and the values were averaged. Data were then analyzed by Analysis of Variance. Pair comparisons among treatments means were tested by Duncan's Multiple Range Test (DMRT) at 5% level by using Statistical Analysis System (SAS) soft ware package.

Table 1: Treatments used in this study

Treatments	Potting mixture	Ratio (v/v)
T_1 (Control)	Sandy soil	
T_2	Sandy soil + Cattle manure	6 : 2
T_3	Sandy soil + Cattle manure + Coir dust	6 : 2 : 1
T_4	Sandy soil + Cattle manure + Paddy husk ash (PHA)	6 : 2 : 1
T_5	Sandy soil + Cattle manure + Coir dust + Paddy husk ash	12 : 4 : 1 : 1

RESULTS AND DISCUSSION

Potting media were analyzed in two different stages. In stage –1, it was done on the day of media preparation in which pH, organic matter content and nutrient content of media (P and K) were measured. In stage –2, it was done four weeks after media preparation in which pH, electrical conductivity, water holding capacity (WHC), particle density, bulk density and porosity were measured. The results given in Table 2 and Table 3 clearly revealed that there were significant differences ($P< 0.05$) in both physical and chemical properties of potting media among the treatments. Changes in the property of media among the treatments may be due to the influence of added organic materials to the potting media.

pH of medium

pH of media were measured on the day of media preparation and four weeks after media preparation. The results (Table 2 and Table 3) showed significant difference ($p< 0.05$) among the treatments and further it was noted that addition of organic manures increased soil pH at the time of application and brought the pH approximately equal to neutral after its decomposition. pH of the media on the day of preparation ranges from 6.4 to 7.6 (Table 2). The rate of increment in pH varied with the pH of organic manures added to the media. Medium 4 (T_4) showed high pH (7.6) because it contained paddy husk ash, paddy husk ash is an alkaline material than coir dust, has pH 8 to 11(Bronzeoak Ltd, 2003) thereby it increases the soil pH highly than others. The results agree with the finding of Ichiban and Chiyoda-ku (2001) who reported that burnt paddy husk increases soil pH and AICOAF (2001) also reported that ash increases soil pH. pH of each medium other than control showed a reduction in stage 2 (Table 3) because in this stage, organic manure added to medium get decomposed. During decomposition of soil organic matter, carbon dioxide is released which gets dissolved in water and form carbonic acid and some other organic anions are formed such as citrate, oxalate, malate and malonate which also formed organic acid when dissolved in water, these organic acids decrease soil pH (Singh, 1995). The pH of media after decomposition of manures ranges from 6.40 to 6.95 (Table 3). In this study among the different organic manures, paddy husk ash increased pH of potting media faster.

Organic matter content

Manures are by nature, organic as it supplies some organic matter to the soil, much of which is lost to the atmosphere as CO_2 and some of which is changed into humus which persists in the soil and improves its physical properties (Simpson, 1986). Organic matter content of potting media varied significantly ($p< 0.05$) among treatments as shown in Table 2. Average organic matter content of potting media ranged from 0.60% to 6.00% and high values measured in media containing coir dust. Control treatment (T_1) showed very low (0.60%) amount of organic matter content. Coir dust is a carbon rich material because of high C: N, 104: 1 (Shekar, 1999). Mupa *et al*., (1994) reported that addition of organic manures to the soil increase soil organic matter content significantly and increase was generally more with higher application.

Total Potassium (K) content

The results shown in Table 2 indicated that there was significant difference ($p<0.05$) in the total K content of potting media among treatments. It was also observed that among the organic manures tested, paddy husk ash increased the total K content distinctly than others. Higher K_2O content of paddy husk ash than coir dust

and cattle manure was the reason for this. It was reported that K_2O content of paddy husk ash, coir dust and cattle manure are 0.1 – 2.54 % K_2O (Bronzeoak Ltd, 2003),0.96 % (Tandon, 1999) and 0.17%(Tandon, 1999) respectively. Average K content ranged from 0.12% to 0.83%. Medium 4 (T_4) contained soil, cattle manure and paddy husk ash at ratio (v/v) of 6:2:1 showed high K content (0.83%) and medium1 (T_1) contained soil alone showed K content as low as 0.12%.

Total Phosphorus (P) content

It was observed that there was significant difference ($p<0.05$) among the treatments in the P content of media. It was also noted that addition of organic materials increase the P content of media however, the magnitude of such change varied with the type. The P content of media ranged from 0.06 % to 0.77 %. Highest total P content recorded in the medium 4 (T_4) contained soil, cattle manure and paddy husk ash at ratio (v/v) of 6:2:1 and lowest value recorded in medium 1 (T_1). The P_2O_5 content in paddy husk ash might be the reason for the high P content in medium 4 (T_4). Earlier report showed that P_2O_5 content of paddy husk ash, coir dust and cattle manure were 0.01- 2.69 % (Bronzeoak Ltd, 2003), 0.18% (Tandon, 1999) and 0.12% (Tandon, 1999). The results hold good in accordance to the finding of by Ichiban and Chiyoda-ku (2001) that burnt paddy husk increases soil pH thereby increase available phosphorus in soil.

Particle and bulk density

Particle density is the weight per unit volume of the solid portion and it depends upon the accumulative densities of the individual inorganic and organic constitutes of the soil. Bulk density is defined as the mass per unit volume of a dry soil including pore space. The results shown in Table 3 revealed that addition of organic manures to potting media showed a reduction in both particle and bulk density of potting media and there were significant differences in both density of potting media among treatments. Gupta (2003) reported that with increase in organic matter of the soil, the particle density decreased and soil containing high organic matter had lower value of bulk density. Lower value of bulk density was recorded in medium 3 (T_3) contained soil, cattle manure and coir dust at ratio (v/v) 6:2:1 that showed high organic matter content (6%). The control treatment (T_1) showed high particle (2.61 g/cm) and bulk density (1.45 g/cm) and very low organic matter content (0.6%). The results indicated that addition of organic materials (cattle manure, coir dust and paddy husk ash) showed a reduction in the density of soil and increase porosity and water holding capacity of potting medium. The similar findings were reported by several researchers (Jeyarani, 1986; Sriskandavel, 1987; Mupa and Silva, 1994; Tesselar Bulb, 2002).

Porosity

Porosity of potting media showed significant difference ($P< 0.05$) among the treatments (Table 3). Porosity of media ranges from 44.38% to 50.91%. Soil porosity was 44.38% as control (Table 3) and it increased by adding organic material. The result is supported with the finding of Jayarani (1986) who reported that addition of organic manures at the higher rate increases the total porosity significantly.

Table 2: Chemical properties of media on the day of media preparation (stage-1)

Treatment	pH	Organic matter content (%)	K content (%)	P content (%)
T_1	6.40 ± 0.02 e	0.60 ± 0.03 d	0.12 ± 0.02 d	0.06 ± 0.006 e
T_2	6.94 ± 0.03 d	1.90 ± 0.04 c	0.56 ± 0.01 c	0.17 ± 0.004d
T_3	7.12 ± 0.02 c	6.00 ± 0.03 a	0.71 ± 0.02 b	0.25 ± 0.003 c
T_4	7.60 ± 0.03 a	2.00 ± 0.03 c	0.83 ± 0.01 a	0.77 ± 0.015 a
T_5	7.40 ± 0.04 b	5.10 ± 0.04 b	0.73 ± 0.02 b	0.31 ± 0.002 b
F value	*	*	*	*

Value represents mean ± standard error of four replicates.
F test: - * P< 0.05
Means followed by the same letter in each coloum are not significantly different according to Duncan's Multiple Range Test at 5% level.

Electricalconductivity

Table 3 showed that electrical conductivity (EC) of potting media, significantly ($p<0.05$) varied among treatments. Mean EC ranged from 31.30 to 59.40 µs / cm and incorporation of organic manures increase the EC of potting media. Increase in nutrient content of media showed an increase in EC.

Table 3: Physical and chemical properties of each mediumat four weeks after media preparation (stage-2)

Treatment	pH	EC (µs / cm)	Dp (g/cm^3)	Db (g/cm^3)	Porosity
T_1	6.40 ± 0.02 c	31.30 ± 0.02 e	2.61 ± 0.02 a	1.45 ± 0.01a	44.38 ± 0.03 c
T_2	6.70 ± 0.02 b	33.30 ± 0.04 d	2.48 ± 0.02 b	1.29 ± 0.02 b	47.80 ± 0.83 b
T_3	6.90 ± 0.03 a	53.80 ± 0.03c	2.46 ± 0.01 b	1.21 ± 0.01 c	50.70 ± 0.58 a
T_4	6.95 ± 0.02 a	57.30 ± 0.04 b	2.57 ± 0.01 a	1.30 ± 0.01 b	49.25 ± 0.71 ab
T_5	6.90 ± 0.01 a	59.40 ± 0.01a	2.34 ± 0.01 c	1.41 ± 0.02 c	50.91 ± 0.54 a
F value	*	*	*	*	

EC – Electrical conductivity Dp -Particle density Db -Bulk density

Value represents mean ± standard error of four replicates.
F test: - * P< 0.05
Means followed by the same letter in each coloum are not significantly different according to Duncan's Multiple Range Test at 5% level.

Water holding capacity

It was observed that there was significant difference (P< 0.05) in the water holding capacity of potting media among treatments and addition of organic manures increase the water holding capacity of soil. Salter and William (1963) found that organic matter improved the water holding capacity of soil by increasing the micro pore volume in soil. The average water holding capacity of potting media ranged from 25.59 to 49.62 % and the high water holding capacity was recorded in the medium 3 (T_3) contained soil, cattle manure and coir dust at ratio of 6:2:1. Swelling ability of coir dust as well as ability to retain water of about 9 – 10 time of it's weight caused to water retension for longer period (Mupa and Priyantha kumara, 1995). Kevin galea (2004) stated that organic manure improves water infiltration and decrease evaporation and also increases water holding capacity, especially in sandy soil.

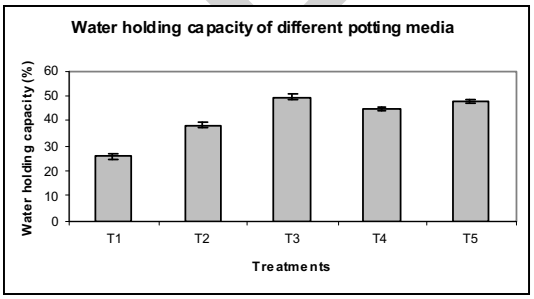

Figure 1: Mean water holing capacity of media at four weeks after media preparation

CONCLUSION

Over all observation in this experiment clearly indicated that addition of organic manures to potting media have significant effect on physical and chemical properties of pottingmedia. Amongtested materials (cattle manure, coir dust and paddy husk ash), paddy husk ash increased pH and nutrients content (P and K) of media distinctly and brought other properties such water holding capacity, electrical conductivity and porosity to optimum level. It is possible to use paddy husk ash as potting material with sandy soil and cattle manure to improve the physical and chemical properties of potting media and it would provide favourable condition to root establishment and crop growth.

REFERENCES

Adedokun, O. M., and Ataga, A. E. (2007). Effects of amendments and bio augumentation of soil polluted with crude oil, automotive gasoline oil,and spent engine oil on the growth of cowpea (*Vigna unguiculata* L.Walp). *Scientific Research and Essay*, 2(5),pp. 197-149.

Adenipekun, C. O. (2008). Bioremediation of engine oil polluted soil by *Pleurotus tuber-regium* Singer, a Nigerian whole-rot fungus. *African Journal of Biotechnology,* 7(1), pp. 55-58.

AICOAF, (2001). Application of the rice husk charcoal. Food and Fertilizer Technology Center for theAsian and Pacific leaflet for Agriculture: Practical Technologies 4. Association for international Cooperation in Agriculture and Forestry (AICOAF), Japan.

Aspinall, C. (2003). How to build an easy rice husk incinerator. In: The small farm Newsletter. No 39 July, 2003.

Bray, R.H., Kurtz L.T. (1945). Determination of total, organic and available forms of phosphorus in soil. *Soil Science* 59, pp. 39-45.

Bronzeoak Ltd. (2003). Report of the rice husk ash market study, Bronzeoak Ltd, UK, pp. 62.

Gupta, P. K. (1999). *Soil, Plant, water and Fertilizer Analysis*, pp. 84-124, New Delhi: Agro Botanical.

Gupta, P. K. (2003). *A Hand Book of soil, fertilizer and manure*, 2nd enlarged ed. pp. 45, 70 and 303 , Jodphur: Agrobios, Agro House.

Ichaiban- cho and Chiyoda-ku. (2001). Application of rice husk charcoal. Association for International Cooperation in Agriculture and forestry. Japan-19

Jeyarani, P. (1986). *A Study of feasibility of regulating water retention capacity of sandy regosoils*. Thesis report B.Sc. Agriculture. Eastern University, Sri Lanka.

Kevin, G. (2004). Water holding capacityin maltese soil. *Institute of Agriculture Research* , University of Malte, Malte.

Mupa, R.B., and De Silva, A. (1994). Effect of organic matter on available water in Noncalcic brown soils, *Sri Lankan journal of Agriculture Science*. 31, pp. 82-93.

Mupa, R., and Priyantha, G. K .K. (1995). Potential of coir dust for Agricultural use. *Sri Lanka Journal of Agriculture Science*, Sri Lanka. 32, pp. 1-12.

Santhirasegaram, K. (1960). Dry Dust from coconut fiber mills a useful soil ameliovant. *Ceylon coconut quarterly*, 11, pp. 85-98.

Savithri, P., and Khan, H.H. (1993). Characteristic of coconut coir peat and its utilization in Agriculture. *Jouranal of plants crop*, 22, pp. 1-18.

Schollenberger, C.J., and Simon, R.H. (1945). Determination of exchange capacity and exchangeable bases in soil- ammonium acetate method. *Soil Science* 59, pp. 13-24.

Shekar, C. A. (1999). Application of coir pith in internal and export market, National seminar on coir, coir product and coir pith. New Delhi, India.

Simpson, K. (1986). *Fertilizer and Manures*, pp. 1-84, England : Longaman Scientific and Technical, Longman House.

Singh, S. S. (1995). *Soil fertility and nutrient management*, pp.11-12, India: Kalyani publisher.

Stephens, J. M., and Kostewicz, S. R. (1994). Producing garden vegetable with organic soil amendents. *Florida Agricultural Science*, University of Florida.

Tandon, H. L. S. (1993) *Method of analysis of soil, plants, water and Fertilizers*, pp. 13-35, New Delhi: Fertilizer Development and Consultation Organization.

Tandon, H. L. S. (1999). Organic *fertilizer and Bio-fertilizer, A Techno- Commercial Source Book*, pp. 3-14, New Delhi: Fertilizer Development and Consultation Organization.

Walkley, A., and Black, I. A. (1934). An examination of the Degtjareff method for determing organic matter and proposed modification of the chromic acid titration method. *Soil Science*, 34, pp. 29- 38.