ФИЗИКА ПОЧВ

PHYSICAL PROPERTIES OF SUGARCANES BAGASSE AND SAWDUST VERMICOMPOSTSOR USE AS A PEAT-SUBSTITUTE GROWING MEDIA

Khomami A.M.[1], Mammadov G. M.[2]
[1]Ornamental Plants and Flowers Research Station, Lahijan, Iran
[2]Institute Soil Science and Agrochemestry of ANAS, Baki, Azerbayjan
mahboub48@yahoo.com; goshgarmm@rambler.ru

The aim of the present work was to assess the response of selected peat (PE) physical properties, after applications of two different vermicomposts. Vermicompost from sawdust (SV) and from sugarcanes bagasse (SBV) were used at substation rates into a soil–less plant growth medium (60 % peat: 30 %vermiculite: 10 % perlite) instead of Peat, at rates of (0 %, 10 %, 20 %, 30 %, 40 %, 50 % and 60 % by volume). Result show that after substitution of PE with equivalent amounts of SV or SBV with increase of bulk densities caused a decrease of porosity, Air-fill porosity and container capacity. Evaluation of these parameters is critical since they are directly related to plant growth. In the present experiments substitute of SV or SVB instead of PE were also obtained optimum physical conditions for most substrate.

Keywords: Physical properties; Vermicompost; Sawdust; sugarcanes bagasse.

INTRODUCTION

Peat as meanly desirable characteristics when used growing media. The demand for peat as a substrate for plant pot culture has remarkably increased in recent years, thus reducing the availability of the resource, worsening its quality and increasing its cost. Developing peat alternative substrates is necessary for three different reasons: the resources of peat are limited; the pressure for using waste coming from human or industrial activities increases rapidly and the economic necessity to use locally produced waste products. In Europe, approximately 95 % of all growing media for the professional and amateur market are based on high moor Peat (Schmilewski, 1996). The improper and indiscriminate disposal of waste materials is posing a great challenge to Iran and other developing nations. They cause odor problem and are potential source of surface and ground water pollutions. Waste products such as Cow manure sawdust or sugarcanes bagasse have been frequently used for nurseries, the availability of other materials is attracting more attention (Chen et al., 2002).vermicomposting has been recognized as an eco-friendly technology for converting organic wastes in to high value organic manure (Kale et al., 1982 ; Senapathi, 1993). Vermicomposts are finely divided peat like materials with high porosity, aeration, drainage, water holding capacity and microbial activity, which make them excellent soil amendments or conditioners (Atiyeh et al., 1999; Edwards and Burrows, 1988). They contain most nutrients in plant available forms such as nitrates, phosphates, and exchangeable calcium and soluble potassium (Edwards, 1998). Vermicomposts, whether used as soil additives or as components of greenhouse bedding plant container media, have improved seed germination, enhanced seedling growth and development, and increased overall plant productivity (Mus-colo et al., 1999). In previous studies Azizi et al. (Azizi et al., 2008.) had shown the feasibility of cow manure vermicompost (SV) as substitutes of peat in substrates formulation for growing Dieffenbachia amona plant. The objective of this study was to characterize changes in the physical properties of peat that had been substituted with a range of different concentrations 10 %, 20 %, 30 %, 40 %, 50 and 60 by volume) of SV and SBV vermicomposts, and to determine their variability.

METHODS

The experiments were conducted in the ornamental plants research station greenhouse at the Lahijan, The treatments consisted of a control treatment (60 % peat: 30 % vermiculite: 10 % perlite), and the same treatments mixed with substitution of different concentration of SV or SBV instead of PE. The SV or SBV was provided by vermicycle organics and consisted of separated cow solids processed by earthworms (Eisenia foetida) in indoor beds (Azizi et al., 2008). The SV consisted of a mixture of cow manure and sawdust in a ratio of 4:1 (v: v) and SBV, mixture of cow manure and sugarcanes bagasse in a ratio of 4:1 (v: v) in the presence of Eisenia foetida. Vermicompost form SV and from SBV were used at substitution rates into a soil-less plant growth medium, instead of Peat, at rates of 0 %, 10 %, 20 %, 30 %, 40 %, 50 % and 60 % by volume. The substrates tested are shown in table 1.The pH was determined by pH meter (Metrohm 691) in a double distilled water suspension of each mixture in the ratio of 1:5 (W/V) that had been agitated mechanically for 30 min and filtered through whatman No.1 filter paper. The same solution was measured for electrical conductivity (Metrohm 644) by a conductance meter that had been standardized with 0.01 and 0.1 M KCl (Verdonck and Gabriels, 1992). Total organic carbon was measured by using the method of Nelson and Sommers (1982). Total Kjeldal Nitrogen was determined after digesting the sample with concentrated H2SO4 and concentrated HClO4 (9:1, V/V) by Bremner and Mulvaney (1982) procedure. Total P was analyzed using the colorimetric method with molybdenum in sulphuric acid. Total K after digesting the sample in diacid Mixture (concentrated HNO3: concentrated $HClO_4$, 4:1, V/V), by flame photometer. Each sampling date, were analyzed statically by SAS (SAS Institute, 2001). The means of biochemical parameters at each sampling data were adjusted for multiple comparisons and were separated statically using Tukey's multiple range tests with cow manure without earthworm set as the control. The chemical properties of peat (PE), cow manure vermicompost (SV) and cow manure and sawdust vermi-compost (SBV) over summarized in table 2.

Table 1 - Composition of substrates tested

Number of treatment	Substrates	Composition
1	(Control)	60 % PE : 30 % VE : 10 % P
2	10 % SV	50 % PE : 10 % SV : 30 % VE : 10 % P
3	20 % SV	40 % PE : 20 % SV : 30 % VE : 10% P
4	30 % SV	30 % PE : 30 % SV : 30 % VE : 10% P
5	40 % SV	20 % PE : 40 % SV : 30 % VE : 10% P
6	50 % SV	10 % PE : 50 % SV : 30 % VE : 10% P
7	60 % SV	0 % PE : 60 % SV : 30 % VE : 10% P
8	10 % SBV	50 % PE : 10 % SBV: 30 % VE : 10% p
9	20 % SBV	40 % PE : 20 % SBV: 30 % VE : 10% p
10	30 % SBV	30 % PE : 30 % SBV: 30 % VE : 10% p
11	40 % SBV	20 % PE : 40 % SBV: 30 % VE : 10% p
12	50 % SBV	10 % PE : 50 % SBV: 30 % VE : 10% p
13	60 % SBV	0 % PE : 60 % SBV: 30 % VE : 10% p

SV: sawdust vermicompost; SBV: sugercan bagasse vermicompost; Control: (60 % peat: 30 % vermiculite: 10 % perlite)

Table 2 - Initial physic-chemical characteristics of Cow manure, Sugarcane bagasse and Sawdust wastes

Waste	(%) N	(%) P	(%) K	(%) OC	C:N ratio	(pH (1:5	(EC (dS|/m
PE	1.27	0.02	0.03	51.10	40.34	6.18	0.30
SV	1.47	0.40	1.15	24.02	16.42	7.20	2.46
SBV	1.67	0.46	0.83	21.34	12.81	8.19	01.04.14

SV: sawdust vermicompost; SBV: sugercan bagasse vermicompost; PE: peat; V; vermicompost;Control: (60 % peat: 30% vermiculite: 10 % perlite)

The Physical properties of the various treatments were determined following the procedures described by Gabriels et al., (1993). Samples of each medium were collected in beginning of plant cultivation. The fresh substrate transfer in increments of ± 100ml to the Buchner funnel (a nylon cloth is present on the bottom of the filter/funnel) without causing compaction and fill to the top, put the plastic ring on top and fill also. Cover the upper ring with a nylon cloth whilst saturating in the bucket. Transfer the whole system into a bucket which is already filled with water of 600±50c and flood some more until the level reaches up to a few mm under the top of the under ring. 10minute of saturation time later, remove the system carefully from the water bath and allow to drain for another 10 minute with gravity equilibration. Here the sample slumps to a lower volume. Remove the upper ring and with a sharp knife strike off the material level with the top of the Bucher funnel. Dry the outside of the funnel with absorbent tissue paper and weigh the Buchner funnel + drained substate (G1). Connect the Buchner funnel to the Buchner flask and apply suction to remove excess water. Dry with microwave in 11 minute and weigh again (G2). For determind % moisture and ash content of the substrate, 20 g fresh sample (G3) in the microwave for 10 minute and weigh(G4). 2 g (G5) of the dried material are ashed with a Bunsen burner for 24 minute in tared porcelain crucible (G6). Cool and weigh (G7). Weight of the Buchner funnel (G), volume of the Buchner funnel (V). Form this measurements, the bulk density, particle density, porosity, Air-fill porosity and Container capacity were calculated using the equations of Gabriels, et al., (1993) (table 3). All physical determinations were carried out in triple. The statistical signification of the results obtained was assessed by multiple ANOVA (F and Tokay's multiple range tests) with a probability level of 95 % (SAS Institute, 2001).

Table 3 - Equation used to determine the physical properties of treatment (adapted from Gabriels, et al., (1993)

Ash (%)	Ash=(G5×(G7-G6)/G5)×100
Organic material (%)	%OM=100-%Ash
Bulk density (g/cm^3)	Bd=(G2-G)/V
Particle density	Pd=1/(%organic matter/(100×1.55)+%ash/(100×2.65))[a]
Moisture on wet weight basis (%)	A=((G1-G2)/(G1-G))×100
Water capacity (%)	WC%=((A)/(100-A))×100
Container capacity (% volume)	CC%=((A×100)/(100-A))×100
Total porosity (% volume)	P=100×(1-(Bd/Pd))
Air-fill porosity (% volume)	AFP %=P- CC%

[a]1.55 and 2.65 are the average particle densities of soil organic and mineral matter, respectively.

RESULTS AND DISCUSSION

Bulk density increased with increasing amount of SV and SBV in the media as found in previous studies (Chen et al., 2002), but were not significantly different between the levels of SV and SBV (table 4). The porosity of substrates decreased with the SV and SBV addition. The comparison between physical properties results from the seven treatments of SV and SBV (table 4) showed that there were no significant differences in total porosity between them. Total porosity is the percentage of the container media volume, which is not occupied by solid media particles. The decreased of porosity with compost addition was also reported by several authors (Guerrero et al., 2002, Ingelmo et al.,1998) for peat and pine bark sewage sludge substrates. The porosity of horticultural substrates is higher than in pure soils where it only represents 50 % vol. or less (Argo, 1997). In general, substrates with peat have a pore volume of 85-95 % depending on particle size as well as on particle density (Michiels et al., 1993). Upon substitution of PE with SV and SBV, the bulk density of the substrates increased with the increasing proportions of vermicompost substituted for PE, and this led to gradual decreases in the total porosity, changed the pore space distribution within the substrates, and resulted in decreased Air-fill porosity, container capacity and Moisture Content (table 4). Where bulk density increases, the number of larger pores is reduced, and the forces of the roots necessary for deformation and displacement of substrate particles readily become limiting, and root elongation rates decrease (Taylor and Ratliff, 1969).

Table 4 - Main physical characteristics of substrates

Substrates	Total porosity (%)	Container capacity (%)	Moisture content (%)	Air-fill porosity (%)	Bulk Density (gr/cm^3)
(control)	ab 84.62	49.76b	ab 62.79	34.86a	b 0.100
SV 10%	ab 84.48	50.68b	a 63.31	33.80a	ab 0.137
SV 20%	ab 83.60	52.16ab	ad 60.93	31.44a	ab 0.157
SV 30%	ab 83.35	52.25ab	ad 58.10	31.35ab	ab 0.173
SV 40%	ab 82.97	52.60ab	ad 57.70	30.37ab	ab 0.175
SV 50%	b 82.53	52.85ab	ad 58.10	29.68ab	a 0.188
SV 60%	b 82.38	54.24a	cd 55.12	28.14ab	a 0.192
SBV 10%	85.77a	51.59b	a 63.01	34.18a	ab 0.128
SBV 20%	84.73ab	51.36b	ac 62.00	33.37a	ab 0.130
SBV 30%	83.75ab	49.76b	ad 58.30	33.97a	ab 0.158
SBV 40%	83.60ab	49.98b	ad 58.38	33.62a	ab 0.160
SBV 50%	83.14ab	50.86b	bd 55.43	32.28ab	ab 0.170
SBV 60%	82.65b	50.54b	d 54.66	32.11ab	0.181a

SV: sawdust vermicompost; SBV: sugercan bagasse vermicompost. Control: (60 % peat: 30 % vermiculite: 10 % perlite)

Means followed by the same letters do not significantly differ ($p \leq 0.05$).

The percentage Air-fill porosity treatment with the addition of SV or SBV, defined as the percentage by volume of air filled macrospores in saturated substrate (Beeson, 1996), Air-fill porosity is the percent volume of media or media component that is filled with air after the media has achieved container capacity or its maximum water holding capacity. Water and air content are the most important physical parameters of substrates (Edwards, 1998; Marfa et al., 1998). Water must be available in the substrate at the lowest possible energy status, but at the same time sufficient air in necessary in the root zone (De Boodt et al., 1974; Inbar et al., 1993). Accordingly, Verdonck and Gabriels (1992) proposed optimum physical properties for all ideal substrates for plant growth: container capacity between 55 % and 75 % and Air-fill porosity between 20 % and 30 %. The Air-fill porosity required for adequate gas exchange should constitute at least 15 %, but ideally it should be 20-35 % of the media volume depending on the plants (Kasica, 1997). In this experiment, SV or SBV treatments were obtained ideal range. Container capacity, also called water-holding capacity, decreased with increased addition of SV or SBV to the treatments. This may have been due to the fact that peat has the ability to absorb a greater amount of moisture than the vermicompost substitute (table 4). Container capacity is the percent volume of the media that is filled with water after an irrigated media has drained. Water retained by the media is likely to be in smaller pores or absorbed by the material itself, so not all of the actual water held by soilless media, as in the case of peat, will be available to the plant. According to Fonteno (1996), peat has about a 25 % volume of water that is unavailable water or water that the plant cannot use at a matric tension of 1.5 Mpa. Moisture content decreased with the addition of vermicompost to the media (table 4). The decrease is probably due to the same reason that peat absorbs a lot more moisture than vermicompost.

REFERENCE

1. Agrochemical methods of soil investigations under, Pub. A.V. Sokolov. Moscow. Science. 1975. 675 p.
2. Argo, W. R.1997. Transplant production and performance: media and physical properties. In: Proceeding of the Fifth National Symposium on Stand Establishment-Transplant Workshop. Ohio State University. Columbus. OH., P. 11-14.
3. Atiyeh, R. M., Subler, S., Edwards, C. A., Metzger. J. D. 1999. Growth of tomato plants in horticultural potting media amended with vermicompost // Pedobiologia. 43: 1-5.
4. Azizi, P., Khomami, A. M. and Mirsoheil. M.: 2008. Influence of cow manure vermicompost on growth of Dieffenbachia // Ecology Environment and Conservation. 14(1). P. 1-4.
5. Beeson Jr., R.C. 1996. Composted yard waste as a component of container substrates. Journal of Environmental Horticulture. 14: 115-121.
6. Bremner J. M. and Mulvaney C. S. 1982. Nitrogen total. In: Page, A. L., Miller R. H., Keeney D. R. (Eds). Methods of soil analysis: American Society of Agronomy, Madison, pp. 575-624.
7. Bunt, A. C. 1976. Modern potting Composts: A manual on the preparation and use of growing media for plants. Denn. State university Press. USA.
8. Chen, J., D.B. McConnell, C.A. Robinson, R.D. Caldwell, and Y. Huang. 2002. Production and interior performances of tropical ornamental foliage plants grown in container substrates amended with composts. Compost Science and Utilization 10:217-225.
9. De Boodt, M., Verdonck, O. and Cappaert, I. 1974. Method for measuring the water release curve of organic substrates. Acta Horticulture. 37: 2054-2062.
10. Edwards, C. A. Burrows, I. 1988. The potential of earthworm compost as plant growth media. In: Edwards, C. A. and Neuhauer, E. (Eds), Earthworms in Waste and Environmental Management. SPB Academic Press, The Hague, the Netherlands, pp. 21–32.
11. Edwards, C.A. 1998. The use of earthworms in the breakdown and management of organic wastes. In: Edwards, CA. (Ed.), Earthworm Ecology. CRC Press, Boca Raton, FL, pp. 327-354.

12. Fonteno, W. C., Cassel, D. K. and Larson, R. A. 1981. Physical properties of three container media and their effect on poinsettia growth. Journal of American Socieity Horticultural Science 106(6):736-741.

13. Gabriel, R., Keirsblulk, W. V., Engels, H .1993. A rapid method for the determination of physical properties of growing media. Acta Horticultur. 342: 243-247.

14. Guerrero, F., J. M. Gasco, and L. Hernandez-Apaolaza. 2002. Use of pine bark and sewage sludge compost as components of substrates for Pinus pinea and Cupressus arizonica production. Journal of Plant Nutrition. 25 (1).129-141.

15. Inbar, Y., Hadar, Y. And Chen, Y., 1993: Rrecycling of cattle manure: The composting process and characterization of maturity. Journal of Environmental Quality. 22, 857–863.

16. Ingelmo F, Canet R, Ibanez, M. A., Garcia P. J.1998. Use of MSW compost, dried sewage sludge and other wastes as partial substitutes for peat, Bioresource technology, 63(2), 123-129.

17. Kale, R. D., Bano, K., Krishnamoorthy, R. V. 1982.Potential of Perionyx excavatus for utilizing wastes. Pedobiologia. 23: 419 – 425.

18. Kasica, A. F.1997.Somthing to grow on- rooted in success:Media. New York: Cornell University. Cornell cooperative Extension. Department of Floriculture and Ornamental Horticulture. http://www.hortcornell. edu/department /faclty/good/ grown /media/ index.html.

19. Mammadov G.Sh., Social-economic and ecological bases of the rational use from Azerbaijan Soil Resources, Baku 2007, Science pub., 854 p.

20. Mammadova S.Z., Jafarov A.B., Fertility character of the Soil, //Baku 2005, 193 p.

21. Marfa, O., Tort, J. M., Olivella, C., Caceres, R., Martinez, F. X. 1998. Cattle manure compost as substrate. II. Conditioning and formulation of growing media for pot plants and bag cultures. In: Proceedings of the ISHS. International Symposium on Composting and Use of Composted 111aterial, 5-11 April 1997. Szmidt, Auchincruive, Scotland. Acta Horticulture. 469: 305-312.

22. Michiels, P., Hartmann, R., Coussenes, C. 1993. Physical properties of peat in an ebb/flood irrigation system. Acta Horticulture. 342: 205-219.

23. Movsumov Z.R., Mammadov G.M., Role of the mineral fertilizers in solution of the food problems, Materials of the Republic Conference, Baku 2002, p. 312-313

24. Muscolo, A., Bovalo, F., Gionfriddo, F., Nardi, S. 1999. Earthworm humic matter produces auxin-like effects on Daucus carota cell growth and nitrate metabolism. Soil Biology and Biochemistry. 31: 1303-1311.

25. Nelson, D. W. and Sommers, L. E. 1982. Total carbon and organic carbon and organic matter. In: Page A. L, Miller, R. H., Keeney D. R. (Eds.), Method of soil Analysis: American Society of Agronomy, Madison, pp. 539-579.

26. SAS Institute, 2001. SAS Procedures Guide, Version 8. SAS Institute, Cary.

27. Schmilewski, G. K. 1996. Horticultural use of peat. In: Lappalainen, E. (Ed.), Global Peat Resources. International Peat Society, Finland, pp. 327–334.

28. Senapathi, B. K. 1993. Vermitechnology in India. In: subba Rao, N.S., Balagopalan, c., Ramkrishna, S. V. (Eds.), New Trends in biotechnology Oxford and IBH, New Delhi, pp. 347-358.

29. Singer M. J. and Hanson, L. 1969. Lead accumulation in soils neat highways in the twin cities metro area. Soil Sconce Society American journal. 33: 152-153.

30. Taylor, H. M. and Ratliff, L. F. 1969. Root elongation rates of cotton and peanuts as a function of soil strength and soil water content. Soil Science. 108: 113-119.

31. Verdonck, O. and Gabriels, R. 1992. Reference method for the determination of physical and chemical properties of plant substrates. Acta Hort. 302: 169–179.