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Production And Utilization Of Aquatic Plant Compost

I. WILE, J. NEIL, G. LUMIS and J. POS

Scientist, Ontario Ministry of the Environment, Water Resources Branch, Box 213, Rexdale, Ontario, M9W 5L1; President, Limnos Ltd, 22 Roe Avenue, Toronto, Ontario, M5M 2H7; Assistant Professor, Department of Horticultural Science and Associate Professor, School of Engineering, University of Guelph, Guelph, Ontario, N1G 2W1.

ABSTRACT

Harvested aquatic plants, primarily Eurasian watermilfoil [*Myriophyllum spicatum* L.] in combination with several additives to reduce moisture levels and balance carbon-nitrogen ratios, were successfully composted in a high-rate aerobic composter in a period of 7 days. The aquatic plant composts were evaluated in greenhouse experiments using chrysanthemums [*Chrysanthemum morifolium* Ram. Bright Golden Ann], tomatoes [*Lycopersicon esculentum* Bailey var. vulgare Veebrite], muskmelon [*Cucumis melo* L. Burpee Hybrid], coleus cuttings [*Coleus blumei* Benth.], pentunias [*Petunia hybrida* Hort. Red Cascade and White Cascade], geraniums [*Pelargonium hortorum* Bailey Crimson Fire], white cedar [*Thuja occidentalis* L. Pyramidalis] and turf grasses, including, creeping red fescue [*Festuca rubra* L.], marion kentucky bluegrass [*Poa pratensis* L. Marion], perennial ryegrass [*Lolium perenne* L.]. In the experimental growth media where salt and pH levels were high, the sensitive test plants suffered initial setbacks. Following reduction of the salt levels through watering, the plants generally recovered and equalled the control plants grown in standard greenhouse media.

INTRODUCTION

In 1973 the Ontario Ministry of the Environment initiated an experimental aquatic plant harvesting program for the purpose of evaluating mechanical weed removal as a viable alternative to chemical control of nuisance species. An important consideration was the establishment of the environmental consequences of such large scale biomanipulations. Concurrent with these studies, detailed investigations into the potential uses of the harvested vegetation were undertaken both as a means of utilizing the vast quantities of plant material generated from harvesting and developing commercial products which could help to offset the high costs of mechanical weed control.

METHODS

The plant utilization studies were contracted to Limnos Ltd. with a major portion of the experimental work completed under subcontract by researchers from the University of Guelph.

The compost was prepared at the University of Guelph in a high rate composter. The composter is approximately 30 m long, 2.5 m wide, with 2 m high concrete slab walls. The blended mixture is processed through the composter by means of an inclined conveyor which is drawn through the material each day. After seven daily moves, the compost reaches the output and is ready for further drying and storage. Air for the composting process is supplied by a compressor through a series of perforated pipes which are buried in the gravel bottom of the composter. Due to the problems experienced in reducing the water content of the plants to acceptable levels for composting, several additives such as peanut shells, poultry litter, tobacco paunch manure compost and corn cobs were added in varying proportions to the aquatic plants. The additives used for the five experimental composts prepared in 1975 are detailed in Table 1.

Evaluations of the aquatic plant composts as growth media were completed in the University of Guelph greenhouses using chrysanthemums, vegetables (tomato and melon), coleus cuttings, white cedar and turf grasses. Control plants were grown in standard greenhouse mixtures of soil (sandy loam), peat moss and perlite. Test plants were grown in the same formulations of soil and perlite with equivalent amounts of aquatic plant compost replacing the peat moss in the mixtures.

RESULTS AND DISCUSSION

Aquatic Plant Composting Studies

Since composting is a biological process, the primary fac-

TABLE 1. COMPONENTS OF THE DIFFERENT COMPOSTING MIXTURES (1975).

Mixture No.	Components	Amount % (by weight)
1	Air-Dried Aquatic Plants	78
	Wet Pondweed	9
	Peanut Shells	6
	Poultry Litter	7
2	Unchopped Aquatic Plants	83
	Peanut Shells	12
	Composted Material from Mixture No. 1	5
3	Chopped Aquatic Plants	80
	Peanut Shells	13
	Composted Material from Mixture No. 2	7
4	Chopped Aquatic Plants	62
	Peanut Shells	10
	Poultry Litter	7
	Tobacco Paunch Manure Compost	21
5	Chopped Aquatic Plants	68
	Ground Corn Cobs	27
	Peanut Shells	5

tors governing microbial activity; namely, moisture content, carbon-nitrogen ratio, pH, phosphorus and potassium content are important. Chemical analyses of the aquatic plants indicated that they were suitable for composting provided the high moisture content of 80 to 90% (by weight) could be reduced to about 65%.

Preliminary composting trials were carried out in 1974 using various additives such as garbage, poultry litter, or straw to reduce the moisture content of the aquatic plants. A compost produced from a mixture containing 25% (by volume) poultry litter was considered the most promising and was used in several greenhouse trials (1). This compost was found to contain extremely high salt levels with values in excess of 500 x 10^{-5} mhos, well above the 150 x 10^{-5} mhos/cm considered as acceptable for standard greenhouse use. The extremely high salt level was attributed to the high content of poultry litter in the initial composting mixture.

In 1975 composting experiments were continued using alternative additives such as corn cobs and peanut hulls to dilute the moisture content of the aquatic plants (Table 1). Eurasian milfoil was the predominant aquatic plant used for these experiments. Its low C/N ratio of 5.8 indicated that the addition of extra carbon (ie. peanut hulls) to absorb the excess moisture would be beneficial to the composting process.

Chemical analyses for the raw materials used in the composting process and the mixed materials prior to composting are provided in Table 2. Values for the finished compost mixtures are presented in Table 3. The nitrogen content increased during the composting process by approximately 45%; phosphorus values declined slightly while potassium levels were similar or slightly higher than in the mixed materials prior to composting. Significant volumetric reductions were observed during the seven day composting process both in 1974 and 1975. Raw material volumes of 2.2 m^3 yielded about 0.9 m^3 of finished material, indicating a 60% volumetric reduction. The finished material was moist and dark in colour with a few remnants of the peanut hulls in evidence.

Evaluations of the aquatic plant composts as growth media

Aquatic plant composts 1, 2, 3 and 4 were selected for greenhouse evaluations to establish their usefulness as a substitute for peat moss in standard greenhouse practise. Tests were performed with a wide range of common greenhouse plants including vegetables, flowering and woody plants as well as turf grasses.

Data on the growth of chrysanthemums in soil mixtures containing aquatic plant compost are summarized in Table 4. For comparative purposes two different watering treatments, namely, standard top hand watering and capillary mat were used during the experiment. Plants grown in the compost mixes and watered by capillary mat were generally less satisfactory than plants grown in peat moss medium due to the coarser texture of the compost medium. Although the plants watered by this technique were larger than the top watered plants, they were extremely fragile and fragmented readily even with minimal handling. Within the top watered group, compost 4 produced plants and flowers which were superior to those grown in the remaining compost mixes and the peat moss. Based on this experiment it is evident that the compost is a suitable substitute for peat moss in the production of chrysanthemums by conventional top watering techniques. Undoubtedly a finer textured compost would be equally suitable for a capillary watering production system.

In a second experiment, aquatic plant composts were compared to peat moss as the organic components of a soil mix for vegetable production. Germination of tomatoes and

TABLE 2. CHEMICAL ANALYSIS OF RAW MATERIALS.

Materials	N %	P %	K %	Ca %	Mg %	Mn ppm	Zn ppm	B ppm	Cu ppm
Tobacco Dust	1.60	0.32	8.05	1.66	0.41	316	61	95	34
Tobacco Stems & Dust	1.85	0.24	3.43	3.59	0.66	77	50	40	38
Paunch Manure	1.70	0.62	0.15	1.36	0.15	41	74	20	14
Peanut Shells	2.20	0.20	1.97	0.55	0.32	93	46	45	14
Poultry Litter	4.20	1.90	2.84	2.89	0.88	361	409	45	44
Corn Cobs	0.40	0.10	0.71	0.71	0.11	29	39	5	5
Wheat Straw	0.40	0.22	1.67	0.42	0.13	12	25	4	3
Milfoil (Air Dried)	1.15	0.12	1.35	19.40	0.30	58	16	20	3
Milfoil (Fresh)	2.30	0.24	1.84	4.50	0.34	207	25	37	17
Milfoil (Squeezed Slightly)	2.70	0.25	1.80	4.33	0.41	247	95	37	18
Milfoil (Squeezed Firmly)	2.40	0.25	1.68	5.62	0.37	245	52	35	5
Mixed Materials Before Composting (#1)	1.55	0.36	1.38	17.10	0.40	75	3	17	3

TABLE 3. CHEMICAL ANALYSIS OF COMPOSTED MIXTURES.

Mixture	N %	P %	K %	Ca %	Mg %	Mn ppm	Zn ppm	B ppm	Cu ppm
No. 1	2.40	.22	1.51	6.99	.40	187	20	25	4
No. 2	2.20	.22	1.69	5.29	.47	282	23	65	6
No. 3	2.30	.24	1.82	4.99	.43	241	19	50	13
No. 4	2.10	.21	1.60	4.98	.49	263	46	60	9
No. 5	2.25	.23	1.66	7.25	.41	160	32	43	5

TABLE 4. INFLUENCE OF COMPOST AND PEAT MEDIA ON THE GROWTH OF CHRYSANTHEMUMS.

Medium[a]	Height (cm)	Dry Wt. (g)	Stem Dia. (mm)	Flower Dia. (cm)	Root Growth Rating[b]	Days to Maturity
			Top Watered			
Soil/Compost 1/Perlite	15.7 d	3.4 d	4.8 e	13.0 d	1.8 c	68.8 c
Soil/Compost 2/Perlite	15.3 d	3.4 d	4.9 e	13.0 d	1.9 c	68.6 c
Soil/Compost 3/Perlite	18.2 c	4.2 bc	5.2 de	13.7 c	2.1 c	69.5 c
Soil/Compost 4/Perlite	20.9 b	4.7 b	5.5 cd	13.8 c	2.2 c	68.0 c
Soil/Peat/Perlite	18.0 c	3.9 cd	5.1 de	13.2 d	2.0 c	68.0 c
			Capillary Mat Watered			
Soil/Compost 1/Perlite	21.6 b	4.6 bc	5.8 bc	14.7 b	3.4 a	75.0 b
Soil/Compost 2/Perlite	21.5 b	4.5 bc	5.9 bc	14.9 ab	3.4 a	73.6 b
Soil/Compost 3/Perlite	21.5 b	4.5 bc	6.0 b	14.8 ab	3.0 b	78.3 a
Soil/Compost 4/Perlite	21.4 b	4.2 bc	5.9 bc	14.6 b	3.6 a	73.6 b
Soil/Peat/Perlite	28.2 a	7.9 a	6.9 a	15.1 a	3.6 a	74.5 b

[a] Growing media consisted of equal parts by volume of soil, compost or peat and perlite.
[b] Value of 1 indicates limited rooting while 4 indicates extensive rooting.
[c] Mean separation in columns by Duncan's multiple range test, 5%. Values followed by the same letters are not significantly different.

melon was significantly higher in mixes containing aquatic plant compost 2 weeks after seeding (Table 5). However, no differences were observed between the growth of the plants in any of the growth media one month following seeding. It is apparent that while the compost was distinctly beneficial for germination, it was similar to peat moss with regard to growth following germination.

TABLE 5. INFLUENCE OF COMPOST AND PEAT MEDIA ON THE GERMINATION OF TOMATO AND MELON.

Medium	Tomato Germination	Melon Germination
Soil/Compost 1/Perlite	70.3 a	50.0 a
Soil/Compost 2/Perlite	65.6 a	51.6 ab
Soil/Compost 3/Perlite	79.7 a	75.0 a
Soil/Compost 4/Perlite	68.8 a	48.4 c
Soil/Peat/Perlite	32.8 b	25.0 c

Mean separation by Duncan's multiple range test, 5%. Values followed by the same letters are not significantly different.

The suitability of aquatic plant composts as a rooting medium for coleus cuttings was compared to standard peat moss mixes. Root growth and quality were generally similar for all treatments, indicating that the composts were as effective as peat moss for coleus propagation (Table 6). Compost 4, however, caused some inhibition of root growth with subsequent stem death.

TABLE 6. INFLUENCE OF COMPOST AND PEAT MEDIA ON THE ROOTING OF COLEUS STEM CUTTINGS.

Medium	Root Rating[a]
Soil/Compost 1/Perlite	3.3 a
Soil/Compost 2/Perlite	3.2 a
Soil/Compost 3/Perlite	2.4 b
Soil/Compost 4/Perlite	1.7 c
Soil/Peat/Perlite	2.7 ab

[a] A value of 1 indicates inhibition of rooting and basal stem injury while a value of 4 indicates extensive rooting.
[b] Mean separation by Duncan's multiple range test, 5%. Values followed by the same letters are not significantly different.

Cuttings of white cedar were planted in pots containing equal quantities of sand and peat or sand and compost. The compost portion contained equal quantities (by weight) of composts 1, 2, 3 and 4. Following a 6-month growth period, the root systems of plants grown in both media were similar in weight (Table 7), although the roots of the plants from the control mixture were more variable, possibly as a result of poorer aeration in the finer textured sand-peat moss substrate. Top growth in the control medium was superior to that in the compost mixture due to the elevated soluble salt content of the compost (Table 8). These results suggest that aquatic plant compost is not a suitable substitute for peat moss in container mixes for white cedar unless the soluble salt levels can be reduced prior to potting.

The use of composted macrophytes as a soil amendment for the establishment of turfgrasses, particularly on relatively low fertility soils was evaluated in the greenhouse

TABLE 7. INFLUENCE OF COMPOST AND PEAT MEDIA ON ROOT AND SHOOT GROWTH OF WHITE CEDAR.

Medium	Root Dry Wt. (g)	Shoot Dry Wt. (g)
Peat-Sand	4.0 a	7.0 a
Compost-Sand	4.2 a	5.4 b

Mean separation by Duncan's multiple range test, 5%. Values followed by the same letters are not significantly different.

TABLE 8. MEDIA ANALYSES FOR WHITE CEDAR CUTTINGS.

	pH	Total Salts (mhos x 10^{-5})
Peat-Sand		
May	6.6	70
August	7.2	28
November	7.5	14
Compost-Sand		
May	9.1	220
August	7.7	60
November	7.5	19

using four types of grasses, (perennial ryegrass, red top, creeping red fescue and marion kentucky bluegrass). The grasses were grown in flats containing mixtures of soil (sandy loam) and composts (1 to 4) in a 4:1 proportion by volume; soil, sand and compost (1) in a 1:3:1 ratio by volume and in unamended soil. No fertilizer was added throughout the experiment in order to assess the influence of nutrients contained in the compost. Eight weeks after seeding, grasses in the unamended soil were chlorotic, probably due to nitrogen deficiency, and considerably shorter than grasses growing on the compost mixes. These results indicate that the compost was of distinct benefit to the growth of these turfgrasses and would be useful for grass establishment on low fertility soils such as excavated rights of way.

As a final method of evaluating the usefulness of aquatic plant compost, a commercial bedding plant grower was asked to compare a mixture containing equal quantities of soil, compost 4 and peat to his normal medium of Promix B. Geranium cuttings and petunia seedlings planted in the two mixtures were fertilized weekly while in the greenhouse, but not after being set outdoors for sale purposes. Geraniums grown in the compost mixture had fewer flowers and roots than the plants grown in Promix B. Soil tests showed toxic levels of total salts and a pH of 9.2 in the medium. Petunia transplants were initially smaller and chlorotic in the compost, again due to elevated salt levels. However, within one month after planting, they recovered and were similar to plants grown in the standard media. By early June, the petunias in the compost mixture were larger with darker green foliage, indicating that the compost was supplying additional nutrients, particularly nitrogen. This would be an important benefit to plants on display for sale purposes once the fertilization program of the commercial greenhouse is no longer practiced. The results of this study again suggest that if salt and pH levels can be reduced, compost-amended media would be superior to currently used commercial mixes such as Promix B.

Studies to date have demonstrated that a suitable compost can be produced from aquatic plants and that where problems have been noted, practical means of resolving them are possible. For example, the texture of the composted material can be altered by introducing a shredding or screening step into the process. Similarily, the high salt levels and pH values may be altered by further experimentation with raw materials, such as wastepaper, which might be used in the composting process.

Greenhouse experiments effectively demonstrated the value of the compost as a growth medium component. Results of these studies indicate that if pH values and salt levels can be reduced, the aquatic plant composts would be equal to or superior to existing commercial products.

Further studies are now underway to resolve the remaining problems as well as to determine the best methods for processing, outputs, marketing, and packaging as well as the cost-benefits for a commercial composting operation which would supply the home garden and greenhouse trades.

LITERATURE CITED

1. Wile, I. and J. Neil. 1975. Harvesting and potential uses of aquatic plants. 50th Anniv. Meeting A.S.A.E. Cornell University, Ithaca, N.Y.