Growth of Three Bedding Plant Species in Soilless Mixes With Alkaline Stabilized Sewage Sludge[1]

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Abstract

Three bedding plant species ('Cooler Grape' Vinca (*Vinca rosea* L.), 'Roc Mix' Pansy (*Viola* x *Wittrochiana* Gams.), and 'Impulse Red' Impatiens (*Impatiens Wallerana* Hook.f.) were grown in soilless mixes: aged N-Viro Soil from the City of Toledo, OH, aged N-Viro Soil blended with sphagnum peat (N-Viro Soil:peat, 3:1 by vol), BioBlend (composted leaf yard waste:N-Viro Soil, 2:1 by vol), and Sunshine Mix LC1. The N-Viro Soil-based media were high in pH (8.3–8.9), soluble salts (3.2–9.6 dS/m) and exchangeable Ca, Mg and K, compared to Sunshine mix. Total porosity was lower in the N-Viro Soil media (62 to 74%) compared to Sunshine (90%), while available water holding capacities were higher in Sunshine mix and N-Viro Soil-peat (7.4 and 7.6% H_2O by volume, respectively) than in aged N-Viro Soil and BioBlend (5.4 and 5.9% H_2O by volume, respectively). Differences among the media in growth index of impatiens were significant ($p = 0.054$) . This reflected the low index for aged N-Viro Soil compared to the other three media. Pansy growth index differences among the media were significant ($p = 0.031$), with the aged N-Viro Soil and BioBlend indices being significantly lower than that of Sunshine mix. There were no significant differences in vinca growth index. There were no significant differences in top growth weights among the four soil media for all three species. The results suggest that aged N-Viro Soil can be blended with peat or fresh N-Viro Soil can be composted with yard waste to produce soilless plant growth media that are comparable in performance to commercial peat-based mixes.

Index words: sewage sludge, impatiens, vinca, pansy, growth media, fertility, physical properties.

Species used in this study: 'Cooler Grape' Vinca (*Vinca rosea* L.), 'Roc Mix' Pansy (*Viola Wittrochiana* Gams.), and 'Impulse Red' Impatiens (*Impatiens Wallerana* Hook.f.).

Significance to the Nursery Industry

Soilless media are significant components of container-grown greenhouse and nursery crops. A number of recyclable waste organic materials like advanced stabilized sewage sludge and composts are becoming increasingly available in the U.S. While many of these materials have been used as soil amendments, there is the potential to blend them with traditional nursery media, such as peat, for commercial greenhouse crop production. Because of the pasteurization processes used to stabilize sewage sludge (N-Viro and composting), and effective industrial pretreatment, concerns about odor, pathogens and heavy metals in sewage sludge are minimized or eliminated. The economics of using these materials is positive because the costs of their production and marketing are heavily subsidized by the wastewater utilities. This study shows that combinations of media with N-Viro soil could be used as alternative media for greenhouse production of three annual species.

Introduction

N-Viro Soil is a soil-like product resulting from the N-Viro process for advanced alkaline stabilization of municipal sewage sludge (5). This product has excellent physical properties for plant growth and is used as a soil amendment to improve the physical properties of degraded soils (7). Studies have shown that N-Viro Soil can be used as a growth medium amendment for horticultural crop production. In a greenhouse pot study, Goodale et al. (2) grew impatiens (*Impatiens Wallerana* Hook.f.) in mineral soil amended with 5 to 25% N-Viro Soil by volume. Maximum top growth was measured with the 5% amendment. In another greenhouse study, Logan and Bargar (4) grew bluegrass (*Poa pratensis* L.), chewings fine fescue (*Festuca rubra* L.), and bermudagrass (*Cynodon dactylon* (L.) Pers.) in sandy and clay loam soils, each amended with 50 and 100 t/ha (25 and 50 tons/acre) N-Viro Soil. The same species were also grown in blends composed of 75% by volume yard waste compost (YWC), 20% N-Viro Soil and 5% mineral soil (either the sandy or clay loam soils). Equivalent mixtures were made with sewage sludge compost instead of YWC. The N-Viro Soil amendments (50 and 100 t/ha treatments) increased growth of all three grasses on both soils compared to the fertilized control, particularly on the sandy soil. The YWC-N-Viro Soil blends produced plant growth similar to that of the unamended soils, but the sludge composts reduced growth, presumably because of ammonia release from the sludge compost. In a companion field study, Logan and Bargar (4) found that bluegrass growth was tripled, compared to a fertilized control, with the addition of 100 t/ha (50 tons/acre) N-Viro Soil to a mineral soil. A blend of 3:1 (by vol) of YWC and N-Viro Soil also tripled growth compared to the unamended soil. In a follow-up study, N-Viro Soil was blended with three mineral soils (loamy sand, calcareous clay and a silt loam) at volumetric ratios ranging from 1:99 to 80:20 mineral soil:N-Viro Soil (6). Growth of KY 31 Kentucky tall fescue (*Festuca arundica*) was best with the 60:40 and 80:20 ratios.

Fresh N-Viro Soil has characteristics that are inhibitory to seed germination and seedling growth: very high pH, high soluble salts, free ammonia and volatile fatty acids. However, Logan et al. (8, 9) showed that aging N-Viro Soil for up to six months lowered pH, reduced soluble salts, eliminated free ammonia and reduced volatile fatty acids. Perennial ryegrass (*Lolium perenne*) germination was uninhibited in six-month old material.

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There have been no reports on the use of aged N-Viro Soil, or fresh N-Viro Soil blended with other media, for horticultural crop production. Thus, the objective of this study was to evaluate the potential use of N-Viro Soil, alone or in combination with other materials, as substitutes for commercial soilless media in greenhouse production of annual horticultural species.

Materials and Methods

Potting media evaluated were aged N-Viro Soil from the City of Toledo, Ohio (8, 9), aged N-Viro Soil blended with sphagnum peat (N-Viro Soil:peat, 3:1 by vol), BioBlend (composted leaf yard waste:N-Viro Soil, 2:1 by vol) (1), and Sunshine Mix LC1 (Sun Gro Horticulture, Inc., Bellevue, WA), as a control. Materials were characterized for selected chemical properties at the Research Extension Analytical Laboratory, Ohio Agric. Res. & Dev. Center (OARDC), Wooster, using standard methods (11). Tests included pH in water (1:5 by vol, solid:H_2O), electrical conductivity (1:5 by vol, solid:H_2O), Bray P1 extractable P, water soluble nitrate-N, and exchangeable Ca, Mg and K. The materials were also characterized in our laboratory for: solids content (oven drying at 105 C), bulk density (packed core), particle density (water-filled pychnometer), total porosity (by calculation with bulk and particle densities), and moisture content at 0, –5.9 kPa, –33 kPa and –1500 kPa matric potentials (pressure plate), using standard methods (3).

The materials were placed in 10 cm (4 in) diameter plastic pots in the greenhouse on April 10, 1995. There were five replications per treatment. Three species were transplanted from 3 cm dia. plugs: 'Cooler Grape' Vinca (*Vinca rosea*), 'Roc Mix' Pansy (*Viola Wittrochiana*), and 'Impulse Red' Impatiens (*Impatiens Wallerana*). This gave a total of 12 treatments (4 growth media × 3 species). Pots were assigned at random to the greenhouse bench, and the experimental design was considered to be a completely randomized block with replication. Pots were watered by hand as needed with tap water, and received a uniform weekly application of Peters 20N–16.6P–8.6K (20–20–20) soluble fertilizer. Natural sunlight was the primary source of illumination in the greenhouse. Ambient greenhouse temperatures were in the range of 15 to 25C (59 to 77F). Growth index (maximum plant height above soil surface x maximum plant diameter) was measured on May 10, 1995 (30 days after transplanting), and plants were harvested by cutting shoots at the ground surface; plants were oven dried and weighed.

Analysis of variance was made on the growth index and shoot weight data using SYSTAT for PC and the GLM routine.

Table 1. Chemical analysis of the growth media.

Media	pH	EC	Bray P1-P	Exchangeable Ca	Exchangeable Mg	Exchangeable K	NO_3-N
		dS/m	kg/ha				
Sunshine	5.4	1.6	80	232	178	28	182
Aged NVS	8.3	6.1	4	17,300	5,170	485	860
NVS-Peat	8.9	9.6	6	15,570	5,165	381	955
BioBlend	8.3	3.2	20	16,450	1,275	1,186	25

Results and Discussion

While Sunshine mix had an acid pH characteristic of peat (Table 1), the N-Viro Soil-based media all had pHs of 8.3 or higher; the equilibrium pH of $CaCO_3$ is 8.2. Aged N-Viro Soil contains about 50% $CaCO_3$, and is likely to buffer the pH of any blend in which it is a significant component at this pH. In previous horticultural studies (2, 4, 6), pHs of the soil or compost mixes were all in the range of 7.8 to 8.3. ECs were much higher in the N-Viro Soil mixes than in Sunshine mix, with the aged N-Viro Soil and the N-Viro Soil-peat mixes exhibiting potentially phytotoxic EC values (Table 1). While this has been shown in previous studies to be a problem for seed germination (4, 6), we did not know if the high soluble salts would affect transplants. Available P was high in Sunshine mix, adequate in BioBlend and low in N-Viro Soil and N-Viro Soil-peat (Table 1). These results are somewhat misleading because the Bray P1 test is not appropriate for highly calcareous soils; the reported values underestimate actual P availability. All N-Viro Soil materials were very high in exchangeable Ca, Mg and K (Table 1); the high K levels in the BioBlend are from the leaf yard waste. Nitrate levels were high in all media except BioBlend (Table 1), where the C:N ratio was still high enough (~30:1) to cause some N immobilization (1).

The four growth media had similar solid contents (Table 2). Bulk densities of the N-Viro Soil media were six times greater than that of Sunshine mix, primarily because of the higher non-organic content of the N-Viro Soil which gave the media much higher particle densities. Total porosities of all N-Viro Soil media were high (as calculated from bulk and particle densities, and from saturated moisture content) but lower than that of Sunshine mix. Porosity reflected the content of organic matter of the media which is higher in Sunshine mix than in the N-Viro Soil media. The N-Viro Soil and N-Viro Soil-peat media had higher moisture retention at –5.9 kPa and –33 kPa matric potentials, reflecting the high degree of structure of this material and the high

Table 2. Physical properties of the growth media

Media	Solids fraction	Bulk density (g/cm³)	Particle density (g/cm³)	Total porosity (% by vol)	Moisture content: Saturation (% by vol)	Moisture content: 5.9 kPa (% by vol)	Moisture content: 33 kPa (% by vol)	Moisture content: 1500 kPa (% by vol)
Sunshine	0.54 (0.006)[z]	0.08 (0.003)	0.78 (0.11)	0.90	70.3 (1.97)	25.9 (1.40)	20.3 (0.98)	18.5 (1.30)
Aged NVS	0.64 (0.006)	0.61 (0.015)	1.59 (0.00)	0.62	66.8 (4.00)	38.6 (1.03)	33.6 (0.91)	33.2 (2.02)
NVS-Peat	0.56 (0.002)	0.47 (0.021)	1.60 (0.02)	0.71	72.3 (1.06)	38.8 (1.58)	36.5 (1.56)	31.2 (0.66)
BioBlend	0.60 (0.008)	0.43 (0.022)	1.65 (0.01)	0.74	57.0 (2.08)	29.7 (1.45)	28.3 (1.47)	23.8 (0.16)

[z]Standard deviation.

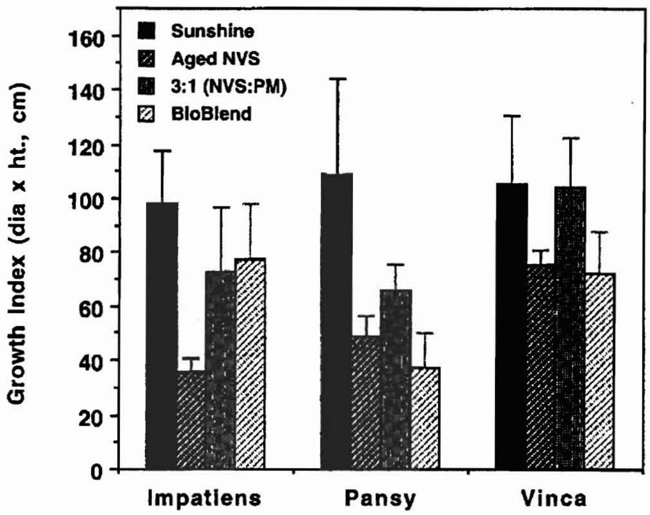

Fig. 1. **Growth index (diameter times height) of 3 annuals grown on 4 artificial soil media.**

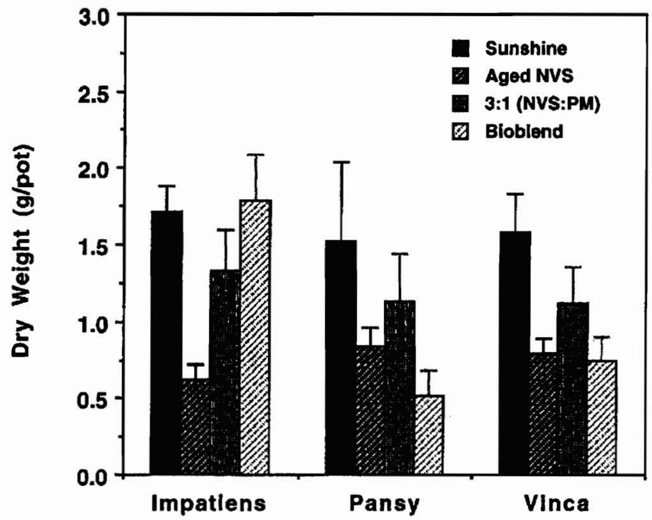

Fig. 2. **Shoot growth (biomass weight) of 3 annuals grown on 4 artificial soil media.**

percentage of small pores (7). Available water holding capacity, calculated as the difference between moisture retention at –5.9 kPa and –1500 kPa, was highest in Sunshine mix and N-Viro Soil-peat (7.4 and 7.6 % H_2O by volume, respectively) and lowest in aged N-Viro Soil and BioBlend (5.4 and 5.9 % H_2O by volume, respectively). The physical properties of the media provide a balance between the seemingly conflicting needs of greenhouse growth media: pore space for expanding root volume and water supply (10).

Growth index varied considerably for the three species (Fig. 1). Differences among the media in growth index of impatiens were significant ($p = 0.054$) . This reflected the low value for aged N-Viro Soil compared to the other three media (Fig. 1). Pansy growth index differences among the media were significant ($p = 0.031$), with the aged N-Viro Soil and BioBlend values being significantly lower than that of Sunshine mix (Fig. 1). There were no significant differences in vinca growth index.

Top growth biomass (Fig. 2) showed similar treatment trends to that of the growth index. Aged N-Viro Soil impatiens top growth was significantly lower than that of the other three mixes ($p = 0.063$ for media). Pansy top growth was highest in Sunshine mix, but only significantly so with respect to BioBlend ($p = 0.09$ for media). Vinca responded similarly to pansy, but the differences were not significant.

The aged N-Viro Soil-peat blend was the only mix that gave growth that was comparable to Sunshine mix for all three species. Visual inspection of the plants showed that plant quality excluding size (leaf color, number and size of blooms; data not shown) was similar for the four treatments.

This study suggests that N-Viro Soil, a processed sewage sludge material with soil-like properties can be aged and blended with other materials like peat to produce a soilless growth media that is comparable to commercial materials like Sunshine mix. Aging is necessary to reduce growth inhibiting factors that include free NH_3, high soluble salts, high pH, and free fatty acids (8, 9). Soil physical properties appeared to be adequate for the requirements of small-pot nursery production, particularly BioBlend and the N-Viro Soil-peat mix. Increasing the ratio of peat to N-Viro Soil might produce a better mix, and the cost of N-Viro Soil is sufficiently lower than that of peat to make any substitution in growth media economically attractive.

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