the effectiveness of fungicides for protection.

The methods described by Lacicowa (5) were essentially followed. Gerbera seeds were placed on petri dishes containing malt agar. All fungi growing from the seeds were transferred to PDA medium and identified. Isolations were made from different sources of seeds over a 3-year period.

Botrytis cinera cultures isolated from seeds were further used for pathogenicity tests. Ten surface-sterilized seeds were plated on sterilized petri dishes containing 5 layers of filter paper. Each seed was inoculated with 1 ml sterilized distilled water containing 600 conidia. Control plates were treated with 10 ml of sterilized distilled water only. Treatments were replicated 5 times. Plates were incubated at 22 ± 1°C. Seeds were checked for germination at the end of 5 days. Disease observations, rated as to the degree of severity were made after 10 days.

Two fungicides were evaluated: methyl 1-butylcarbamoyl-2 benzimidazole carbamate (Benlate) at 0.025, 0.05 and 0.1% and tetramethyl thiram disulfide (Thiram) at 0.1, 0.2 and 0.3%. We dipped 200 seeds in each fungicide suspension for 1, 5 and 10 min. After chemical treatments, seeds were plated on petri dishes containing 10 layers of filter paper and 15 ml of distilled water. Four replications were used. The plates were incubated at 22 ± 1°C. Germination and Botrytis infection were evaluated after 5 days.

The results obtained over 3 years of isolations indicated that about 7, 6 and 9 of gerbera seeds were infected with *Botrytis cinerea* (Table 1). Since 100 of each seed were examined each year, this amounts to an average of 7% Botrytis infection. The fungus did not inhibit seed germination (Table 2) but adversely affected the growth of the young seedlings. The mortality rate of inoculated seedlings was 89.5%. The pathogen caused post-germination damage to roots and/or cotyledons. Infected seedlings died within a few days. Therefore, we assume that seeds not treated with fungicides can be associated with the spread of gray mold fungus on germinating seedlings, as our results have indicated. In the actual production of gerbera, seeds are grown under 20 – 24°C and 70% relative humidity or more, and this provides optimum environmental conditions for germination as well as Botrytis infection.

Table 1. Isolation of fungi from commercial gerbera seeds.

Year[z]	All fungus[y] isolates (colonies)	*Botrytis cinerea* isolates No.	%	No. of seeds contaminated with *Botrytis cinerea*
1970	93	9	9.7	7
1971	114	16	14.0	6
1972	109	11	10.0	9

[z]3 lots each year.
[y]mean of 100 seeds.

Table 2. Effect of *Botrytis cinerea* infection on germination and growth of gerbera seedlings.

Seed treatment	Germination (%)	Seedling mortality (%)
Noninoculated	80a[z]	5.0a
Inoculated	78a	89.5b

[z]Mean separation in columns by Duncan multiple range test, 1% level.

Thiram and Benlate dips gave satisfactory control of Botrytis infection on gerbera seedlings, although complete control on all treatments was not found. Benlate seemed to give better results than Thiram, however statistical analysis did not give significantly better results with Benlate than Thiram (Table 3). Benlate at 0.1% gave also no more protection than Benlate at 0.05 or 0.025% in terms of significant differences. Therefore, Benlate (0.025 – 1%) as well as Thiram (0.1 – 3%) can be used as effectively to protect gerbera seeds from Botrytis.

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Table 3. Effect of chemical dips on germination and seedling infection of gerbera.[z]

Fungicides	Concn (%)	Germination[y] 1 min	5 min	10 min	Avg infected seedlings
Control		178a	188a	182a	12a
Benlate	0.025	182a	182a	186a	2b
	0.050	184a	186a	182a	2b
	0.100	185a	181a	187a	0b
Thiram	0.1	188a	191a	193a	4b
	0.2	184a	185a	184a	2b
	0.3	189a	189a	189a	2b

[z]Mean separation in columns by Duncan's multiple range test, 5% level.
[y]From 200 seeds.

A Nutritional Disorder of Red Oak Seedlings[1]

P. Fenn and R. D. Durbin[2]
University of Wisconsin, Madison

Abstract. **Seedlings of red oak (*Quercus rubra* L.) grown in various planting media without nutritional supplements developed marginal necrosis and puckering on their first whorl of leaves. These symptoms were prevented by supplying Ca++ to seedlings growing in a vermiculite-peatmoss mixture. An exogenous supply of Ca++ was also required for initial growth in silica sand.**

The initial growth of red oak seedlings is thought to depend largely on cotyledonary reserves thus making them essentially independent of the external nutritional environment (4, 5). However we have observed a nutritional disorder in the early development of red oak seedlings grown in various planting media. The abnormality was first noticed on seedlings grown in a crossed gradient controlled environment room (University of Wisconsin Biotron) where 16 light and temperature environments were simultaneously maintained. Temperature ranged from 17 – 30°C

[1]Received for publication September 8, 1973.

[2]Research Assistant, Professor and Laboratory Leader, respectively, Department of Plant Pathology, University of Wisconsin and Agricultural Research Service, U.S. Department of Agriculture, Madison, Wisconsin.

and light intensity from 0.4 – 1.3 klx (15-hr photoperiod).

Stratified acorns were planted in a mixture of 1 vermiculite: 1 peatmoss having a pH of 4.7 (7). The seedlings were watered daily with tap water. As leaf expansion occurred, the bristles and adjacent tissues at the tips of the midrib and lateral veins became dry and necrotic. A marginal necrosis developed from these loci and, as leaf expansion continued, afflicted leaves curled and puckered and did not expand to full size (Fig. 1). Although seedlings at all light-temperature combinations showed these symptoms, those at the higher light intensities were most severely affected. A second planting of seedlings grown in the controlled-environment room in the same planting medium but watered with Hoagland's solution (3) from the time of planting developed normal foliage.

Seedlings grown in the greenhouse in flats containing vermiculite, the vermiculite-peatmoss mixture, or masonry sand, with no nutritional supplement developed symptoms identical to those observed in the controlled environment facility. In contrast, seedlings grown in clay loam soil or the various planting media and watered with Hoagland's solution either from the time of planting or with a preemergence application of 8 g per flat of fertilizer 10–4.3–8.3 (N–P–K) did not develop symptoms. Hoagland's micronutrient solution alone was ineffective in preventing the symptoms.

Seedlings grown in the vermiculite-peatmoss mixture and watered with glass-distilled water developed more severe symptoms than those given tap water. This suggested that the disorder was not caused by the pH or salinity of the tap water. Furthermore, when EDTA (5×10^{-5} M) in tap or glass-distilled water was supplied to remove metal ions that may have been in toxic levels (2), symptoms were even more severe. They were, however, totally prevented by watering with $CaCl_2$ (6 mM) in either glass-distilled or tap water. Tap water was found to contain 69 ppm Ca.

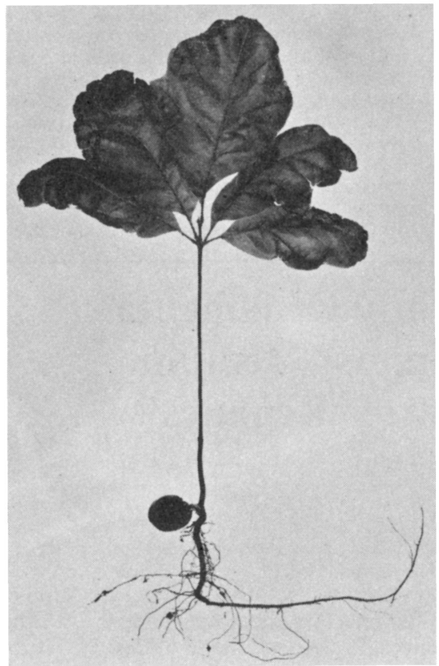

Fig. 1. **Marginal necrosis and puckering on first whorl leaves of a 24-day-old red oak seedling grown in vermiculite-peatmoss and watered with tap water, grown at 30°C and 1.3 klx.**

In parallel trials using acid-washed silica sand, seedlings developed normal leaves when given tap water with or without $CaCl_2$ (6 mM) or EDTA (5×10^{-5} M). When acorns germinating in silica sand were watered with glass-distilled water, with or without EDTA, their roots became brown and soft and ceased elongation when 3-5 cm in length. The shoots either failed to emerge or became black and died when 2-3 cm tall. This effect was observed in 2 consecutive plantings. When $CaCl_2$ (6 mM) in glass-distilled water was supplied, the seedlings grew well and developed normally except that the foliage was chlorotic.

Elemental analysis of leaf tissues (1) revealed major differences in content of Ca, Ba, Fe and Mn depending on the planting medium and watering treatment (Table 1). Growth and normal leaf development occurred at foliar Ca levels of 0.32% on seedlings planted in silica sand and supplied Ca^{++}. The fact that leaves on vermiculite-peatmoss-grown seedlings not supplied Ca^{++} contained 2 to 3 × this level but still showed symptoms suggests that the disorder is not entirely due to a leaf Ca deficiency. Rather, since Ca^{++} was required to prevent the symptoms it may indicate that the disorder was related to metal toxicity, the Ca^{++} functioning to prevent the toxic effects of metal ions as has been shown for other plants (2). This possibility is supported by the analysis data which show high levels of Fe, Mn and Ba in leaves of vermiculite-peatmoss-grown seedlings compared to those found in leaves of silica sand- or soil-grown seedlings. The correlation between increased symptom severity and Fe content when EDTA was added also suggested a possible toxic effect. Leaf analysis data and the fact that symptoms were only observed on seedlings grown in the vermiculite-peatmoss mixture (Table 1) indicated that the vermiculite-peatmoss mixture was the source of these ions.

Although the cotyledon reserves can affect seedling growth through the second leaf-whorl stage (6), the capacity of the cotyledons to supply certain inorganic ions required by the young seedling is probably insufficient. Cotyledons were found to contain only 0.095% Ca on a dry weight basis, which is probably not readily translocated to the seedling, and low levels, 0.083%, of Mg. Similar low levels of Ca and Mg, i.e., 0.07% and 0.04% respectively, were found in acorns of *Q. petraea* (Matt.) Liebl. and young seedlings showed large accumulations of these ions during early growth (5). The inorganic nutrients required by young red oak seedlings have not been defined but our observations indicate that an exogenous supply of at least Ca^{++} is required for their initial growth and leaf development.

Table 1. **The effect of planting media and watering treatments on element content of leaves and foliar symptoms of 30-day-old *Q. rubra* L. seedlings.**

Planting Medium	Treatment	Ca (% dry wt)	Fe (ppm)	Mn (ppm)	Ba (ppm)	Symptoms
Vermiculite-peat	Glass-distilled H_2O	0.65	108	325	125	+[z]
	Ca in glass-distilled H_2O[y]	1.04	95.4	949	131	–
	EDTA in glass-distilled H_2O[x]	0.99	406	435	175	++
	Tap H_2O	0.91	87.3	435	147	+
	Ca in tap H_2O	1.26	70.9	874	130	–
	EDTA in tap H_2O	0.99	290	581	153	++
Silica sand	Ca in glass-distilled H_2O	0.32	54	26.2	<2.00	–
	Tap H_2O	0.61	49.9	22.5	<2.00	–
	Ca in tap H_2O	0.77	40.1	71.2	<2.00	–
Soil	Tap H_2O	0.99	54.9	113	37.3	–

[z]+ = symptoms; – = no symptoms

[y]6.0 mM $CaCl_2$

[x]5×10^{-5} M EDTA

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Performance of Woody Ornamentals in Municipal Compost Medium under Nine Fertilizer Regimes[1]

Kenneth C. Sanderson and Willis C. Martin, Jr.[1]
Auburn University Agricultural Experiment Station
Auburn, Alabama

Abstract. **Dry weight and total plant height of *Ilex cornuta* Lindl. cv. Burfordii and *Thuja occidentalis* L. were greater in municipal compost-amended medium than in sphagnum peat moss-amended medium. *Viburnum burkwoodii* Burkwood did not show any differences in the two media. Generally, constant and biweekly liquid fertilizer regimes produced more growth than other regimes.**

Peat moss, the main organic ingredient in most container plant media, is becoming increasingly unavailable, expensive, and variable. Concern for the environment has placed emphasis on material which usually is an ecological liability. Byproducts of rice (3), sugar (9), oil cake (8), and lumber (2, 4, 8, 11) have been used successfully in container plant production. Conover and Joiner (1) found that 3 week composted municipal refuse could substitute for peat moss in potted chrysanthemum production but high soluble salt-injury has been reported with cut chrysanthemums (5). Because composting time and methods vary with municipal compost to create differences in decomposition rates, fertility levels may be a problem.

Objectives of the present study were to determine the feasibility of using municipal compost as a soil amendment in the production of 3 woody ornamentals and to evaluate 9 fertilizer regimes.

Potted liners, 6-12 months old clones, of *Ilex cornuta, Thuja occidentalis,* and *Viburnum burkwoodii* were transplanted into 2.5 liter nursery cans containing either 1 soil:1 perlite:1 sphagnum peat moss or 1 soil:1 perlite:1 processed municipal compost (all v/v). The municipal compost was produced by the City of Mobile, Alabama by removing most of the metal, rags, and large items of refuse from garbage, grinding the remainder in a hammermill, spraying with raw sewage, and composting for 12-16 weeks in windrows. Spurway analysis (10) of dilute acetic acid extracts revealed NO_3 (0-5 ppm); P 0-1 ppm); K (20-40 ppm); and Ca (100-150 ppm). The compost had a pH of 8.4 and a soluble salts reading (1:5 dilution) of 30-86 mhos. Using ammonium acetate extraction for exchangeable bases, Hiltbolt (7) reported the following analyses for this compost: total N (0.9%); total P (0.2%); K (6.0 meq/100g); Ca (42.2 meq/100g); Mg (4.3 meq/100g); and Na (15.4 meq/100g). In addition, the compost had a C/N ratio of 38.5, exchange capacity of 13.7 meq/100g, 34.2% total carbon, and negative tests for NH_4, NO_3, Cl and SO_4 ions. X-ray spectographic analysis revealed the presence of Pb, Sn, Cu, Mn, Fe, and Zn. After mixing with soil and perlite, media pH was adjusted to 6.0 using either limestone or sulfur. Sypsum was added to the compost medium at the rate of 1.7 kg per m^3 to compensate for Ca added in the form of limestone to the peat moss medium. Preliminary investigations had shown municipal compost to be low in available Ca, Fe, and P. Sheldrake[2] has indicated that high aluminum content of municipal compost ties up phosphorous. Both media received 2.5 kg per m^3 $FeSO_4$ and 1.6 kg per m^3 superphosphate and were steam pasteurized after mixing and prior to initiating the fertilizer regimes shown in Table 1.

Table 1. Description, analysis, and application method of fertilizer regimes used on woody ornamentals grown in 2 media.

Fertilizer[z]	Description and analysis (N-P-K)	Application
1. Constant (liquid feed)	Water soluble inorganic, 150 ppm N, 26 ppm P and 50 ppm K from 25—4.4—8.4.	At each watering with a pressurized, stock solution, tank proportioner.
2. Biweekly (liquid feed)	Water soluble inorganic, 615 ppm N, 108 ppm P and 207 ppm K from 25—4.4—8.4.	At watering with a venturi, open stock solution, tank proportioner.
3. Agriform tablet	12 g compressed, organic and inorganic pill, 14—1.8—5.0 plus Ca, S and Fe, controlled-release N.	Pressed in media surface (4.8kg per m^3) at planting, 9 and 13 mo.
4. Eeesy-Grow packet	28 g perforated plastic envelope containing water soluble inorganic 16—3.5—13.3, controlled release.	Placed in root zone at potting (11.2 kg per m^3).
5. Mag-Amp	Dry, inorganic combination of $MgNHPO_4$, $6H_2O$ and $MgKPO_4 \cdot H_2O_3$ 7—19.5—5.0 plus 12% Mg, medium granule, controlled release.	1.5 kg per m^3 preplant and 6 g per container (2.4 kg per m^3 at 9 and 13 mo.
6. Osmocote 18-9-9	Plastic coated, water soluble, granular inorganic, 18.0—4.0—7.5, controlled release.	Same as 5.
7. Osmocote 14—14—14	Plastic coated, water soluble, granular inorganic, 14—6.2—11.6, controlled release.	Same as 5.
8. Dry inorganic	8.0—3.5—6.6.	Same as 5.
9. Sta-Green	Combination organic and inorganic, 12—2.6—5.0 plus micronutrients, controlled release.	Same as 5.

[z]Trademark name fertilizers used (with manufacturer) were: Agriform tablet (Agriform International, Newark, Calif.), Eeesy-Grow packet (Specialty Fertilizer Inc., Suffern, N.Y.), Osmocote (Sierra Chemical Co., Newark, Calif.), and Sta-Green (Sta-Green Plant Food, Sylacauga, Ala.).

[1]Received for publication October 10, 1973. Published with the approval of the Director, Auburn Univ., Agr. Expt. Sta. Appreciation is expressed to R. M. Patterson, Research Data Analyst, Auburn Agr. Expt. Sta.

[2]Personal communication from Raymond Sheldrake, Jr., Dept. of Vegetable Crops, Cornell Univ., Ithaca, N.Y.