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Growth of *Dieffenbachia maculata* 'Camille' in Growing Media Containing Sphagnum Peat or Coconut Coir Dust

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Abstract. **A comparison was made of Canadian sphagnum peat (SP) and Philippine coconut (*Cocos nucifera* L.) coir dust (CD) as growing media components for *Dieffenbachia maculata* [(Lodd.) G. Don] 'Camille' greenhouse production. Three soilless foliage plant growing mixes [Cornell, Hybrid, Univ. of Florida #2 (UF-2)] were prepared using either SP or CD and pine bark (PB), vermiculite (V), and/or perlite (P) in the following ratios (percent by volume): Cornell = 50 CD or SP:25 V:25 P, Hybrid = 40 CD or SP:30 V:30 PB, UF-2 = 50 CD or SP:50 PB. Initial Cl concentrations and electrical conductivities were higher for CD-containing media (CDM) than SP-containing media (SPM). At termination, Ca, Mg, and NO_3-N concentrations were higher for SPM than CDM. Bulk densities were lower for CDM than SPM for one medium, but not for the others. Water-filled pore space (W-FPS) and water-holding capacity (W-HC) were larger and air-filled pore space (A-FPS) generally was smaller for CDM than SPM. Cornell had the highest W-FPS and W-HC, lowest A-FPS and percentage of large particles, and produced the highest grade and heaviest plants. Plant top grades, fresh mass and overall mass, but not root grades and mass, were higher for CDM than SPM. Plant mass was positively correlated with initial medium W-HC but not with A-FPS. Lower K in mix UF-2 compared to the mixes containing vermiculite may have been partly responsible for the lesser growth in that mix.**

Most foliage plants are grown using peat-based soilless growing media (Poole et al., 1981). Peat, especially sphagnum peat (SP), has many desirable characteristics when used in growing media—high cation-exchange and water-holding capacities, a structure that allows good aeration, and resistance to decomposition (Nelson, 1978). However, peat is a part of wetland ecosystems and some ecologists and environmentalists have raised concerns about detrimental effects of peat harvesting (Barber, 1993; Barkham, 1993; Buckland, 1993). Despite assertions by the peat industry that peat harvesting is not a factor or is only a minor factor compared to development pressures causing degradation and loss of wetlands (Keys, 1992; Robertson, 1993), there are many reasons to seek peat alternatives for use in horticulture. For example, there are times when peat may be in short supply because inclement weather conditions interfere with harvesting. In addition, peat is difficult to rewet after it dries out and provides an environment that is conducive to fungus gnat and shore fly development (Knauss, 1996). Coconut coir dust (CD) is reported to have many characteristics that make it equal or superior to peat as a component in growing media (Cresswell, 1992; Evans et al., 1996; Meerow, 1994). In addition, CD has been used as a soil amendment and an alternative to peat moss in soilless mixes in Eastern Hemisphere countries for years (Josko, 1996).

In 1993, the latest year for which there are adequate data, dieffenbachias were the second most popular indoor foliage plants in the United States and *Dieffenbachia maculata* 'Camille' was by far the leading dieffenbachia cultivar produced (Sheehan, 1994). High-quality dieffenbachias can be grown in a variety of media if the media are well aerated and low in soluble salts (Henny et al., 1991). Growth index was higher and shoot dry mass larger of the interspecific hybrid *Anthurium* 'Lady Jane', another foliage plant in the same family (Aracea) as dieffenbachia, in a medium containing 40% (by volume) waste-grade coir than in a similar medium containing 40% sedge peat (Meerow, 1995). In a companion experiment comparing waste-grade coir with SP, 'Lady Jane' anthuriums grew equally well in either medium.

The purposes of our experiment were to compare chemical and physical properties of three foliage plant growing media containing SP or CD and to evaluate the relative growth of *D. maculata* 'Camille' in the media.

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Materials and Methods

Three types of growing mixes designed for use in containerized foliage plant production were prepared, with each type made with SP or CD (Table 1). Cornell is based on the Cornell Univ. foliage plant mix formula and is recommended "for those plants that need a mix with high moisture-retention characteristics" (Mott, 1971). UF-2 is Univ. of Florida (UF) potted foliage plant mix #2, which has the lower aeration of the two UF mixes used for greenhouse production (Poole et al., 1981). Hybrid is a mix intermediate between Cornell and UF-2. These mixes are similar to those presently used commercially for containerized foliage plant production.

CD (UniCoir, Laguna province, Luxon, Philippines) was prepared by rehydrating compressed blocks and hand-mixing to break up any aggregates. Baled Canadian SP (Yellow, Tourbe Blonde, 2:1 compressed; SOGEVEX, New Rochelle, N.Y.) was prepared for use with a shredder (model M; Lindig Manufacturing, St. Paul, Minn.). Coarse horticultural vermiculite (Strong-Lite Products, Seneca, Ill.) and horticultural perlite (Chemrock, a subsidiary of GREFCO, Torrance, Calif.) were used as supplied. Dolomite (Asgrow Florida, Plant City, Fla.) was added to all mixes at the recommended rate of 4.15 $kg \cdot m^{-3}$ to supply Ca and Mg (Conover, 1995; Conover et al., 1995).

Initial and final growing media nutrient content were determined using the North Central Regional Committee for Soil and Plant Analysis saturated media extract method (Warncke, 1988). Electrical conductivity (EC) was measured using a Beckman (Cedar Grove, N.J.) solu-bridge and pH was determined using an Orion (Cambridge, Mass.) pH meter. Analyses for mineral concentrations were: Nitrate N, copperized cadmium reduction procedure (Keeney and Nelson, 1982); Cl, mercury thiocyanate procedure (Fixen et al., 1988); B, Ca, Cu, Fe, K, Mg, Mn, Na, P, and Zn by simultaneous inductively coupled argon plasma emission spectrometry on the filtered extract (Jones, 1977; Munter and Grande, 1981). Initial and final particle size distributions were measured by air-drying the media and sieving 100-g samples on a CSC Scientific (Fairfax, Va.) rotary shaker for 10 min using screens with pore diameters of 0.5, 2.0, 4.0, 6.3, and 8.0 mm. The material collected in each screen was weighed. These analyses were not replicated, but the three media containing SP were compared to the three containing CD.

Air-filled (A-FPS) and water-filled pore space (W-FPS), water-holding capacity (W-HC) at container capacity, bulk density, and total pore space were determined using loose-packed cores and methods adapted from Byrne

Table 1. Chemical properties of three types of growing mixes made using either sphagnum peat or coconut coir dust. Properties were determined before (initial; I) and after (final; F) being used to produce *Dieffenbachia maculata* 'Camille'.

	Mix components (% by vol)					pH		Electrical conductivity (mS·cm^{-1})		Mineral concn (mg·L^{-1}): Cl		Nitrate-N		Mg		Ca		K		P	
Mix[z]	Peat	Coir	Vermiculite	Pine bark	Perlite	I	F	I	F	I	F	I	F	I	F	I	F	I	F	I	F
Cornell	50	0	25	0	25	6.95	7.60	0.35	0.38	16	16	2	3.4	17	24	53	30	44	12	43.4	6.0
	0	50	25	0	25	7.19	7.65	1.40	0.30	710	7	1	0.3	31	17	27	15	417	12	34.6	6.3
Hybrid	40	0	30	30	0	7.13	7.40	0.32	0.34	40	14	1	2.0	17	29	27	32	34	16	24.1	10.0
	0	40	30	30	0	6.82	7.45	1.30	0.24	753	9	2	0.0	32	17	26	14	392	14	27.6	9.0
UF-2	50	0	0	50	0	6.76	6.90	0.28	0.20	35	10	2	3.2	17	22	26	23	29	3.6	25.2	9.1
	0	50	0	50	0	6.60	7.25	1.65	0.16	940	6	2	0.6	10	16	29	13	637	2.4	39.7	7.6
Significance																					
Peat- vs. coir-containing media						NS	NS	***	NS	***	*	NS	**	NS	*	NS	**	**	NS	NS	NS

[z]Cornell = Cornell Univ. foliage plant potting mix, UF-2 = Univ. of Florida potted foliage plant mix #2, Hybrid = combination mix based on Cornell and UF-2.

NS,*,**,***Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively.

and Carty (1989) as described by Evans et al. (1996). Physical properties were measured at the beginning and end of the experiment and were replicated three times.

Eight- to 10-cm-tall tissue-culture-produced *D. maculata* 'Camille', grown in 72-cell pack liners, were planted, one per pot, into 1.9-L (15.2-cm-diameter) plastic pots (Green Maxi Grow Pot; REB Plastics, Orlando, Fla.) on 21 Feb. 1995. After potting, plants were spaced ≈25 cm apart on raised benches in a glasshouse and watered in; thereafter, they were all hand-watered two to three times weekly as needed. Additional selective watering of individual pots needing water, as determined by lifting the pots off the bench to assess their mass, was done when pots started drying out between scheduled waterings. Maximum photosynthetically active light intensity in the greenhouse was 528 μmol·m^{-2}·s^{-1} and the air was maintained between 18 and 32 °C. Evaluations of dieffenbachia growth were based on 10 replications in this randomized complete-block experiment.

At the time of planting, fertilizer containing micronutrients was applied as a top-dressing at the recommended rate of 4.5 g of 17N–2.6P–10K (Sierra 17–6–12; Scotts, Milpitas, Calif.) per pot (Conover and Poole, 1990). After 6.5 weeks, plants were finished using once-a-week applications of 20N–8.8P–16.6K liquid fertilizer (Peters Florida 20–20–20; Scotts) with N at 600 mg·L^{-1}.

By 24 July 1995, most of the plants had reached marketable size and were graded visually for appearance where: 1 = very poor; 2 = poor quality, unsalable; 3 = fair quality, salable; 4 = good quality, no detectable chlorosis in green areas of leaves; and 5 = excellent quality, large leaves with dark green margins. Height and widths (two, taken at right angles) of the aboveground portion of the plants were then measured. Tops of the plants were cut at the soil line and weighed. Extent of white, healthy roots covering the outside of the soil mass was visually evaluated, where: 1 = ≤20%; 2 = ≥20% ≤ 40%; 3 = ≥40% ≤ 60%; 4 = ≥60% ≤ 80%; and 5 = ≥80% ≤ 100% coverage. Root balls were removed from pots, loose medium was removed by hand, and that sample was used for postproduction (final) soil analyses. Root balls were then gently agitated in a tub of water to remove additional medium. Finally, a stream of water was used to remove the remaining medium from the roots. Root systems were shaken and air-dried for 5 min to remove excess water and then weighed.

Data were tested by analysis of variance with multiple means comparisons using Duncan's new multiple range test at $P \leq 0.05$ (SAS Institute, Cary, N.C.).

Results and Discussion

Media characteristics

Nutrient content. For all media, saturated extract Cu and Mn levels were <0.03 mg·L^{-1}, Fe and Zn levels were <0.18 mg·L^{-1}, and B <0.24 mg·L^{-1} (data not shown). Beginning and final pH values for all media were >6.5 and similar for the peat-containing media (SPM) and the coir-containing media (CDM) (Table 1). Initial EC values and Cl concentrations were higher for CDM than for SPM but were not excessive for this crop (C.A. Conover, personal communication). Final EC values did not differ between mixes containing coir or peat; however, final Cl concentrations were lower in CDM than SPM. Initial NO_3-N levels were low in all media. At termination, NO_3-N levels were lower for CDM than SPM. Initial Mg and Ca values for CDM and SPM were similar and, like NO_3-N, were followed by lower final CDM compared to SPM values. Potassium levels were higher initially in CDM compared to SPM but did not differ at termination. High K and Cl concentrations in saturated CD media extracts have been reported (Evans et al., 1996; Handreck, 1993). Initial and final P levels were the same for CDM as for SPM. The lower nutrient content of CDM compared to SPM at experiment termination was probably due to higher nutrient extraction by the larger plants in the CDM and the higher cation exchange capacity of SP compared to this source of CD (Evans et al., 1996).

Physical properties. There were significant growing mix (Cornell, Hybrid, UF-2) × media component (SP vs. CD) interactions for all physical characteristics measured, except for W-HC determined at the end of the experiment. A-FPS was generally lower and W-FPS and W-HC higher for CDM than for SPM (Table 2).

Initial bulk densities (BD) of all media, except Hybrid mix made with coir, were below the minimum recommended level of 0.15 g·cm^{-3} (Poole et al., 1981); however, final BD values clustered around that minimum value. Initial and final BD of Cornell and UF-2 mixes

Table 2. Growing media physical characteristics at experiment initiation (I) and after being used for 5 months (final; F) to grow *Dieffenbachia maculata* 'Camille'.

	Mix components (% by vol)					Bulk density (g·cm^{-3})		Air-filled pore space at container capacity (% by vol)		Water-filled pore space at container capacity (% by vol)		Water-holding capacity (% by mass)	
Mix[z]	Peat	Coir	Vermiculite	Pine bark	Perlite	I	F	I	F	I	F	I	F
Cornell	50	0	25	0	25	0.11	0.14	23.6	13.1	62.1	75.4	575	554
	0	50	25	0	25	0.10	0.13	11.6	3.6	64.6	86.2	650	692
Hybrid	40	0	30	30	0	0.16	0.19	27.7	8.5	54.4	66.2	344	342
	0	40	30	30	0	0.12	0.15	21.3	5.5	62.6	83.4	538	536
UF-2	50	0	0	50	0	0.13	0.15	21.9	8.7	57.7	70.9	430	449
	0	50	0	50	0	0.14	0.14	13.0	7.6	65.1	77.0	480	565
Significance													
Growing mix (GM)						***	***	***	**	***	***	***	***
Peat vs. coir (P/C)						***	***	***	***	***	***	***	***
GM × P/C						***	**	***	***	***	***	***	NS

[z]Cornell = Cornell Univ. foliage plant potting mix, UF-2 = Univ. of Florida potted foliage plant mix #2, Hybrid = combination mix based on Cornell and UF-2.

NS, *, **, ***Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively.

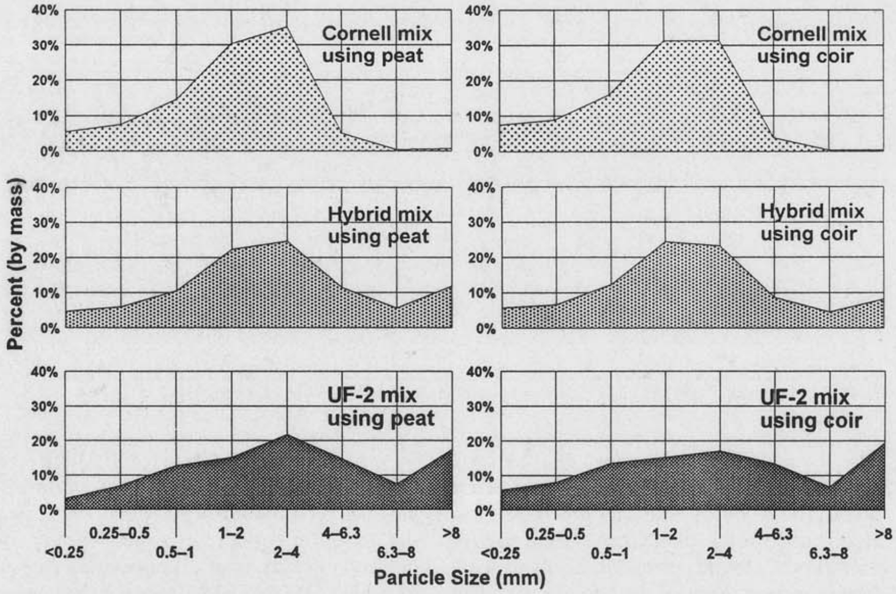

Fig. 1. Initial particle size distribution of three foliage plant growing mixes containing either Canadian sphagnum peat or Philippine coconut coir dust (percent by volume: Cornell = 50% sphagnum peat or coconut coir dust : 25% vermiculite : 25% perlite; Hybrid = 40% peat or coir : 30% pine bark : 30% vermiculite; UF-2 = 50% peat or coir : 50% bark).

were the same, regardless of whether they were made with coir or peat. For the Hybrid mix, initial and final BD were lower when coir was used than when peat was used. For CDM, initial BD were UF-2 > Hybrid > Cornell and final BD were Hybrid ≯ UF-2 but Hybrid > Cornell. For SPM, initial BD were Hybrid > UF-2 > Cornell and final BD were Hybrid > Cornell and UF-2.

Initial A-FPS at container capacity was above the 5% minimum recommended for potting media for foliage plant production for all media (Poole et al., 1981); however, A-FPS of the Cornell mix made with coir was below the minimum after 5 months of use (Table 2). Comparing CDM and SPM, A-FPS (both initial and final) was lower for CDM except for UF-2 mix at termination. Both versions of UF-2 had the same A-FPS. A-FPS for the mixes differed for both CDM media (initial A-FPS—Hybrid > UF-2 > Cornell; final A-FPS—UF-2 > Hybrid > Cornell) and SPM (initial A-FPS—Hybrid > Cornell and UF-2; final A-FPS—Cornell > Hybrid and UF-2).

Initial and final W-FPS at container capacity were at or above the recommended range of 20% to 60% by volume for all media (Poole et al., 1981). Comparing CDM and SPM, initial and final W-FPS were higher for CDM than for SPM for all three mixes. Initial W-FPS values for CDM were Cornell and UF-2 > Hybrid and final values were Cornell > Hybrid > UF-2. Initial W-FPS values for SPM were Cornell > Hybrid > UF-2 and final values were Cornell > UF-2 > Hybrid.

W-HC of each mix was higher when coir rather than peat was used. Initial W-HC of CDM were Cornell > Hybrid > UF-2 and final W-HC were Cornell > Hybrid and UF-2. For SPM, both initial and final W-HC were Cornell > UF-2 > Hybrid.

The higher W-FPS and lower A-FPS for CDM compared to SPM were due to the relatively higher ratio of smaller to larger particles in CDM than SPM (Fig. 1). Cornell mix had the lowest percentages of particles >6.3 mm and the highest initial and final W-HC because it did not contain pine bark, the coarsest of the media components. The use of media components with large particle sizes can increase noncapillary pore space (macropores) and, thereby, increase soil matric potential, which increases gravitational water drainage and decreases water-holding capacities.

Plant growth and grades

There were no significant growing mix (Cornell, Hybrid, UF-2) × media component (SP vs. CD) interactions for either plant growth or quality.

Tops. Plant top growth indices were affected by growing media (Cornell > Hybrid > UF-2), but there were no differences between top growth indices of plants grown in CDM compared to those grown in SPM (Table 3). However, plant top grades were higher for CDM compared to SPM, as well as being higher for Cornell and Hybrid than for UF-2. Average plant grades for Cornell and Hybrid mixes were very good (4.3 and 3.9, respectively) and good for UF-2 (3.4). Plant top mass was also heavier for CDM vs. SPM, and Cornell > Hybrid > UF-2.

Roots. Root grades and mass were the same for CDM and SPM; however, grades and mass were affected by growing mix (Cornell > Hybrid > UF-2).

Overall plant growth. Total plant fresh mass for *D. maculata* 'Camille' was highest when grown in Cornell, intermediate in Hybrid, and lowest in UF-2 (Fig. 2). In addition, overall plant growth was higher when the media contained CD rather than SP.

Plant growth differences were probably due, in part, to media W-HC. Average plant mass was positively correlated with initial W-HC ($y = 208.6 + 22.4x$, $r = 0.77$). These results agree with those in a study of *D. maculata* 'Perfection' (Poole and Conover, 1982). Initial A-FPS of all media was in the recommended range (Poole et al., 1981) and was poorly correlated with final plant mass (r = 0.22); therefore, differences in A-FPS probably were not a significant factor affecting 'Camille' growth in this experiment. Although

Table 3. Growth and plant grades of *Dieffenbachia maculata* 'Camille' grown in three growing mixes prepared using either sphagnum peat or coconut coir dust.

	Mix components (% by volume)					Plant tops			Plant root	
Mix[z]	Peat	Coir	Vermiculite	Pine bark	Perlite	Growth index[y]	Grade[x]	Mass (g)	Grade[w]	Mass (g)
Cornell	50	0	25	0	25	1509	4.1	220	3.6	101
	0	50	25	0	25	1581	4.4	251	4.1	103
Hybrid	40	0	30	30	0	1420	3.8	203	3.0	79
	0	40	30	30	0	1433	4.0	224	2.9	88
UF-2	50	0	0	50	0	1113	3.2	138	2.2	64
	0	50	0	50	0	1269	3.6	181	2.1	71
Significance[v]										
Growing mix						***	***	***	***	***
Peat vs. coir						NS	*	***	NS	NS

[z]Cornell = Cornell Univ. foliage plant potting mix, UF-2 = Univ. of Florida potted foliage plant mix #2, Hybrid = combination mix based on Cornell and UF-2.
[y]Plant growth index = [(width 1 + width 2) ÷ 2] × height.
[x]1 = very poor; 2 = poor quality, unsalable; 3 = fair quality, salable; 4 = good quality, no detectable chlorosis; 5 = excellent quality, large leaves with dark green margins.
[w]Soil ball coverage: 1 = ≤20%, 2 = ≥20% ≤ 40%, 3 = ≥40% ≤ 60%, 4 = ≥60% ≤ 80%, 5 = ≥80% ≤ 100%.
[v]Only the main effects were significant; there was no significant interaction.
[NS,*,**,***]Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively.

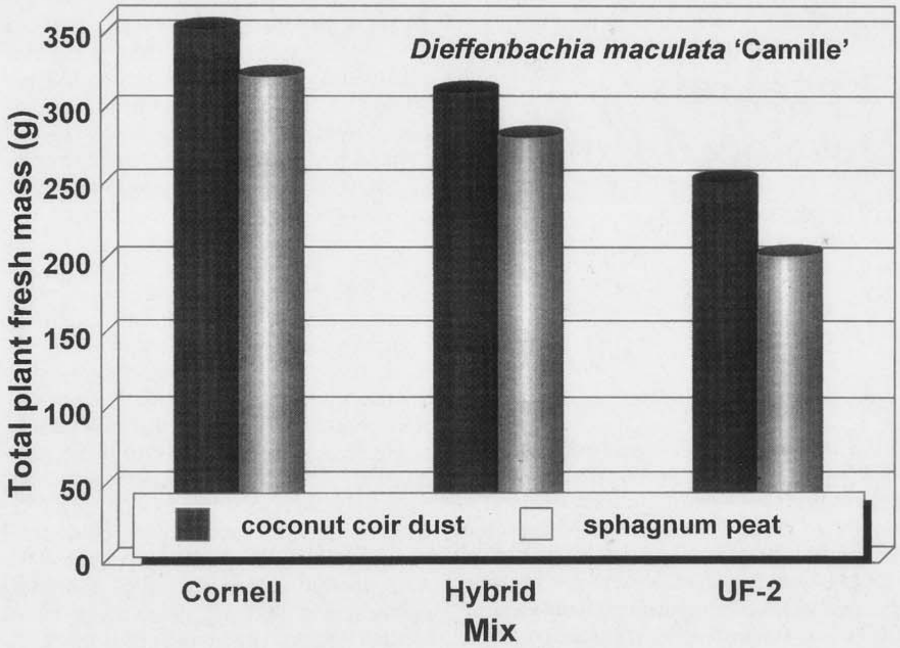

Fig. 2. *Dieffenbachia maculata* 'Camille' growth after 5 months using three foliage plant growing mixes containing either Canadian sphagnum peat or Philippine coconut coir dust (percent by volume: Cornell = 50% sphagnum peat or coconut coir dust : 25% vermiculite : 25% perlite; Hybrid = 40% peat or coir : 30% pine bark : 30% vermiculite; UF-2 = 50% peat or coir : 50% bark).

research suggests that reduced medium aeration can enhance toxic effects of fertilizers on dieffenbachia (Martinez et al., 1982), in our study, the medium (Cornell made with coir) that produced the biggest, heaviest, and highest grade plants had the lowest initial and final A-FPS.

Higher initial K levels may also have affected plants growing in CDM; however, final K levels were the same in CDM as SPM. Lower K in UF-2 compared to the other mixes, suggested by the final K values, may have been partly responsible for the reduced growth in that mix compared to the others. The other mixes contained vermiculite, a source of K.

The CD used in this experiment appears to be a more than adequate substitute for SP in the three growing mixes we used for *D. maculata* 'Camille' production. Costs, product consistency, and availability are some other factors that dieffenbachia growers should consider when deciding whether to use CD or CDM.

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