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STABY

ILI Upfront

Proof positive: Plants clean the air

By Ross Brown

Information was released in July showing that foliage plants can remove both small- and large-particled toxic substances from indoor air, providing interior landscapers with the first scientific proof of the physiological benefits of plants.

The data, from tests conducted by the National Aeronautics & Space Administration and the Associated Landscape Contractors of America, Interior Plantscape Div., was presented by NASA's Dr. B.C. Wolverton at Florida Foliage Expo in Hollywood, FL. The research indicates that "plants may help you live longer and healthier," Wolverton said.

Living longer and healthier is a challenge today in part because, as Wolverton put it, living in a new, modern structure "is like living in a gas chamber." Like a gas chamber, modern buildings are tightly constructed and have low ventilation rates. The poison gas emitted in these buildings comes from toxic substances that are released by everything from walls to hairspray.

In February, NASA and ALCA agreed to conduct joint research on the ability of plants to remove these toxic substances from the air. At Florida Foliage Expo, Wolverton presented some of NASA's research conducted over the past eight years and

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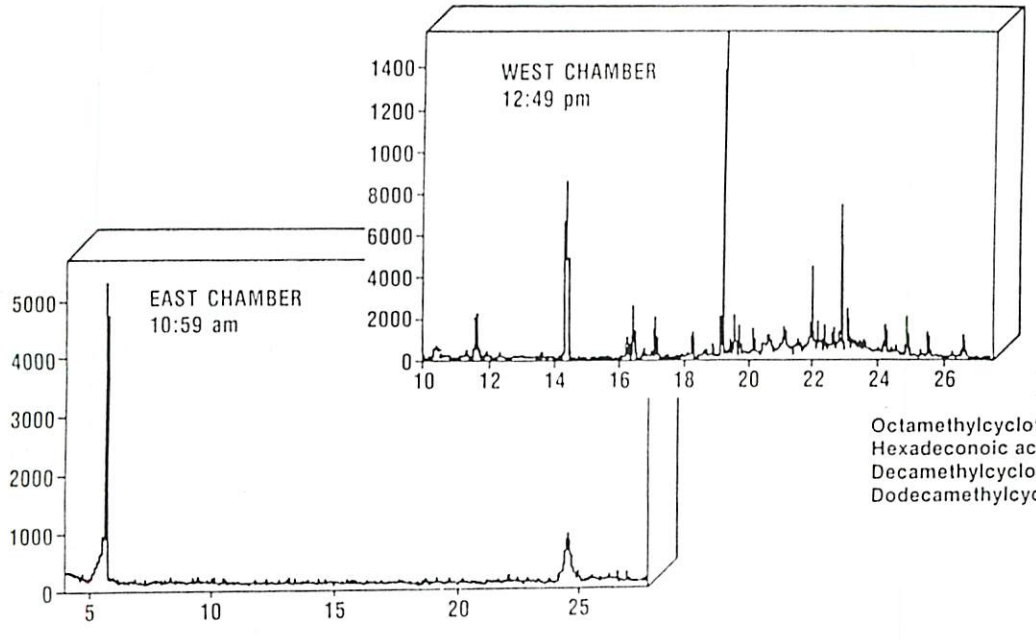
Fig. 1. A comparison of the presence of chemicals in sealed chambers with and without plants. (Illustration courtesy of Dr. B.C. Wolverton.)



HYPERTAT CHAMBER—EMPTY

Commonly found chemicals:

1,1,1-Trichloroethane
Hexanol
Ethylbenzene
1,2-Dimethylbenzene
1,4-Dimethylbenzene
Octamethylcyclotetrasiloxane
Hexadeconoic acid, (2-pentadecyl-1,3-dio)
Decamethylcyclopentasiloxane
Dodecamethylcyclohexasiloxane

HYPERTAT CHAMBER—WITH PLANTS
(*Philodendron domesticum*)

Commonly found chemicals:

1,1-Dibromo-2-chloro-2-fluorocyclopropane

recent work done with the ALCA.

A dramatic indication of the air-cleaning abilities of plants is shown in Fig. 1 (page 8), a comparison of the pollutants found in two tightly sealed chambers. One chamber had plants, the other did not. The chambers, each approximately 350 square feet, are two sides of a structure at the Stennis Space Center in Mississippi.

The significantly lower pollution levels in the chamber with plants are a result of the ability of plants to take in gaseous substances from the surrounding atmosphere through their stomates, the tiny openings.

Fig. 2 (page 9) shows the results of recent NASA/ALCA research, indicating the levels of benzene removed over 24 hours by eight plants. Fig. 3 (page 10) shows 13 plants' abilities to remove formaldehyde.

Dr. B.C. Wolverton (Photo by Ross Brown)

Previous NASA research indicating the ability of plants to remove substantial amounts of benzene, formaldehyde and carbon monoxide from sealed experimental chambers is summarized in Figs. 4, 5 and 6 (page 11). All three of these substances are known to be harmful to human health and are often present in interior atmospheres.

Other contaminants in indoor air could be cleaned from the interior atmosphere by a plant's roots. Wolverton is conducting tests to determine if larger quantities of toxins and larger particles (such as those found in cigarette

Benzene Removal During a 24-Hour Exposure Period

Plant[1]	Total Benzene in Chamber (micrograms)			Average Leaf Surface (square centimeters)	Benzene Removal (micrograms per square centimeter of leaf area)	
	Initial	Six Hours	24 Hours		Six Hours	24 Hours
Gerbera jamesonii (African daisy)	65,000	46,000	21,000	4,620.2 (5,008.0)[2]	3.79	8.79
Chrysanthemum x morifolium (mum)	57,667	49,333	27,333	1,296.9 (4,225.2)[2]	1.97	7.18
Spathiphyllum 'Mauna Loa' (peace lily)	27,667	17,667	11,000	7,804.1	1.28	2.14
Dracaena deremensis 'Warneckii' (striped dracaena)	27,333	21,333	12,667	7,239.7	0.83	2.03
Dracaena marginata (red-edged dracaena)	24,000	19,667	12,000	7,578.2	0.57	1.58
Chamaedorea seifrizii (reed palm)	18,500	14,000	9,000	10,322.9	0.44	0.92
Dracaena deremensis 'Janet Craig'	23,333	18,667	12,333	15,270.0	0.31	0.72
Dracaena fragrans 'Massangeana' (corn plant)	14,667	13,333	11,333	8,674.0	0.15	0.38

[1]Average of three experiments, except Chamaedorea seifrizii (average of two experiments).
[2]Total surface area, including flowers.

Fig. 2. NASA and ALCA research results indicating the ability of eight plants to remove benzene from a sealed chamber in 24 hours.

The activated carbon in the device holds the contaminants in the medium, where the roots and associated bacteria can biologically degrade the substances.

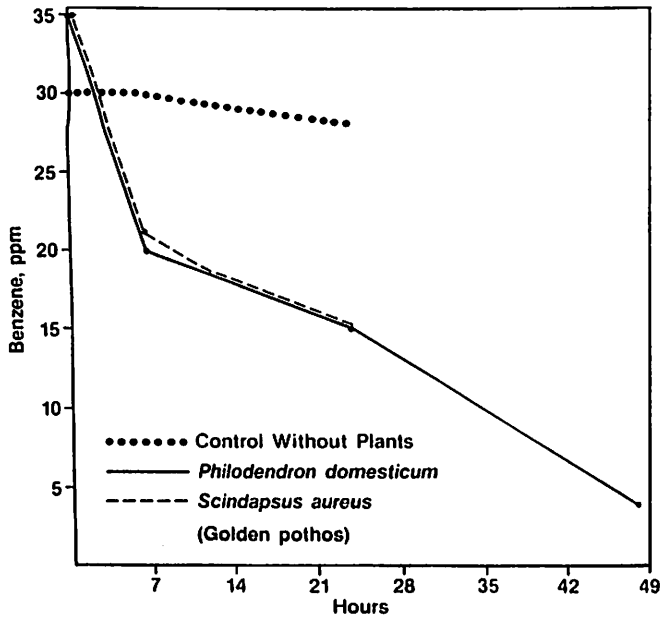
smoke) can be removed from the indoor atmosphere by circulating air through a plant growing medium containing activated carbon. The activated carbon holds the contaminants in the medium, where the roots and associated bacteria can biologically degrade the substances.

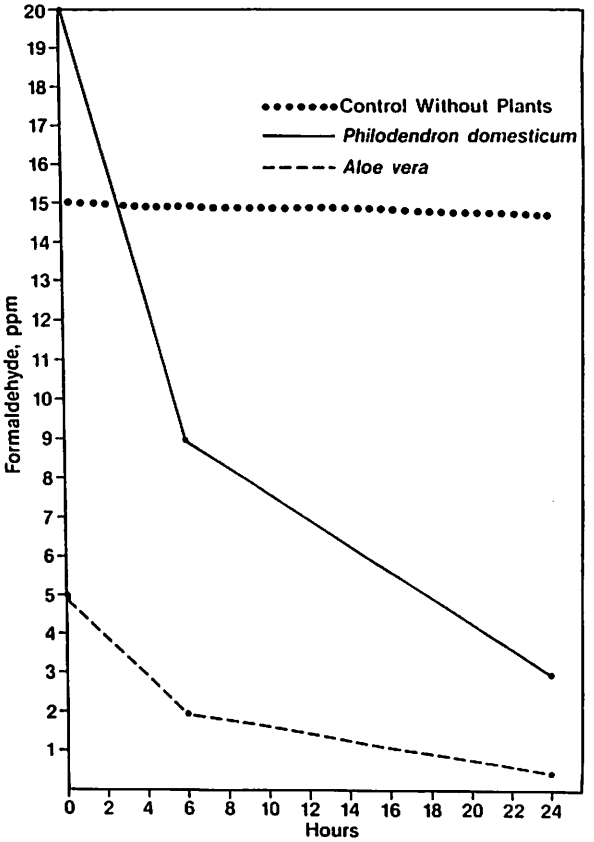
Formaldehyde Removal During a 24-Hour Exposure Period

Plant*	Total Formaldehyde in Chamber (micrograms)			Average Leaf Surface (square centimeters)	Formaldehyde Removal (micrograms per square centimeter of leaf area)	
	Initial	Six Hours	24 Hours		Six Hours	24 Hours
Philodendron scandens oxycardium (heart-leaf philodendron)	11,921	5,256	3,455	1,696	3.93	4.99
Philodendron domesticum (spade-leaf philodendron)	11,575	4,665	1,555	2,323	2.97	4.31
Philodendron selloum (lacy-tree philodendron)	11,403	4,665	2,747	2,373	2.84	3.65
Chlorophytum capense	12,975	7,319	2,709	2,471	2.29	4.15
Epipremnum aureum (golden pothos)	10,741	4,325	1,854	2,723	2.35	3.26
Aglaonema modestum (Chinese evergreen)	11,248	8,238	6,866	1,894	1.59	2.31
Aloe vera	2,592	1,037	259	713	2.18	3.27
Brassaia arboricola (Hawaiian schefflera)	8,333	—	4,904	1,743	—	1.96
Spathiphyllum 'Clevelandii' (peace lily)	10,298	6,655	5,387	3,476	1.05	1.41
Peperomia obtusifolia (baby rubber plant)	10,140	6,971	5,387	3,264	0.96	1.46
Dracaena fragrans 'Massangeana' (corn plant)	10,003	7,878	5,974	2,934	0.72	1.37
Sansevieria trifasciata (snake plant)	9,330	5,636	2,954	4,881	0.76	1.31
Tradescantia sillamontana (white-velvet)	10,298	7,341	5,704	6,843	0.43	0.67

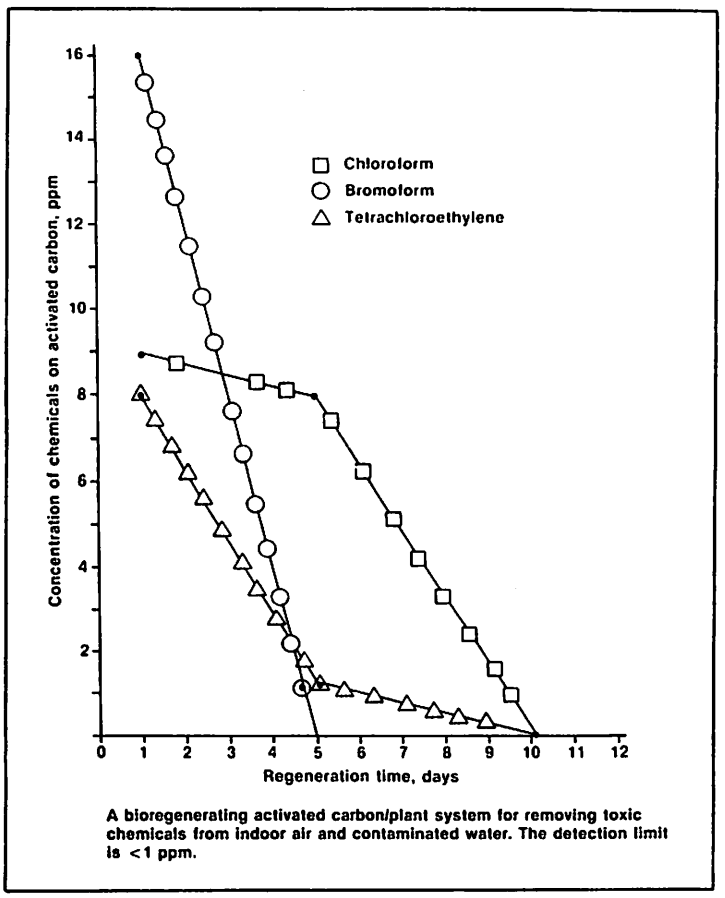
*Average of three or more different experiments.

Fig. 3. NASA research results indicating the ability of 13 plants to remove formaldehyde from a sealed chamber in 24 hours.





Figs. 4, 5 and 6 (above, right and bottom right) indicate the benzene, formaldehyde and carbon monoxide reduction in the atmosphere of closed chambers with and without common foliage plants. (Illustrations courtesy of Dr. B.C. Wolverton.)



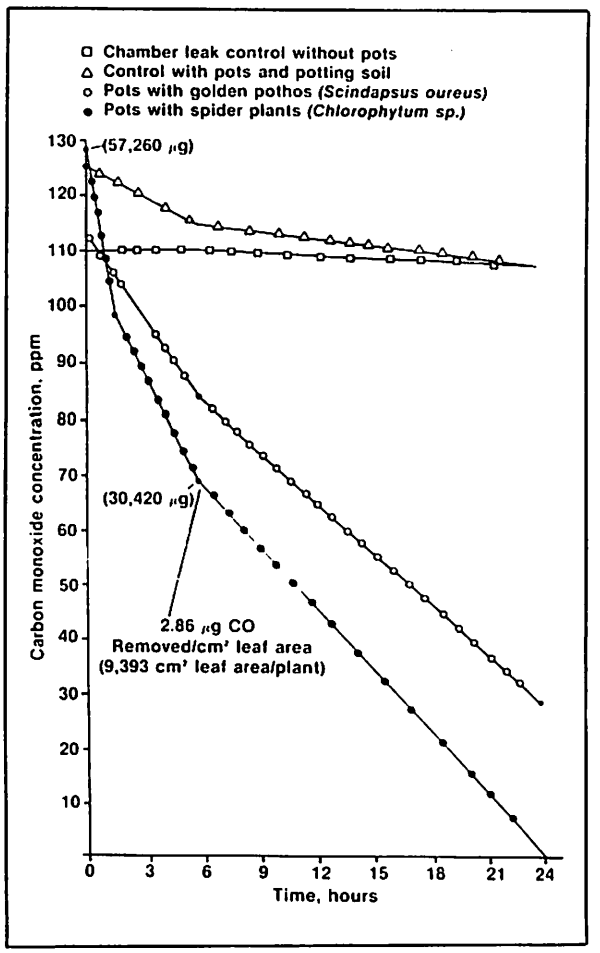


Fig. 7. The results of tests using an activated carbon and plant system for removing three substances from the atmosphere (Illustrations courtesy of Dr. B.C. Wolverton.)

Results from tests of plants in these carbon and blower devices are shown in Fig. 7 (page 11). The technology may also help remove radon gas from interiors, according to Wolverton.

More Pollutants?

While plant roots and leaves absorb substances from the surrounding atmosphere, some also release what Wolverton called "exotic organics," plant metabolites that may be harmful to other plants. Many plants give off such substances, but some species may absorb the metabolites of other plants.

"We will hopefully be able to identify a pollution problem and clean it up with a specific plant," Wolverton said. If the prescribed plant gives off harmful metabolites, it could be combined with another species that absorbs those metabolites.

Wolverton said he did not expect the metabolites released by plants to be troublesome or harmful to humans.

Up and Running

Wolverton showed slides of how plants can be integrated to clean the air of a modern, tightly sealed structure: his house. The Wolverton residence has a solarium with an air exchange vent connected to the home's heating and cooling system, which diverts a fourth of the airflow to the solarium. He said the plants could also be placed around the house for the same effect as locating them in a solarium.

Wolverton's home is a working model of how plants can be used to clean air indoors, and he said he thinks further applications will also be made on earth before the technology is used in outer space.

This is because there is a current need on earth to clean the air inside buildings, while the recent shuttle debacle makes NASA reluctant to take risks with any new or unproven technology. The use of plant leaves and roots to clean the air inside buildings will not come, Wolverton predicted, until the first installation with such an intent is made.