UNIVERSITY OF TECHNOLOGY SYDNEY

POTTED-PLANTS IMPROVE INDOOR ENVIRONMENTAL QUALITY

Research Review and Sponsorship Opportunities

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Why worry about indoor air quality?

About 80% of Australians and Americans live in cities, where urban air pollution is a significant problem (as it is around the world); and –city dwellers spend about 90% of their time indoors, so *indoor air quality* (IAQ) is a national (and global) health issue. Also -indoor air pollution is virtually always higher than outdoors. Outdoor pollutants (mainly from fossil fuel emissions) include oxides of carbon, nitrogen and sulfur, organics (PAHs etc), ozone & fine particulates (organic 'dust'). The mixture freely diffuses indoors, where pollution is raised further.

Volatile organic compounds (VOCs) are the major class of indoor-generated air pollution. They outgas continually from 'plastics' or 'synthetics' in furniture and fittings, painted surfaces, solvents etc. Imperceptible levels of these cocktails can cause loss of concentration, headaches, dry eyes and nose, nausea, or breathing problems – "sick building syndrome". Urban air pollution kills – it accounts for over 1,400 premature deaths per year in Sydney alone (pop. 4.2 M); and for thousands more people suffering health problems, including asthma, strokes, and other cardiovascular conditions.

How can indoor plants help?

Overseas studies have shown that indoor plants can improve IAQ in a number of ways:
by reducing nitrogen and sulfur oxides & dust, stabilising humidity, and reducing noise levels. *Staff wellbeing and productivity are also directly improved where indoor plants have been installed*.

Following on from the pioneering work of Wolverton et al. in the USA, our UTS laboratory test-chamber studies have shown that potted-plants can reliably eliminate repeated, very large, daily air-borne doses of VOCs. Once 'induced' (stimulated) by exposure to a single dose, high removal rates are attained, and maintained in light or dark (24/7), & rise further to deal with increased VOC concentrations. We have so far tested in detail 10 species*.

We demonstrated experimentally that normal microorganisms of the potting-mix are the main VOC removal agents. The role of the plants here is in feeding their root-zone microbial communities. So, the potted-plant system works as a '*symbiotic microcosm'*. Take care of the plants, and the plants will take care of their microbes! (Their normal job is breaking down soil humus and releasing nutrients, which are then available to plant roots. Many soil microorganisms can degrade liquid-phase petroleum hydrocarbons, and so are used in bioremediation of oil spills.)

OK- but can potted-plants make any difference in the 'real world'?

YES, we found they can reduce & keep indoor VOC pollution to negligible levels (<100 ppb).
We used 60 UTS offices, in three buildings - two air-conditioned, one naturally ventilated. We had 4 treatments: 0 plants (reference offices); 3 or 6 floor pots of *D.* 'Janet Craig'; or 6 smaller desk pots - 5 *S.* 'Sweet Chico' plus 1 *D.* 'Janet Craig'. Results were very positive, as outlined overleaf.

**Spathiphyllum 'Petite'; S.* 'Sensation'; *Dracaena* 'Janet Craig'; *D. marginata*; *Howea forsteriana* (Kentia Palm) *Epipremnum aureum (*Devil's Ivy); *Schefflera* 'Amate' (Umbrella Tree). *Zamioculcas zamiifolia; Aglaonema modestum; & Philodendron var.*)

UTS office study findings

We found the potted-plants performed extremely well, as follows:

- When Total VOC levels (TVOCs) rose above about 100 ppb, all three planting arrangements reduced concentrations by up to 75%, always to below 100 ppb once more.
- They worked equally well with or without air-conditioning.
- Since the smallest plant treatment was as effective as the other two, ***any*** of them was more than enough to cleanse the air of TVOC loads. We are now working to find the minimum number needed – see below.
- Follow-up laboratory tests confirmed again the graded induction of VOC removal rates to meet any increase in load, over a wide range of concentrations, from 200 ppb (middle of range in offices), to above the Ausralian WorkSafe allowable 8-hr-avr. exposure maxima (to 100 ppm)**.** VOCs in test-chamber air were always reduced to about zero.
- We also found the potted-plants lowered CO_2 levels by 10-20%, and trace carbon monoxide (CO) levels by about 90%. (Such air freshening improves alertness.)

Significance for indoor plant useage

The results show that interior potted-plants really do make an efficient, self-regulating, low-cost, sustainable, attractive cleaning system for indoor air -

- **Suitable in any type of building**
- **They also directly promote human wellbeing and performance**
- **Have now, for example, been adopted by the Green Building Council of Australia for Green Star ratings for plant installations in new commercial buildings or refurbishments**

UTS research in progress on *'Greening the great indoors'*

With funding from the (Aust.) National Interior Plantscape Association (NIPA) and Horticulture Australia Ltd (HAL) we have started a second office study, this time with 100 offices, to investigate simultaneously*:*

- Minimum numbers of plants needed for effective removal of TVOCs, CO_2 and CO
- Effects of plants-in-the-office on participants' health and wellbeing, as measured by survey questionnaires and any reductions in sick leave absences
- Other plant species/varieties, in test-chamber trials

Further R&D directions: Opportunities for you to sponsor research for - '*Greening the Great Indoors'*

A 3-pronged R&D approach is needed for the further development of interior plantscape horticulture, to promote improved indoor environmental quality (IEQ), health and wellbeing of building occupants, and towards a sustainable city environment. In satisfying the 'triple bottom line' of economic, environmental and social considerations, indoor plants should be expected to become a vital building element.

We see the following as priorities, and welcome other ideas from the interiorscape industry.

a) Plants – for enhanced removal of VOCs, CO_2, CO, particulates, etc-

i. Other species / varieties in office field trials
ii. Optimising / balancing removal capacities with respect to different pollutants
iii. Specialist plantings for different building situations?

b) Potting mixes – to maximize root-zone microorganism removal capacities

iv. Differences in activity with different potting mixes
v. Plant/root-zone microorganism interactions
vi. Potting mix enhancement for VOC removal

c) People's needs –the ultimate goal –demonstrating the human and socioeconomic values of the indoor potted-plant microcosm

vii. Designing placements for maximum benefits
viii. Quantifying improved satisfaction and productivity
ix. Marketing the message more effectively to building managers