



Life in the great indoors

Over 80% of Australians live in cities and on average spend 90% of their time indoors.

Indoor air is generally more polluted than outdoor air due to Volatile Organic Compounds (VOCs) produced by furnishings, carpets, paints, and outdoor VOCs (mainly fuel emissions) trapped indoors.

Research conducted by the Plants and Environmental Quality Group at the University of Technology, Sydney has shown that:

- Indoor pot plants usually reduce Volatile Organic Compounds by 50% to 70%
- Pot plants clean indoor air in both air-conditioned and non air-conditioned environments.

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Using pot plants to clean indoor air

Polluted indoor air, air contaminated by Volatile Organic Compounds (VOCs), are a major cause of headaches, nausea, concentration loss and other 'building-related illnesses'. Previous laboratory research by the Plants and

Environmental Quality Group at the University of Technology, Sydney (UTS) has shown that the 'pot plant system' (plants-and-potting-mix combination) can daily eliminate several times the Australian maximum exposure concentrations of the common VOCs benzene and n-hexane.

The main removal agents are the potting-mix micro-organisms. The plants mainly contribute by maintaining their root-zone microbial communities (see Nursery Paper 2001/2).

How many pot plants are needed?

To help discover how many pot plants are needed to bring about significant reductions in VOCs in 'real world' offices, a project was set up by the UTS group. The 34 chosen offices were used to determine the number of pot-plants needed to bring about a significant reduction in VOCs. These offices were located in three different UTS buildings across Sydney, two of which were air-conditioned and in the city while the other was not air-conditioned and was in the northern suburb of Gore Hill. Air quality in planted and unplanted offices was monitored and compared and outdoor air quality was also sampled.

The offices were designed for single occupancy being 10-12 m² with a ceiling height of between 3-4m, which is comparable with



Six table sized pot plants (200 mm pots) are as effective as 3 floor standing pot plants (300 mm pots) in improving indoor air quality.

residential rooms. The air-conditioned buildings supply 6-8 air changes per hour per office but the buildings receive only 10-15% fresh air input every 24 hours. While this is in accordance with international standards, the quality of the indoor air bears little relationship to that of outdoor air at any given time.

The project was conducted over two successive 5-9 week periods using the plant species *Dracaena deremensis* 'Janet Craig' and *Spathiphyllum* 'Sweet Chico'. These plant species were selected because they are popular indoor plant varieties and have previously found to be effective in removing VOCs.

Large floor standing pot plants

Using a total of 18 offices, air-conditioned and non air-conditioned, 2 sets of 9 were randomly supplied with:

- Six large floor standing pot plants
Dracaena deremensis 'Janet Craig'
(ht 1.3m; 300mm pots)
- Three large floor-standing pot plants
Dracaena deremensis 'Janet Craig'
(ht 1.3m; 300mm pots), or
- No pot plants (control offices).

Weekly measurements of air quality were then made over a nine-week period after which the pot-plants were randomly reassigned for a second nine-week period.

While six large floor standing plants may be considered too many for one office or room, this density was included: to compare its effectiveness with that of three specimens.

Table sized pot plants

To compare the effectiveness of table sized pot plants with that of the large floor standing pot plants, a total of 16 offices, 2 sets of eight were supplied with:

- Six table-sized pot plants, five *Spathiphyllum* 'Sweet Chico' plus one *Dracaena deremensis* 'Janet Craig' (ht 30-40cm; 200mm pots), or
- No pot plants.

Six table sized pot plants can easily fit in most rooms using tables and/or shelves. Air quality measurements were made during nine and five-week periods.



Research has shown that only 3 floor standing pot plants are required to significantly improve air quality in an average sized office or room.

Monitoring the air quality

Portable monitors were used to sample every office on a weekly basis and provide readings of Total Volatile Organic Compounds (TVOCs), carbon dioxide, carbon monoxide, relative humidity and temperature. Individual VOCs were identified using passive Organic Vapour Monitors placed on shelves for one week, and analysed by WorkCover, NSW.



Just a few pot plants can significantly improve indoor air quality in both air-conditioned and non air-conditioned offices or rooms.



'Real World' research has shown that as few as 3 pot plants are required to significantly improve indoor air quality, not a jungle.

Results – large floor standing pot plants

Either 3 or 6 of the large floor standing pot plants significantly reduced TVOC levels, see figure 1. The results also showed that when TVOC loads in the unplanted offices were over 100 ppb (9 of the 18 weeks), levels in planted offices were lower by up to 50–70%.

In addition the results showed that three pot plants were as effective as six, and the plantings were effective in air-conditioned and non-air-conditioned circumstances.

Figure 1: Large floor standing pot plants investigation - TVOC levels recorded over two successive nine-week periods.

- A. All readings with nil, 3, or 6 D. 'Janet Craig' plants and ambient (outside).
 B. Readings in weeks when TVOC levels were >100ppb in unplanted offices.

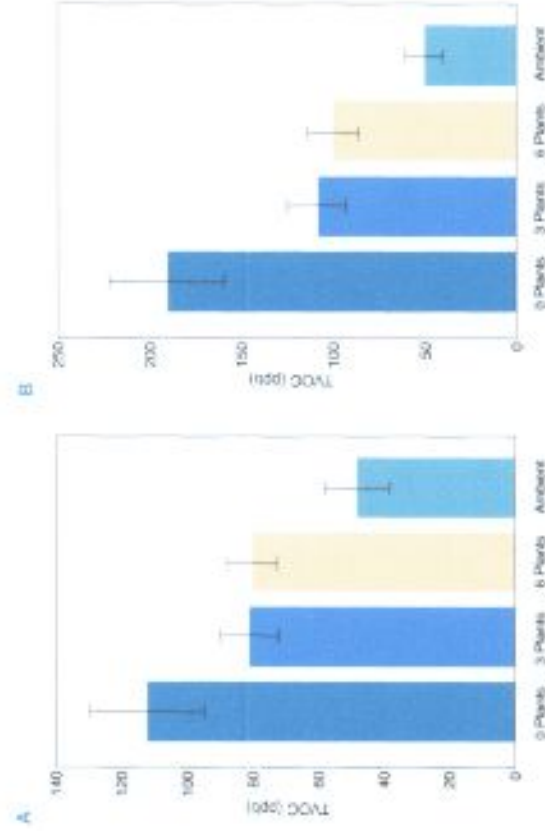
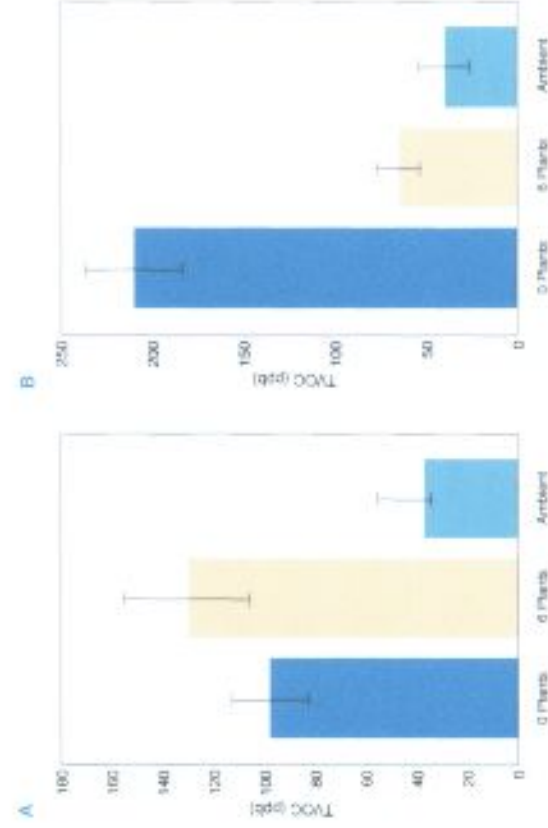


Figure 2: Table sized pot plants investigation - TVOC levels over a nine week and five week period.

- A. All readings with nil or 5 S. 'Sweet Chico' plus 1 *Dracaena 'Janet Craig'* plants and ambient (outside).
 B. Readings in weeks when TVOC levels >100 ppb in unplanted offices



Results – table sized pot plants

Figure 2 shows that overall TVOC levels in the planted offices were generally a bit higher than the unplanted offices, probably because the *Spathiphyllum 'Sweet Chico'* was in flower. However, as with the large floor standing pot plants, in those weeks when TVOC concentrations in unplanted offices were higher than 100 ppb (3 of 14 weeks), there was a large (70%) reduction in the presence of TVOC in the planted offices.

The TVOC loads in indoor air were generally higher than in outdoor air, see figures 1 and 2. Table 1 shows mean values for other air variables. Note the carbon dioxide levels are typically higher indoors due to people exhaling.

Table 1. Air quality characteristics for both large floor standing and table sized pot plant investigations. (mean \pm standard variation).

Investigation/ Building/ No. Plants	Temperature (°C)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)
Large floor standing pot plants				
Building 1	22.8 \pm 0.2	44.2 \pm 2	365 \pm 17	0
Outdoors	21.2 \pm 1.0	47.5 \pm 2	248 \pm 41	0.04 \pm 0.20
Building 3	20.8 \pm 0.4	47 \pm 3	280 \pm 15	0.02 \pm 0.02
Outdoors	18 \pm 1.0	51 \pm 6	180 \pm 13	0.02 \pm 0.02
Table sized pot plants				
Building 2	22.8 \pm 0.2	45 \pm 3	320 \pm 7	0
Outdoors	22.7 \pm 1.5	56 \pm 5	170 \pm 5	0.02 \pm 0.01
Building 3	21.0 \pm 0.6	49 \pm 5	420 \pm 80	0.10 \pm 0.01
Outdoors	20.7 \pm 1.3	47 \pm 7	180 \pm 12	0

Implications

The results imply indoor air-borne TVOC concentrations above a threshold of about 100 ppb (considered an extremely low concentration) stimulate a metabolic VOC-removal response in potted plants. TVOC loads lower than this threshold do not stimulate the response, indicating the system is adaptive and self-regulating.

Further research is being carried out to better understand and/or verify this suggested mechanism of VOC removal.

Summary

The studies showed that:

- Total Volatile Organic Compounds (TVOCs) were higher indoors, with or without plants.
- Pot-plants consistently reduced office or room TVOC levels by 50 to 70% where more than 100 ppb TVOC load was present without pot plants
- Three large floor standing pot plants were as effective as six in bringing about large TVOC reductions in offices or rooms that are 10–12 m² with a ceiling height of between 3–4m
- Six table-sized pot plants were as effective as three (or six) of the larger floor standing pot plants.
- Pot-plants reduce TVOC levels in air-conditioned and non-air-conditioned circumstances.

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