AIR POLLUTION GREENHOUSE FIGURES, CHARTS AND PHOTOGRAPHS

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA 1990-91
THE AIR POLLUTION GREENHOUSE

The Los Angeles State and County Arboretum, the California Air Resources Board [and in 1990, the South Coast Air Pollution Management District] are co-operating in establishing, maintaining, and improving the Air Pollution Greenhouse Display on the grounds of the Arboretum, in Arcadia, California. The exhibit, which runs from April thru October, was first opened in 1987. Visitors can see, touch and smell plants grown in air from which all pollution has been removed. They can then compare the appearance of these commonly grown plants with those grown in a matching greenhouse which has no filtered air. Environmental conditions in the greenhouses match each other and those in the outside [ambient] air in Arcadia as closely as possible. Therefore, the reason for the difference in the plants is the air pollution.

Over 100 kinds of kinds of plants have been on display, with many showing dramatic responses to air pollution. Very little is known about the impact of air pollution on ornamentals. The photographic record of the response of the plants to air pollution is the first of its kind. The display combining a working greenhouse with living plants and museum quality educational materials is the only one of its kind.

During the time it has been open, the display has undergone improvements and modifications which are pictured in the pages which follow. More than 100 thousand visitors have viewed the exhibit and many more have learned about it through coverage on TV, newspapers, and in popular magazines. Most people have never seen plants growing in clean air, and go away from the exhibit planning to take action to help reduce pollution.

The pages which follow identify the location, layout, and contents of the display; identify the improvements to the facilities and the display materials in the greenhouses and information center; and document the responses of both the plants and of the visitors to the display.

PHOTOGRAPHS, CHARTS, AND FIGURES FOLLOW
AIR POLLUTION GREENHOUSE
INTRODUCTION

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA 1990-91
FLOOR PLAN OF FACILITIES
AIR POLLUTION GREENHOUSE DISPLAY

CLEAN AIR GREENHOUSE 35'  X 7'  X 13'

PATHWAY

PLANTING BED

GLASS WALL

PLANTING BED

PATHWAY

SINK

EDUCATIONAL DISPLAY

BLOOM

STORAGE COUNTER

AIR POLLUTION GREENHOUSE
ARCADIA, CA

AMBIENT AIR GREENHOUSE

L.A. STATE AND COUNTY ARBORETUM, ARCADIA CA
THE AIR POLLUTION GREENHOUSE DISPLAY AND INFORMATION CENTER

"SMOGGY" GREENHOUSE AND "CLEAN AIR" GREENHOUSE PORTION OF THE DISPLAY ON THE LEFT; INFORMATION CENTER WITH AIR QUALITY MONITORS AND EDUCATIONAL MATERIALS ON THE RIGHT

THE AIR POLLUTION GREENHOUSE EXHIBIT AS SEEN FROM THE WALKWAY
THE AIR POLLUTION GREENHOUSE DISPLAY AND INFORMATION CENTER

DUST FILTERS AND COOLERS FOR "SMOGGY AIR" SIDE RECEIVED REGULAR SERVICE, AND KEPT THE AIR TEMPERATURES MATCHED TO THAT OF THE OUTSIDE AIR IN ARCADIA.

CHARCOAL FILTERS AND COOLERS FOR "CLEAN AIR" SIDE RECEIVED REGULAR SERVICE AND KEPT THE GREENHOUSE FREE OF AIR POLLUTION, BUT AT THE SAME TEMPERATURE AS THE OUTSIDE AIR.
THE AIR POLLUTION GREENHOUSE
DISPLAY AND INFORMATION CENTER

BENCHES FOR SMALLER POTS WERE INSTALLED WITH TRADITIONAL SIZED SIGNS WHEN THE GREENHOUSE WAS OPENED IN 1987.

LARGER PLANTS IN FIVE GALLON CONTAINERS WERE SET IN LARGER POTS IN THE GROUND FOR DISPLAY IN 1987, BUT SIGNS WERE NOT INCLUDED.
THE AIR POLLUTION GREENHOUSE
DISPLAY AND INFORMATION CENTER

THE LAYOUT OF THE PLANTS IN THE FILTERED SIDE OF THE
GREENHOUSE (TOP) IS A MIRROR IMAGE OF THE
PLANTING ARRANGEMENT ON THE UNFILTERED SIDE (BOTTOM.)
LAYOUT OF GREENHOUSE DISPLAY
AIR POLLUTION GREENHOUSE, 1987

L.A. STATE AND COUNTY ARBORETUM, ARCADIA CA
LAYOUT OF GREENHOUSE DISPLAY
AIR POLLUTION GREENHOUSE, 1988

Base plants on opposite side of greenhouse.

Acer saccharinum
Raphiolepis indica
Itea mays
Pittosporum tobira
Ficus carica cv. Blue Celeste
Platanus occidentalis
Camellia japonica
Podocarpus macrophyllus
Atriplex olmunder
Catalpa speciosa
Washingtonia filifera
Hibiscus rosa-sinensis
Juniperus chinensis 'Pfitzerana'
Morus alba
Lantana hybrids
Pelargonium hortorum
Allanthus altissima
Pinus canariensis
Rosa
Ligustrum abmentis
Cytisus scoparius
Poa pratensis 'Marathon'
Vitis cv. Fredonia

Cucurbita pepo
Lobularia maritima
Gazania rigens
Delosperma 'Alba'
Daucus carota var. sati

Dahlia hybrids
Viola wittrockiana
Matthiola incana
Raphanus sativus
Phaseolus vulgaris
Cucumis sativus
Lycopersicon lycopersicum
Tagetes sp.
Antirrhium majus
Menta
Dianthus sp.
Petroselinum crispum
Petunia hybrida
Phaseolus vulgaris

L.A. STATE AND COUNTY ARBORETUM, ARCADIA CA
LAYOUT OF GREENHOUSE DISPLAY
AIR POLLUTION GREENHOUSE, 1989

Some plants on one opposite side of greenhouse

Prunus caroliniana
Rosa sp.
Ulmus parvifolia
Pittosporum tomentosum
Magnolia grandiflora
Podocarpus macrophyllus
Rosa sp.
Camellia japonica
Washingtonia filifera
Nerium oleander
Felicia amelloides
Juniperus chinensis 'Pfitzer'
Citrus
Raphiolepis indica
Lantana camara
Fortunella margarita
Betula alba
Rosa sp.
Schinus molle
Vitis cv. Fredonia

Gazania rigida
Lobularia maritima
Daucus carota var. sativus
Raphanus sativus
Brassica oleracea
(Broccoli)
Brassica oleracea
(Cauliflower)
Zinnia elegans
Cleome spinosa
Dahlia hybrids
Lobelia erinus
Ageratum houstonianum
Cucumis sativus
Antirrhinum majus
Solanum melongena
Coreopsis species
Lycopersicon esculentum
Tagetes
Phaseolus vulgaris
Capsicum annuum
Dianthus sp.
Menta
Petroselinum crispum
Petunia hybrids

L.A. STATE AND COUNTY ARBORETUM, ARCADIA CA
| California pepper tree       | Mother fern     |
|                            | Common tansy    |
| Pfitzer Juniper            | Floss flower    |
| India Hawthorn             | Snapdragon      |
| Oleander                   | Globe amaranth  |
| Silverado rose             | Columbine       |
| Playboy rose               | Cockscob        |
| Bonica rose                | Lettuce         |
| Bougainvillea              | Carrot          |
| Camellia                   | Cucumber        |
| Pineapple guava            | Eggplant        |
| Weeping willow             | Pepper          |
| Southern magnolia          | President tomato|
| Pink iron bark             | Patio tomato    |
| Yew pine                   | Celery          |
| Chinese flame tree         | Corn            |
| Avocado                    | California Red Onion |
| Lantana                    | Bush bean       |
| Fig                        | Pinto bean      |
| Waxleaf privet             | Kentucky blue bean |
| Mock orange                | Radish          |
| California Fan Palm        | Cauliflower     |
| Niagara grape              | Nicotiana       |
|                            | Parsley         |
|                            | Coriander       |
|                            | Rosemary        |
|                            | Sorrel          |
|                            | Basil           |
|                            | Oregano         |
|                            | French tarragon |
|                            | Curry plant     |
|                            | Peppermint      |
|                            | Pennroyal       |
|                            | Chives          |
|                            | Society garlic  |
|                            | Scarlet sage    |
|                            | Swan River daisy|
|                            | Viola           |
|                            | Carnation       |
|                            | Dahlia          |
|                            | Primrose        |
|                            | Petunia         |
|                            | Common geranium |
|                            | N. Washington geranium |
|                            | Lemon Balm geranium |
THE AIR POLLUTION GREENHOUSE
DISPLAY AND INFORMATION CENTER

VISITORS OF ALL AGES COME TO THE GREENHOUSE. BENCHES ON THE RIGHT HOLD SMALLER CONTAINERS. LARGER PLANTS ARE PLACED IN FIVE GALLON CONTAINERS AND BURIED IN THE PLANTING BED, SHOWN HERE ON THE LEFT HALF OF THE PICTURE. WHEN THE PLANTS IN THE SMALL POTS SHOWN HERE ON THE GROUND ARE LARGER, THEY WILL BE PLACED ON THE BENCHES. SOME WILL GO IN "SMOGGY AIR" SIDE, SOME TO THE "CLEAN AIR" SIDE. THE GLASS WALL ON THE LEFT EDGE OF THE PICTURE SEPARATES THE TWO SIDES OF THE GREENHOUSE. THE DOOR BETWEEN THE TWO SIDES IS NOT OPEN IN THIS PICTURE.
THE AIR POLLUTION GREENHOUSE
DISPLAY AND INFORMATION CENTER

IN 1987, VISITORS TO THE INFORMATION CENTER COULD SEE AN AIR QUALITY MONITOR AT WORK AND WALL CHARTS DESCRIBING THE SOURCES OF AIR POLLUTION, THE TYPES OF AIR POLLUTANTS, AND HOW POLLUTION IMPACTED PLANTS.

THE HOUSE PLANTS IN THESE PICTURES HAD NO SYMPTOMS OF AIR POLLUTION AND WERE LATER REPLACED WITH LIVING PLANTS WITH AIR POLLUTION SYMPTOMS. THE AIR CONDITIONER IS NEEDED TO KEEP THE AIR QUALITY MONITOR IN OPERATION.
POSTERS ON DISPLAY
INFORMATION CENTER, 1987-1989

What Air Pollution Numbers [PSI] Mean
Ozone Alert Levels
Parts of the Air Quality Monitor
Air Pollution and Plants
Air Pollutants that Damage Plants
The Air Pollution Triangle
Sources of Air Pollution that Form Ozone
Smog Costs Agriculture Millions
Geography and Air Pollution
Climate and Air Pollution
Air Pollution Damage to Plants
What You Can Do About Air Pollution
Growth Reduction in Dusty Miller

AIR POLLUTION GREENHOUSE, LASCA
This Season's Smoggiest Day
Example of the Air Quality Monitor's Strip Chart
The Greenhouse: How We Filter the Air
Air Pollution Can Have the Same Effect on Different Plants: Yellow Leaves
Air Pollution Can Have the Same Effect on Different Plants: Reduced Growth
Air Pollution Can Have Different Effects on the Same Plant: Petunia and Cockscomb
Confused about "Ozone?" An Air Pollutant and the Greenhouse Effect
Structure of the Earth's Atmosphere
Smog Damage to Leaf Cuttings
What We Do at the Air Pollution Greenhouse
What is Smog?
The Air Pollution Poll: What I did to reduce pollution!
AIR POLLUTION GREENHOUSE IMPROVEMENTS TO THE FACILITIES

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA 1990-91
THE AIR POLLUTION GREENHOUSE
PHOTOGRAPHS OF THE IMPROVEMENTS TO THE FACILITY

IMPROVEMENTS WERE MADE TO THE ORIGINAL FACILITIES TO MAKE THE EXHIBIT EASIER TO FIND AND TO UNDERSTAND

New, large direction signs were installed to help the visitors locate the greenhouse.

A new door and welcome sign were added to the entrance of the information center.

A new air conditioner was installed to permit the operation of the pollution monitoring equipment.

The information center was rearranged to permit the construction of a photography studio.

Equipment was added to the potting area and to the information area to fumigate sample plants with ozone so that symptoms were always on display in the greenhouse and information center until the ambient smog levels were high enough to produce symptoms in the smoggy side of the greenhouse.

PHOTOGRAPHS ILLUSTRATING THE IMPROVEMENTS FOLLOW
THE AIR POLLUTION GREENHOUSE
UPGRADE DIRECTION SIGNS TO DISPLAY

NEW SIGN FOR
WALKWAY TO
FRONT OF THE
GREENHOUSE WAS
ADDED 1989-90.

NEW SIGN FOR
WALKWAY TO
SIDE OF THE
GREENHOUSE WAS
ADDED 1989-90.
THE AIR POLLUTION GREENHOUSE
IMPROVEMENTS TO INFORMATION CENTER FACILITIES

ENTRANCE TO
INFORMATION CENTER
1987

A NEW SIGN AND
DOOR TO
INFORMATION
CENTER WERE
ADDED 1989-90.
THE AIR POLLUTION GREENHOUSE
IMPROVEMENTS TO INFORMATION CENTER FACILITIES

IN 1989, A NEW AIR CONDITIONER WAS INSTALLED TO KEEP THE AIR QUALITY MONITOR OPERATING AND THE ELECTRICAL CIRCUITS WERE UPGRADED

THE AIR QUALITY MONITOR WAS RELOCATED TO MAKE ROOM FOR A PHOTOGRAPHY STUDIO. A LED DISPLAY TO INCREASE THE SIZE OF THE AIR QUALITY READOUT NUMBERS ECHOED THE RECORDED OZONE LEVELS
The first set up to take photographs was to "borrow" the table used to house the questionnaire and move it outside. These photographs show onions produced smaller bulbs in the ambient air side of the greenhouse and that Browallia speciosa was almost impossible to grow in the ambient air side of the greenhouse.
In 1988 a photography studio was set up in the information center to photograph the smaller plants. At first a plain white backdrop was tried. Because of the location of the power outlets, the studio was near the entrance. The information center had to be closed to the public while photographs were being taken.
In 1990 the photography studio was moved to the rear of the information center. The air quality monitor was re-located to permit photography of larger plants. A large pull down backdrop was installed near the ceiling. A new poster describing how the air was filtered was displayed when the photography studio was not in use.

The new photography studio in use by the photographer, Ken Quigley.
THE AIR POLLUTION GREENHOUSE
IMPROVEMENTS TO INFORMATION CENTER FACILITIES

Equipment was installed to generate ozone, including (LEFT TO RIGHT) a strip chart, ozone monitor, tubes connecting the ozone chamber to the monitor, the generator itself, and an oxygen tank. The potting area was used as the chamber, and the greenhouse was closed to the public during fumigations.

The new ozone generating equipment in use by the air pollution consultant from UC Riverside, Gerrit Kats. Three treatments were required to provide examples of air pollution injury before the ambient side contained high enough levels of "smog" to produce symptoms in the display plants.
THE AIR POLLUTION GREENHOUSE
PHOTOGRAPHS OF IMPROVEMENTS TO THE DISPLAYS

IMPROVEMENTS WERE MADE TO THE DISPLAYS IN THE INFORMATION AREA AND THE GREENHOUSES TO HELP THE VISITORS IDENTIFY THE PLANTS AND THE AIR POLLUTION SYMPTOMS

Improvements were made to the signs and posters in the Information Center and new posters and a slide show were added.

A Free-standing floor display was added.

Pairs of plants, one from each side of the Greenhouse, were moved to the Information Center to give visitors a preview and aid in identification of air pollution symptoms.

Visitors were polled about measures they preferred to use in reducing air pollution, and the questionnaire about the Display continued to give feedback about the display.

Vegetation was replaced for the opening of the exhibit season in April and replanted as necessary to maintain examples of pollution symptoms until the exhibit closed in October.

Tour Guides were added to answer questions and to improve the maintenance of the display plants, and increase security.

Photographs were taken of the plants and used in new signs to help the visitors identify the plant species and the pollution symptoms. Photographs of the 77 plants showing the most striking symptoms were used in the signs. An example of the sign is included.

Changes were made to the photography set up to provide a standard background for each picture.

PHOTOGRAPHS ILLUSTRATING THE IMPROVEMENTS FOLLOW
AIR POLLUTION GREENHOUSE IMPROVEMENTS TO THE INFORMATION CENTER

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA 1990-91
THE AIR POLLUTION GREENHOUSE
EXPAND AND IMPROVE INFORMATION DISPLAY

INFORMATION CENTER
MAIN ENTRANCE, 1987
BEFORE GRAPHICS
AND DISPLAYS WERE
ADDED

THE CLOSED DOOR LEADS TO
THE POTTING SHED AND
GREENHOUSE
THE AIR POLLUTION GREENHOUSE
EXPAND AND IMPROVE INFORMATION DISPLAY

FREE STANDING DISPLAY:
"SMOG COSTS AGRICULTURE MILLIONS"
ADDED, 1989-90

SYMPTOM IDENTIFICATION POSTERS,
ACTIVITY POLL, AND NEW HANDOUTS
ADDED, 1990-91
THE AIR POLLUTION GREENHOUSE
EXPAND AND IMPROVE INFORMATION DISPLAY

VIEW OF THE GRAPHICS ON THE WALLS AND DISPLAY ITEMS ON THE WORK BENCH IN THE DISPLAY AREA OF THE INFORMATION CENTER. AN AUTOMATIC SLIDE PROJECTOR WITH A BUILT IN SCREEN SHOWED PHOTOGRAPHS OF SYMPTOMS AND SELECTED PLANTS GAVE VISITORS A PREVIEW OF THE "SYMPTOM OF THE DAY" TO AID THEM IN IDENTIFYING SYMPTOMS IN THE GREENHOUSE. NEW POSTERS WERE ADDED, SHOWN HERE NEXT TO THE WINDOW AND AS A FREE STANDING DISPLAY ON THE FLOOR. THE NEW POSTERS EXPLAINED HOW THE GREEN HOUSE WAS OPERATED AND SHOWED VISITORS HOW AIR POLLUTION SYMPTOMS SHOW UP ON LEAVES. A PULL DOWN BACKDROP WAS CONSTRUCTED TO COVER THE WINDOW WHEN THE PHOTOGRAPHS WERE BEING TAKEN. IT PROVIDED A STANDARDIZED GRIDDED BACKGROUND FOR ALL THE PHOTOGRAPHS TO AID THE VIEWER IN IDENTIFYING THE PLANT'S NAME, TYPE OF EXPOSURE, SIZE, DATE AND LOCATION.
AIR POLLUTION GREENHOUSE IMPROVEMENTS TO THE GREENHOUSE DISPLAY

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA 1990-91
THE AIR POLLUTION GREENHOUSE
EXPAND AND IMPROVE GREENHOUSE DISPLAY

GREENHOUSE
IN 1987 BEFORE
PLANTS WERE
ADDED, SHOWING
SHOWING BENCH
AND FLOOR
AREAS. THE
GLASS WALL
BETWEEN THE
FILTERED SIDE
AND THE NON
FILTERED SIDE
IS ON THE LEFT
OF THE PICTURE.

NEW DISPLAY
PLANTS ARE
ADDED IN APRIL
WHEN THE EXHIBIT
OPENS. THIS 1987
PHOTOGRAPH OF THE
CLEAN AIR SIDE
INDICATES HOW
VIGOROUSLY THE
PLANTS GROW IN
CLEAN AIR. PLANTS
IN THIS LAYOUT
ARE DIFFICULT TO
IDENTIFY AND THE
VIEWER CANNOT
EASILY COMPARE
PLANTS FROM
ONE SIDE WITH
PLANTS FROM
ANOTHER.
THE AIR POLLUTION GREENHOUSE
EXPAND AND IMPROVE GREENHOUSE DISPLAY

AFTER THE
FIRST DISPLAY
SEASON, PLANTS
WERE DISCARDED
WHEN THEY NO
LONGER DISPLAYED
AIR POLLUTION
SYMPTOMS, SO
THE EXHIBIT
DID NOT APPEAR
SO CLUTTERED.
HERE, JOE WILLIAMS
IS PROVIDING THE
NECESSARY CARE TO
MAINTAIN THE PLANTS
AT THE QUALITY REQUIRED
FOR A DISPLAY OF
AIR POLLUTION
SYMPTOMS.

NEW PLANTS IN POTS
ARE REPLACED
AS NEEDED TO KEEP
THE SYMPTOMS CLEARLY
VISIBLE. PLASTIC
DUCTS NEAR THE
ROOF MOVE THE AIR
FROM THE AIR
CONDITIONING
AND FILTERING
EQUIPMENT THROUGH
THE GREENHOUSE.
THE AIR POLLUTION GREENHOUSE
EXPAND AND IMPROVE GREENHOUSE DISPLAY

In 1989, tour guides were added to the display. Here, in 1990, Gloria Mao gives a tour designed for the age of the audience. These junior high school students enjoy smelling the air in the filtered side. The glass wall in the background separates the potting area/fumigation chamber from the rest of the plant display area and the information center. Staffing the greenhouse with guides all the hours it was open improved security.
THE AIR POLLUTION GREENHOUSE
EXPAND AND IMPROVE GREENHOUSE DISPLAY

Visitors commented that differences in size shape, or color of leaves and flowers were difficult to see from one side of the greenhouse to the other. The signs on the plants were improved in 1989-1990. The sign nailed bench in front of the Dahlia is traditional, but expensive and too small to see easily. The sign in front of the plant is too big to leave in the display and too small to use in a photograph. The sign above the plant helps the visitor identify the type of smog injury.
THE AIR POLLUTION GREENHOUSE
EXPAND AND IMPROVE GREENHOUSE DISPLAY

New, large laminated signs show the plant’s scientific
and common names. These signs are cheap, easy to make, read
and relocate. Photos were taken in the filtered side.
Plume cockscomb makes a good display plant because the flowers fade dramatically in the smoggy side of the greenhouse (top photograph). The bottom photograph was taken in the clean air side.
THE AIR POLLUTION GREENHOUSE
EXPAND AND IMPROVE GREENHOUSE DISPLAY

The group of coleus plants on the left are grown in the clean air side of the greenhouse, and are brighter and bigger than the photograph below. However, this difference is not obvious all season long. In 1990, signs were hung behind each type of plant, showing the visitor what symptom is most obvious. Photographs taken in 1989 were used to make the improved signs. Coleus is a good plant to put in the display because the growth reduction is obvious even when viewed from the pathway in the greenhouse. A photocopy of a sign is on the next page.
LEAF SPOTS

SMALLER LEAVES
THE AIR POLLUTION GREENHOUSE
EXPAND AND IMPROVE GREENHOUSE DISPLAY

Reductions in growth due to air pollution were documented using groups of plants kept in each side of the greenhouse and photographed every two weeks against a standard background. The photograph below is the group of Dusty Miller plants in the unfiltered side. Although available space limited the size of the group, these plants all appear to be of a similar size and without symptoms. Unless compared with the matched set from the unfiltered side, it is difficult to see any growth reductions.
THE AIR POLLUTION GREENHOUSE
EXPAND AND IMPROVE GREENHOUSE DISPLAY

All these Dusty Miller plants were grown from seed in the filtered side, and then half were transferred to the unfiltered side. Both the "A" plants and the "B" plants showed growth reductions in the smoggy side of the greenhouse. The growth reduction photographs were made possible by the addition of the photography studio in 1989-90.

DUSTY MILLER
Centaurea cineraria
Arcadia, Ca
August 30, 1989
THE AIR POLLUTION GREENHOUSE
EXPAND AND IMPROVE GREENHOUSE DISPLAY

These 1987 photographs of Washingtonia filifera show that California Fan palm is a good tree to put in the exhibit because differences in the leaves were striking. Additional improvements are needed to the photography set up to photograph air pollution symptoms on plants which live longer than one season or are too large have more than one plant in each side of the greenhouse.
THE AIR POLLUTION GREENHOUSE
EXPAND AND IMPROVE GREENHOUSE DISPLAY

This 1989 photograph of the California Fan Palm was taken at a time in which the leaf injury symptoms were not as striking as they were in the previous photographs, which were taken in 1987. The time of the visit and the timing of the photography can be critical in seeing the symptoms and the order in which they appear. The tree on the right is from the smoggy side of the greenhouse, and is smaller and has lost some of its fronds.
## PROBLEMS WITH DISPLAY PLANTS IN GREENHOUSE, 1990

<table>
<thead>
<tr>
<th>TYPE OF PROBLEM</th>
<th>PLANT WITH PROBLEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNAILS</td>
<td>CAULIFLOWER, CUCUMBER, RADISH, GRAPE</td>
</tr>
<tr>
<td>ANTS</td>
<td>CORIANDER, IMPATIENS, PEPPER</td>
</tr>
<tr>
<td>APHIDS AND ANTS</td>
<td>CAULIFLOWER, PEPPER, CORIANDER, CARROT, CARNATION, PARSLEY, AVOCADO</td>
</tr>
<tr>
<td>SPIDER MITES</td>
<td>FLOSSFLOWER, CELERY, PEPPER, CORIANDER, DAHLIA, CARROT, CARNATION, GARDENIA, IMPATIENS, MINT, BASIL, PARSLEY, RADISH, ROSES, SCORER, MARIGOLD, CORN, COREOPSIS, BEANS</td>
</tr>
<tr>
<td>WHITEFLIES</td>
<td>ORANGE, TOMATO, AVOCADO, MOCK, ORANGE</td>
</tr>
<tr>
<td>POWDERY MILDEW</td>
<td>BEGONIA, EGGPLANT, PRIMROSE, VIOLA</td>
</tr>
<tr>
<td>SOOTY MOLD</td>
<td>ORANGE, AVOCADO, TOMATO, LANTANA, NICOTIANA, GERANIUM</td>
</tr>
<tr>
<td>HEAT STRESS</td>
<td>SNAPPDRAGON, COLUMBINE, SWAN RIVER DAISY, CAULIFLOWER, COREOPSIS, CUCUMBER, LAVENDER, LETTUCE, PRIMROSE, EGGPLANT, VIOLA, GRAPE, BEGONIA</td>
</tr>
<tr>
<td>POOR ADAPTATION, CAUSE UNKNOWN</td>
<td>FRENCH TARRAGON, CHINESE FLAME TREE, YEW PINE WEEPING WILLOW</td>
</tr>
</tbody>
</table>

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA CA
PESTICIDES USED IN GREENHOUSE, 1990
GREENHOUSE CLOSED DURING CHEMICAL APPLICATIONS

<table>
<thead>
<tr>
<th>CHEMICAL, DATE APPLIED</th>
<th>EFFECTIVENESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>METALDEHYDE 4/11/90</td>
<td>1 application eradicated snails for entire season</td>
</tr>
<tr>
<td>SAFER SOAP 6/15, 6/30, 7/15</td>
<td>Mildly effective on aphids for 3 days to one week. Severe damage to scarlet</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 application very effective on ants for up to 2 months</td>
</tr>
<tr>
<td>DIAZINON 5/8, 6/15, 8/13</td>
<td>1 application very effective on aphids, whiteflies, or spider mites for up</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>MAVRIK 6/18 [24 hr shutdown]</td>
<td>1 application effective on spider mites for up to 3 week</td>
</tr>
<tr>
<td>PENTAK 6/18 [24 hr shutdown]</td>
<td></td>
</tr>
<tr>
<td>RESMETHRIN 7/9, 8/13 [16 hr shutdown]</td>
<td>1 application moderately effective for aphid and whitefly for up to 2 weeks</td>
</tr>
<tr>
<td>ORTHENE 7/16 [16 hr shutdown]</td>
<td>1 application gave moderate control for spider mites &amp; whitefly for up to 2 weeks</td>
</tr>
<tr>
<td>EXCLUDE 8/18, 9/7</td>
<td>Spot treatments moderately effective for aphids, spider mites and whiteflies for 2-3 weeks</td>
</tr>
<tr>
<td>CHIPCO 6/18</td>
<td>Fungicide to control powdery mildew; 1 application eliminated fungus for 3 months</td>
</tr>
</tbody>
</table>

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA CA
PHOTOGRAPHS OF ORNAMENTALS

EQUIPMENT USED AND CHANGES IN THE SET-UP

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA 1990-91
EQUIPMENT USED IN PHOTOGRAPHY STUDIO
AIR POLLUTION GREENHOUSE DISPLAY DOCUMENTATION

2 Cannon AE-1 Cameras
Minolta X700 CAMERA
Minolta 50MM MACRO LENS
Dot Line Corp. 24" Cable Release
Craig DT 6000 Tripod with support for two cameras
3 Smith Victor K62 steel light stands
Smith Victor 85 Mini Boom
3 Smith Victor Q60 video lighting units
4 Smith Victor A12UL clip lights
HOYA 87MM Filter 80B
HOYA 55MM Skylight Filter 1B
Falcon Dust off II
4 Extension cords with 2 or 4 way sockets
KODACOLOR Color Print Film, 100 ASA
ECKTACHROME Color Slide Film, 200 ASA
STANDARD BACKGROUND MATERIALS
  Grey backdrop paper and roller
  Grey grid-board backdrop
  Grey cloth backdrop
  Ruler made for backdrop
  Grey frontboard
  Grey signs with plant names, date, location
  Prop boxes and boards
Photographer
Photographer helper to move plants in and out

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA CA
PHOTOGRAPHY SET UP CHANGES, 1989-1990
HELPING VISITORS IDENTIFY AIR POLLUTION SYMPTOMS

Celery grown in unfiltered half of Greenhouse. Photo does not identify species, size, date, type of exposure, or location. Visitor cannot compare this leaf to one grown in filtered air.

Los Angeles State and County Arboretum, Arcadia
PHOTOGRAPHY SET UP CHANGES, 1988-1990
HELPING VISITORS IDENTIFY AIR POLLUTION SYMPTOMS

Dahlia grown in filtered half (LEFT) and unfiltered half (RIGHT) of the greenhouse. Photo pairs permit a comparison of leaves of similar age and position on plant, but do not identify species, size, date, type of exposure, or location.

Los Angeles State and County Arboretum, Arcadia
Radish grown in the Air Pollution Greenhouse. Photo does not identify species, size, date, type of exposure, or location. Photo shows yield reduction and leaf stipple symptoms.

Los Angeles State and County Arboretum, Arcadia
Slipper flower grown in the Air Pollution Greenhouse. Photo identifies species, common name, and date; but not the type of exposure, or location. Photo shows annuals bloom earlier and die sooner in air pollution.

Los Angeles State and County Arboretum, Arcadia
In 1989 a display board was added to hide the pots and provide space to display the name of the plant, the location and the date. A ruler was added to the white background. Too much contrast resulted from the black and white background.

Los Angeles State and County Arboretum, Arcadia
Nicotiana grown in the Air Pollution Greenhouse. Photo identifies species, common name, date, the type of exposure, size, and location, with an all grey background. Photo shows air pollution reduces the value of ornamentals.

Los Angeles State and County Arboretum, Arcadia
Displays of leaf injury symptoms were made. Visitors to the information center saw photographs like these and could touch leaf tissues taken from display plants.

Los Angeles State and County Arboretum, Arcadia
Improvements were made in displays of leaf injury. Visitors to the information center saw photographs like these and could touch leaf tissues taken from display plants.

Los Angeles State and County Arboretum, Arcadia
Selected plants were fumigated with ozone so visitors who arrived before the high-level smog days could see symptoms of air pollution. Photos of fumigated Begonia leaves (RIGHT) and non-fumigated Begonia leaves (LEFT) were part of displays of leaf symptoms in the information center.

Los Angeles State and County Arboretum, Arcadia
Selected plants were fumigated with ozone so visitors who arrived before the high-level smog days could see symptoms of air pollution. Photos of fumigated Necotiana leaves (RIGHT) and non-fumigated Necotiana leaves (LEFT) were part of displays of leaf symptoms in the information center.

Los Angeles State and County Arboretum, Arcadia
RESPONSES
OF VEGETATION TO

AMBIENT LEVELS OF AIR POLLUTION
AFTER GROWING FROM
APRIL TO OCTOBER, 1990

IN THE AIR POLLUTION GREENHOUSE EXHIBIT
LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA CA
PICTURES WERE TAKEN TO DOCUMENT THE EFFECTS OF AIR POLLUTION ON COMMON ORNAMENTAL PLANTS.

Most of the plants were photographed every two weeks. Care was taken to photograph each plant under standard conditions of light, background, and camera. The same plant was photographed repeatedly to assess the impact of air pollution on growth and development.

Photographs of the plants on display were grouped according to the most striking symptoms of air pollution impacts and are presented in the pages which follow.

A special series of pictures traces the growth and development of three species of plants.

PHOTOGRAPHS ILLUSTRATING THE RESULTS FOLLOW
RESPONSE TO AMBIENT AIR POLLUTION:
TYPE OF SYMPTOMS SEEN, APRIL-OCTOBER, 1990

<table>
<thead>
<tr>
<th>DESCRIPTION OF EFFECT</th>
<th>SCIENTIFIC TERM USUALLY USED</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEAF INJURY</td>
<td>FOLIAR INJURY</td>
</tr>
<tr>
<td>PALE LEAVES</td>
<td>CHLOROSIS</td>
</tr>
<tr>
<td>PALE SPOTS ON LEAVES</td>
<td>CHLOROTIC MOTTLE</td>
</tr>
<tr>
<td>BRONZE SPOTS</td>
<td>OZONE BRONZING OR</td>
</tr>
<tr>
<td></td>
<td>OZONE STIPPLE</td>
</tr>
<tr>
<td>FEWER LEAVES</td>
<td>PREMATURE LEAF DROP</td>
</tr>
<tr>
<td>LOSS OF OLDER LEAVES</td>
<td></td>
</tr>
<tr>
<td>GROWTH DISTURBANCES</td>
<td></td>
</tr>
<tr>
<td>REDUCED GROWTH</td>
<td>STUNTING</td>
</tr>
<tr>
<td>SMALLER LEAVES</td>
<td>YIELD LOSS</td>
</tr>
<tr>
<td>FEWER FLOWERS</td>
<td>YIELD LOSS</td>
</tr>
<tr>
<td>SMALLER FLOWERS</td>
<td>YIELD LOSS</td>
</tr>
<tr>
<td>FEWER FRUITS</td>
<td>YIELD LOSS</td>
</tr>
<tr>
<td>SMALLER FRUITS</td>
<td>YIELD LOSS</td>
</tr>
<tr>
<td>CHANGES IN LENGTH OF STEM</td>
<td></td>
</tr>
<tr>
<td>CHANGES IN OVERALL FORM</td>
<td></td>
</tr>
<tr>
<td>SHORTENED LIFE SPAN</td>
<td>PREMATURE SENESCENCE</td>
</tr>
</tbody>
</table>

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA CA
### 1987 DISPLAY SUITABILITY TRIALS
DISPLAY OF PLANTS WITH UNKNOWN SENSITIVITY

<table>
<thead>
<tr>
<th>PLANT NEW TO DISPLAY</th>
<th>DEGREE OF INJURY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CALIFORNIA FAN PALM</td>
<td>SEVERE</td>
</tr>
<tr>
<td>CORN</td>
<td>SEVERE</td>
</tr>
<tr>
<td>ONION</td>
<td>re-evaluate for bulb growth</td>
</tr>
<tr>
<td>CELERY</td>
<td>SEVERE</td>
</tr>
<tr>
<td>BEGONIA</td>
<td>SEVERE</td>
</tr>
<tr>
<td>SWISS CHARD</td>
<td>SEVERE</td>
</tr>
<tr>
<td>MUSTARD</td>
<td></td>
</tr>
<tr>
<td>BROWELLIA</td>
<td>SEVERE</td>
</tr>
<tr>
<td>ASTER</td>
<td></td>
</tr>
<tr>
<td>CANTALOUPE</td>
<td></td>
</tr>
<tr>
<td>DAHLIA</td>
<td>SEVERE</td>
</tr>
<tr>
<td>CARROT</td>
<td>SEVERE</td>
</tr>
<tr>
<td>CARNATION</td>
<td>SEVERE</td>
</tr>
<tr>
<td>ICEBERG LETTUCE</td>
<td>TOO HOT</td>
</tr>
<tr>
<td>SWEET PEA</td>
<td></td>
</tr>
<tr>
<td>PETUNIA</td>
<td>SEVERE</td>
</tr>
</tbody>
</table>

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA CA
1987 GREENHOUSE DISPLAY
PLANTS SHOWING AIR POLLUTION DAMAGE

Acer saccharinum
Adiantum
Antirrhinum majus
Apium graveolens var. dulce
Begonia sp.
Browallia speciosa
Calceolaria
Catalpa speciosa
Coleus hybridus
Dahlia hybrids
Daucus carota var. sativus
Ficus carica var. Blue Celeste
Impatiens
Lycopersicon lycopersicum
Mentha
Morus alba
Petroselinum crispum
Petunia hybrida
Phaseolus vulgaris
Phaseolus vulgaris
Platanus occidentalis
Raphanus sativus
Tagetes
Vitis cv. Fredonia
Washingtonia filifera
Zea mays

Silver Maple
Maiden Hair Fern
Snapdragon
Celery
Begonia
Browallia
Slipper Flower
Western catalpa
Coleus
Dahlia
Carrot
Celeste Fig
Busy Lizzie
Tomato
Mint
White Mulberry
Parsley
Petunia
Bush bean
Pinto Bean
American Sycamore
Radish
Marigold
Fredonia Grape
California Fan Palm
Sweet Corn

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA CA
1987 GREENHOUSE DISPLAY
PLANTS SHOWING NO SIGNIFICANT FOLIAR DAMAGE

Ailanthus altissima
Allium sp.
Beta vulgaris
Brassica sp.
Calistephus sp.
Capsicum annum
Cucumis melo
Cucumis sativus
Cyclamen
Dianthus
Helianthus annus
Lactua sativa
Lathyrus odoratus
Liquidambar styaciflua
Rheum raphonticum
Spinacia oleracea

Tree of Heaven
Onion
Swiss Chard
Mustard
Aster
Pepper
Cantaloupe
Cucumber
Florist's Cyclamen
Carnation
Sunflower
Iceberg lettuce
Sweet Pea
American Sweetgum
Rhubarb
Spinach

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA CA
<table>
<thead>
<tr>
<th>Plant New to Display</th>
<th>Degree of Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet Alyssum</td>
<td>Severe</td>
</tr>
<tr>
<td>Rose</td>
<td>Some Pale Leaves</td>
</tr>
<tr>
<td>Rose</td>
<td>Some Pale Leaves</td>
</tr>
<tr>
<td>Camellia</td>
<td>Retest</td>
</tr>
<tr>
<td>Squash</td>
<td>Severe Insect Problems</td>
</tr>
<tr>
<td>Gazania</td>
<td>Severe</td>
</tr>
<tr>
<td>Chinese Hibiscus</td>
<td>Severe</td>
</tr>
<tr>
<td>Juniper</td>
<td>Retest</td>
</tr>
<tr>
<td>Lantana</td>
<td>Problems with Insects</td>
</tr>
<tr>
<td>Stock</td>
<td>Retest</td>
</tr>
<tr>
<td>Geranium</td>
<td>Retest</td>
</tr>
<tr>
<td>Canary Island Pine</td>
<td>Retest</td>
</tr>
<tr>
<td>Pittosporum</td>
<td>Retest</td>
</tr>
<tr>
<td>Bluegrass</td>
<td>Color Change</td>
</tr>
<tr>
<td>Bermuda Grass</td>
<td>Color Change</td>
</tr>
<tr>
<td>India Hawthorn</td>
<td>Retest</td>
</tr>
<tr>
<td>Pansy</td>
<td>Severe</td>
</tr>
<tr>
<td>Oleander</td>
<td>Leaf Spot</td>
</tr>
<tr>
<td>Yew Pine</td>
<td>Retest</td>
</tr>
<tr>
<td>Zinnia</td>
<td>Retest</td>
</tr>
<tr>
<td>Okra</td>
<td>Leaf Spots</td>
</tr>
<tr>
<td>American Sycamore</td>
<td>Retest</td>
</tr>
<tr>
<td>Pepper</td>
<td>Severe</td>
</tr>
</tbody>
</table>
1988 GREENHOUSE DISPLAY
PLANTS SHOWING AIR POLLUTION DAMAGE

Abelmoscus esculentus
Acer saccharinum
Adiantum
Antirrhinum majus
Apium graveolens var. dulce
Begonia sp.
Browallia speciosa
Calceolaria
Catalpa speciosa
Coleus hybridus
Cucumis sativus
Dahlia hybrids
Daucus carota var. sativus
Ficus carica var. Blue Celeste
Hibiscus rosa-sinensis
Impatiens
Lycopersicon lycopersicum
Lobularia matitima
Lantana camera
Mentha
Morus alba
Nerium oleander
Petroselinum crispum
Petunia hybrida
Phaseolus vulgaris
Phaseolus vulgaris
Platanus occidentalis
Raphanum sativus
Rosa sp.
Tagetes
Vitis cv. Fredonia
Washingtonia filiera
Zea mays

Okra
Silver Maple
Maiden Hair Fern
Snapdragon
Celery
Begonia
Browallia
Slipper Flower
Western catalpa
Coleus
Cucumber
Dahlia
Carrot
Celeste Fig
Chinese hibiscus
Busy Lizzie
Tomato
Sweet alyssum
Lantana
Mint
White Mulberry
Oleander
Parsley
Petunia
Bush bean
Pinto Bean
American Sycamore
Radish
Prima Donna Rose
Marigold
Fredonia Grape
California Fan Palm
Sweet Corn

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA CA
1988 GREENHOUSE DISPLAY
PLANTS SHOWING NO SIGNIFICANT FOLIAR DAMAGE

Ailanthus altissima
Allium sp.
Beta vulgaris
Brassica sp.
Calistephus sp.
Camellia japonica
Capsicum annum
Cucumis melo
Cucurbita pepo
Cyclamen
Cyndodon dactylon
Delosperma 'Alba'
Dianthus
Gazania rigens
Juniperus chinensis
    'Pfitzerana'
Lathyrus odoratus
Liquidambar styaciflua
Matthiola incana
Pelargonium hortorum
Pinus canariensis
Pittosporum tobira
Poa pratensis 'Marathon'
Podocarpus macrophyllum
Raphiolepis indica
Rosa
Rosa
Rosa
Viola wittrockiana
Zinnia elegans

Tree of Heaven
Onion
Swiss Chard
Mustard
Aster
Camellia
Pepper
Cantaloupe
Squash
Florist's Cyclamen
Common burmuda
White trailing ice plant
Carnation
Gazania
Pfitzer juniper

Sweet Pea
American Sweetgum
Stock
Common geranium
Canary Island Pine
Tobira
Marathon bluegrass
Yew Pine
India Hawthorn
Cecile Brunner
Honest Abe cv. Aron
Beverly Hills cv. Delmatore
Pansy
Zinnea

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA CA
### 1989 Display Suitability Trials

**Display of Plants with Unknown Sensitivity**

<table>
<thead>
<tr>
<th>Plant New to Display</th>
<th>Degree of Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>Too Hot, Bolted</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>Too Hot, Bolted</td>
</tr>
<tr>
<td>Eggplant</td>
<td>Severe</td>
</tr>
<tr>
<td>Flossflower</td>
<td>Severe</td>
</tr>
<tr>
<td>White Birch</td>
<td>Severe</td>
</tr>
<tr>
<td>Cockscob</td>
<td>Severe</td>
</tr>
<tr>
<td>Dusty Miller</td>
<td>Severe</td>
</tr>
<tr>
<td>Annual Coreopsis</td>
<td>Severe</td>
</tr>
<tr>
<td>Pineapple Guava</td>
<td>Retest</td>
</tr>
<tr>
<td>Lobelia</td>
<td>Severe</td>
</tr>
<tr>
<td>Southern Magnolia</td>
<td>Severe</td>
</tr>
<tr>
<td>Carolina Laurel</td>
<td>Severe</td>
</tr>
<tr>
<td>California Pepper Tree</td>
<td>Severe</td>
</tr>
<tr>
<td>Scarlet Sage</td>
<td>Severe</td>
</tr>
<tr>
<td>Chinese Evergreen Elm</td>
<td>Retest</td>
</tr>
<tr>
<td>Kumquat</td>
<td>Severe</td>
</tr>
<tr>
<td>Orange</td>
<td>Severe</td>
</tr>
<tr>
<td>Primrose</td>
<td>Severe</td>
</tr>
</tbody>
</table>

Los Angeles State and County Arboretum, Arcadia CA
1989 GREENHOUSE DISPLAY
PLANTS SHOWING AIR POLLUTION DAMAGE

Ageratum houstonianum
Antirrhinum majus
Begonia sp.
Betula alba
Brassica oleracea
Brassica oleracea
Capsicum annuum
Camellia japonica
Celosia plumeria
Centaurea cineraria
Coereopsis sp.
Cucumis sativus
Cyclamen
Dahlia hybrids
Daucus carota var. sativus
Gazania rigids
Impatiens
Lantana camera
Lobelia erinus 'Crystal Palace'
Lobularia maritima
Lycopersicon lycopersicum
Mentha
Nerium oleander
Petroselinum crispus
Petunia hybrida
Phaseolus vulgaris
Primula polyantha
Raphanus sativus
Rosa sp.
Salvia splendens
Schinus molle
Solanum melongena
Tagetes
Ulmus parvifolia
Vitus cv. Fredonia
Washingtonia filifera
Zea mays
Zinnia elegans

Floss Flower
Snapdragon
Begonia
European White Birch
Broccoli
Cauliflower
Pepper
Camillia
Cockscomb
Dusty Miller
Coreopsis
Cucumber
Florists's Cyclamen
Dahlia
Carpt
Gazania
Busy Lizzie
Lantana
Lobelia
Sweet Alyssum
Tomato
Mint
Oleander
Parsely
Petunia
Bush Bean
Primrose
Radish
Rose
Scarlet Sage
California Pepper Tree
Eggplant
Marigold
Chinese Evergreen Elm
Fredonia Grape
California Fan Palm
Corn
Zinnia

L.A. State and County Arboretum, Arcadia CA
1989 GREENHOUSE DISPLAY
PLANTS SHOWING NO SIGNIFICANT FOLIAR DAMAGE

Camellia japonica
Citrus
Cucurbita sp.
Dianthus sp.
Feijoa sellowiana
Juniperus chinensis ‘Pfitzer’
Magnolia grandiflora
Pelargonium vulgaris
Pittosporum tobira
Podocarpus macrophyllus
Raphiolepsis indica

Camellia
Orange
Squash
Carnation
Pineapple Guava
Pfitzer Juniper
Southern Magnolia
Common Geranium
Mock Orange
Yew Pine
India Hawthorn

L.A. State and County Arboretum, Arcadia  CA
<table>
<thead>
<tr>
<th>PLANT NAME</th>
<th>DEGREE OF INJURY</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLANT NEW TO DISPLAY</td>
<td>SEVERE</td>
</tr>
<tr>
<td>CALIFORNIA RED ONION</td>
<td>SEVERE</td>
</tr>
<tr>
<td>CHIVES</td>
<td>SEVERE</td>
</tr>
<tr>
<td>FRENCH TARRAGON</td>
<td>DIED</td>
</tr>
<tr>
<td>MOTHER FERN</td>
<td>SEVERE</td>
</tr>
<tr>
<td>COREIANDER</td>
<td>SEVERE</td>
</tr>
<tr>
<td>CURRY PLANT</td>
<td>SEVERE</td>
</tr>
<tr>
<td>PATIO TOMATO</td>
<td>SEVERE</td>
</tr>
<tr>
<td>PEPPERMINT</td>
<td>SEVERE</td>
</tr>
<tr>
<td>PENNYROYAL</td>
<td>SEVERE</td>
</tr>
<tr>
<td>BASIL</td>
<td>SEVERE</td>
</tr>
<tr>
<td>MARTHA WASHINGTON GERANIUM</td>
<td>RETEST</td>
</tr>
<tr>
<td>LEMON BALM GERANIUM</td>
<td>REDUCED GROWTH</td>
</tr>
<tr>
<td>AVOCADO</td>
<td>DIED</td>
</tr>
<tr>
<td>SORREL</td>
<td>SEVERE</td>
</tr>
<tr>
<td>COMMON TANSY FERN</td>
<td>REDUCED GROWTH</td>
</tr>
<tr>
<td>SOCIETY GARLIC</td>
<td>RETEST</td>
</tr>
<tr>
<td>NIAGRA GRAPE</td>
<td>REDUCED GROWTH</td>
</tr>
</tbody>
</table>
Ageratum houstonianum
Allium cepa
Allium schoenoprasum
Antirrhinum majus
Aptium graveolens var. dulce
Aquilegia sp.
Asplenium bulbiferum
Begonia sp.
Bougainvillea sp.
Brachycome iberidifolia
Brassica oleracea
Capsicum annuum
Celosia plumeria
Centaurea cineraria
Citrus sinensis
Coleus hybridus
Coriopsis sp.
Coriandrum sativum
Cucumis sativus
Cyclamen sp.
Dahlia hybrids
Daucus carota var. sativus
Dianthus sp.
Ficus carica
Gardenia sp.
Gomphrena globosa
Helichrysum conglobulatum
Impatiens
Lantana camara
Lavandula sp.
Lactuca sativa
Lobelia erinus ‘Crystal Palace’

Phaseolus vulgaris
Phaseolus vulgaris
Primula sp.
Raphanus sativus
Rosa sp.
Rosa sp.
Rosmarinus officinalis
Rumex scutatus
Salvia splendens
Schnus molle
Solanum melongena var. esculentum
Viola sp.
Washingtonia filifera
Zeae mays
Zinnia elegans

Floss Flower
California Red Onion
Chives
Snapdragon
Celery
Columbine
Mother Fern
Begonia
Bourgainvillea
Swan River Daisy
Cauliflower
Pepper
Cockscomb
Dusty Miller
Orange
Coleus
Coriopsis
Coriander
Cucumber
Florent’s Cyclamen
Dahila
Carpt
Carnation
Fig
Gardenia
Gazania
Globe Amaranth
Curry Plant
Busy Lizzie
Lantana
Lavender
Lettuce
Lobelia

Mock Orange
Kentucky Blue Bean
Primrose
Radish
Bonica Rose
Playboy Rose
Silverado Rose
Rosemary
Sorrel
Scarlet Sage
California Pepper Tree
Eggplant

Viola
California Fan Palm
Corn
Zinnia
<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camellia japonica</td>
<td>Camellia</td>
</tr>
<tr>
<td>Eucalyptus sideroxylon rosea</td>
<td>Pink Iron Bark</td>
</tr>
<tr>
<td>Feijoa sellowiana</td>
<td>Pineapple Guava</td>
</tr>
<tr>
<td>Juniperus chinensis</td>
<td>Pfitzer Juniper</td>
</tr>
<tr>
<td>Magnolia grandiflora</td>
<td>Southern magnolia</td>
</tr>
<tr>
<td>Nerium oleander</td>
<td>Oleander</td>
</tr>
<tr>
<td>Pelargonium vulgaris</td>
<td>Martha Washington</td>
</tr>
<tr>
<td>'Martha Washington'</td>
<td></td>
</tr>
<tr>
<td>Podocarpus macrophyllus</td>
<td>Yew Pine</td>
</tr>
<tr>
<td>Raphiolepsis indica</td>
<td>Indian Hawthorn</td>
</tr>
<tr>
<td>Tulbaghia violacea</td>
<td>Society Garlic</td>
</tr>
</tbody>
</table>
RESPONSES
OF VEGETATION TO

AMBIENT LEVELS OF AIR POLLUTION
AFTER GROWING FROM
APRIL TO OCTOBER, 1990

IN THE AIR POLLUTION GREENHOUSE EXHIBIT
LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA CA

RESPONSE TO AMBIENT AIR POLLUTION:
TYPE OF SYMPTOMS SEEN, APRIL-OCTOBER, 1990

<table>
<thead>
<tr>
<th>DESCRIPTION OF EFFECT</th>
<th>SCIENTIFIC TERM USUALLY USED</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEAF INJURY</td>
<td>FOLIAR INJURY</td>
</tr>
<tr>
<td>PALE LEAVES</td>
<td>CHLOROSIS</td>
</tr>
<tr>
<td>PALE SPOTS ON LEAVES</td>
<td>CHLOROTIC MOTTLE</td>
</tr>
<tr>
<td>BRONZE SPOTS</td>
<td>OZONE BRONZING OR</td>
</tr>
<tr>
<td></td>
<td>OZONE STIPPLE</td>
</tr>
<tr>
<td>FEWER LEAVES</td>
<td>PREMATURE LEAF DROP</td>
</tr>
<tr>
<td>LOSS OF OLDER LEAVES</td>
<td></td>
</tr>
</tbody>
</table>

GROWTH DISTURBANCES

| REDUCED GROWTH               | STUNTING                    |
| SMALLER LEAVES               | YIELD LOSS                  |
| FEWER FLOWERS                | YIELD LOSS                  |
| SMALLER FLOWERS              | YIELD LOSS                  |
| FEWER FRUITS                 | YIELD LOSS                  |
| SMALLER FRUITS               | YIELD LOSS                  |
| CHANGES IN LENGTH OF STEM    |                             |
| CHANGES IN OVERALL FORM      |                             |
| SHORTENED LIFE SPAN          | PREMATURE SENESCENCE        |

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA CA
## RESPONSE TO AMBIENT AIR POLLUTION: REDUCED GROWTH

<table>
<thead>
<tr>
<th><strong>SCIENTIFIC NAME</strong></th>
<th><strong>COMMON NAME</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Allium cepa</td>
<td>CALIFORNIA RED ONION</td>
</tr>
<tr>
<td>Allium schoenoprasum</td>
<td>CHIVES</td>
</tr>
<tr>
<td>Centaurea cineraria</td>
<td>DUSTY MILLER</td>
</tr>
<tr>
<td>Citrus sinensis</td>
<td>ORANGE</td>
</tr>
<tr>
<td>Coleus hybridus</td>
<td>COLEUS</td>
</tr>
<tr>
<td>Coreopsis sp.</td>
<td>COREOPSIS</td>
</tr>
<tr>
<td>Gazania sp.</td>
<td>GAZANIA</td>
</tr>
<tr>
<td>Helichrysum congestifolium</td>
<td>CURRY PLANT</td>
</tr>
<tr>
<td>Lavendula sp.</td>
<td>LAVENDER</td>
</tr>
<tr>
<td>Ligustrum japonicum</td>
<td>WAX LEAF PRIVET</td>
</tr>
<tr>
<td>Origanum vulgare</td>
<td>OREGANO</td>
</tr>
<tr>
<td>Pelargonium</td>
<td>LEMON BALM</td>
</tr>
<tr>
<td>Pittosporum tobria</td>
<td>MOCK ORANGE</td>
</tr>
<tr>
<td>Rosa sp.</td>
<td>BONICA ROSE</td>
</tr>
<tr>
<td>Rosa sp.</td>
<td>PLAYBOY ROSE</td>
</tr>
<tr>
<td>Rosa sp.</td>
<td>SILVERADO ROSE</td>
</tr>
<tr>
<td>Rosmarinus officinalis</td>
<td>ROSEMARY</td>
</tr>
<tr>
<td>Washingtonia filifera</td>
<td>CALIFORNIA FAN PALM</td>
</tr>
<tr>
<td>Zinnia elegans</td>
<td>ZINNEA</td>
</tr>
</tbody>
</table>

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA 90-91

## RESPONSE TO AMBIENT AIR POLLUTION: LEAF INJURY

<table>
<thead>
<tr>
<th><strong>SCIENTIFIC NAME</strong></th>
<th><strong>COMMON NAME</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Brassica oleracea</td>
<td>CAULIFLOWER</td>
</tr>
<tr>
<td>Dianthus sp.</td>
<td>CARNATION</td>
</tr>
<tr>
<td>Gomphrena globosa</td>
<td>GLOBE AMARANTH</td>
</tr>
<tr>
<td>Mentha pulegium</td>
<td>PENNYROYAL</td>
</tr>
<tr>
<td>Rumex scutatus</td>
<td>SORREL</td>
</tr>
<tr>
<td>Schinus molle</td>
<td>CALIFORNIA PEPPER TREE</td>
</tr>
</tbody>
</table>

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA 90-91
### RESPONSE TO AMBIENT AIR POLLUTION: SHORTER LIFE SPAN

<table>
<thead>
<tr>
<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactuca sativa</td>
<td>LETTUCE</td>
</tr>
</tbody>
</table>

**Los Angeles State and County Arboretum, Arcadia 90-91**

### RESPONSE TO AMBIENT AIR POLLUTION: PALE LEAVES AND REDUCED GROWTH

<table>
<thead>
<tr>
<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ageratum houstonianum</td>
<td>FLOSS FLOWER</td>
</tr>
<tr>
<td>Capsicum annum</td>
<td>PEPPER</td>
</tr>
<tr>
<td>Celosia plumeria</td>
<td>COCKSCOMB</td>
</tr>
<tr>
<td>Cucumis sativus</td>
<td>CUCUMBER</td>
</tr>
<tr>
<td>Dahlia hybridus</td>
<td>DAHLIA</td>
</tr>
<tr>
<td>Gardenia sp.</td>
<td>GARDENIA</td>
</tr>
<tr>
<td>Lycopersicon lycopersicum</td>
<td>PATIO TOMATO</td>
</tr>
<tr>
<td>Lycopersicon lycopersicum</td>
<td>PRESIDENT TOMATO</td>
</tr>
<tr>
<td>Mentha piperita</td>
<td>PEPPERMINT</td>
</tr>
<tr>
<td>Ocimum basilicum</td>
<td>BASIL</td>
</tr>
<tr>
<td>Saliva splendens</td>
<td>SCARLET SAGE</td>
</tr>
<tr>
<td>Solanum melongena</td>
<td>EGGPLANT</td>
</tr>
<tr>
<td>Tanacetum vulgaris</td>
<td>COMMON TANSY</td>
</tr>
</tbody>
</table>

**Los Angeles State and County Arboretum, Arcadia 90-91**
## RESPONSE TO AMBIENT AIR POLLUTION:
### SPOTTED LEAVES AND REDUCED GROWTH

<table>
<thead>
<tr>
<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Begonia sp.</td>
<td>BEGONIA</td>
</tr>
<tr>
<td>Phaseolus vulgaris</td>
<td>BUSH BEAN</td>
</tr>
<tr>
<td>Phaseolus vulgaris</td>
<td>KENTUCKY BLUE BEAN</td>
</tr>
<tr>
<td>Phaseolus vulgaris</td>
<td>PINTO BEAN</td>
</tr>
<tr>
<td>Raphanus sativus</td>
<td>RADISH</td>
</tr>
<tr>
<td>Vitus sp.</td>
<td>NIAGRA GRAPE</td>
</tr>
<tr>
<td>Zea mays</td>
<td>CORN</td>
</tr>
</tbody>
</table>

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA 90-91

## RESPONSE TO AMBIENT AIR POLLUTION:
### FEWER LEAVES AND REDUCED GROWTH

<table>
<thead>
<tr>
<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bougainvillea sp.</td>
<td>BOUGAINVILLEA</td>
</tr>
<tr>
<td>Cyclamen sp.</td>
<td>FLOREST'S CYCLAMEN</td>
</tr>
<tr>
<td>Impatiens sp.</td>
<td>BUSY LIZZIE</td>
</tr>
</tbody>
</table>

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA 90-91
### RESPONSE TO AMBIENT AIR POLLUTION:
#### FEWER FRUITS AND REDUCED GROWTH

<table>
<thead>
<tr>
<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ficus carica</td>
<td>FIG</td>
</tr>
</tbody>
</table>

Los Angeles State and County Arboretum, Arcadia 90-91

### RESPONSE TO AMBIENT AIR POLLUTION:
#### FEWER FLOWERS AND REDUCED LIFE SPAN

<table>
<thead>
<tr>
<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antirrhinum majus</td>
<td>SNAPDRAGON</td>
</tr>
</tbody>
</table>

Los Angeles State and County Arboretum, Arcadia 90-91
RESPONSE TO AMBIENT AIR POLLUTION: REDUCED GROWTH AND REDUCED LIFE SPAN

<table>
<thead>
<tr>
<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lobelia erinus</td>
<td>CRYSTAL PALACE LOBELIA</td>
</tr>
</tbody>
</table>

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA 90-91

RESPONSE TO AMBIENT AIR POLLUTION: LEAF SPOTS AND REDUCED LIFE SPAN

<table>
<thead>
<tr>
<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tagetes sp.</td>
<td>MARIGOLD</td>
</tr>
</tbody>
</table>

LOS ANGELES STATE AND COUNTY ARBORETUM, ARCADIA 90-91