POLLUTION AND TREES: AIR OR SOIL?

Taken from

Arborist News (February, 2022)

By

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INTRODUCTION

- **Pollution** – unfavorable alternation of our surroundings due to human activities that causes changes in energy patterns, radiation levels, chemical and physical constitution, and abundance of organisms

- **Pollutant** – any substance that adversely affects something that humans value if its concentration is high enough

INTRODUCTION

- **Effect of a pollutant depends on:**
  - Concentration
  - Duration of exposure
  - Number of exposures
- **High doses** – acute response
- **Low doses** – chronic response

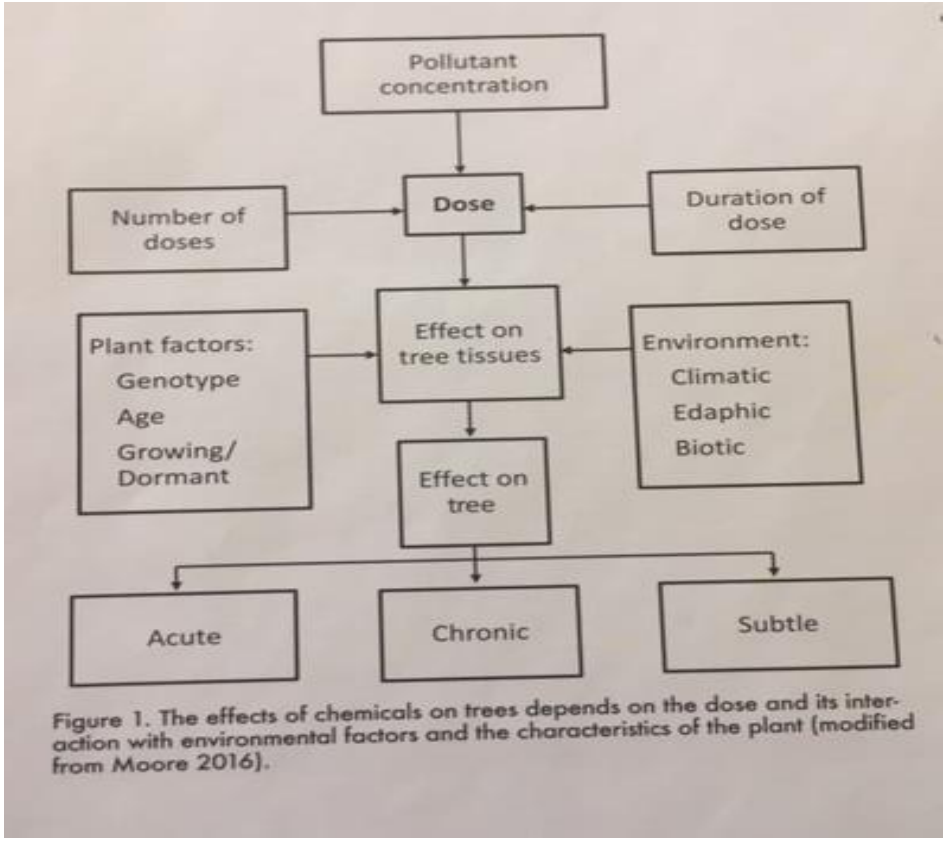

Figure 1. The effects of chemicals on trees depends on the dose and its interaction with environmental factors and the characteristics of the plant (modified from Moore 2016).

PRODUCTION OF PAN
(Photochemical Smog)

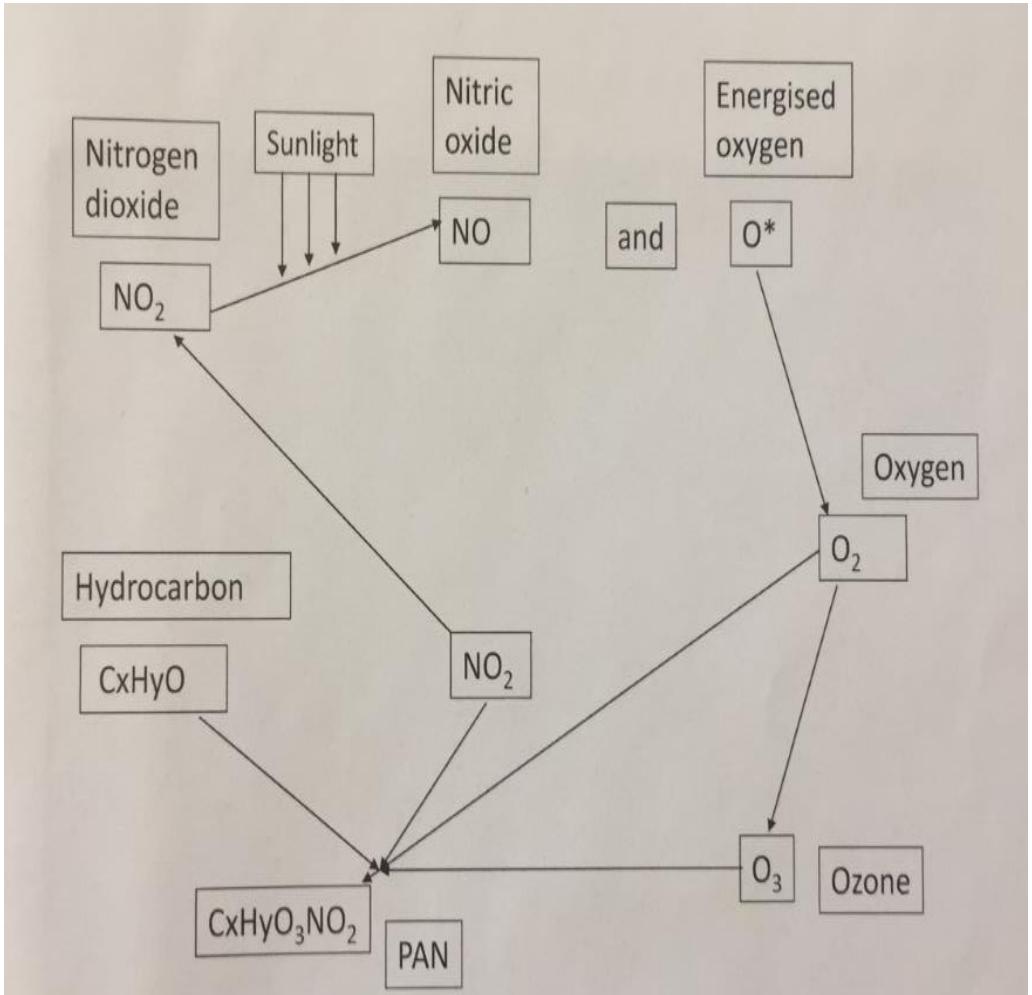

Figure 2. The cycle of air pollutants that leads to the production of peroxyacetyl nitrate (PAN), often called photochemical smog.

RELATIVE PARTICULATE MATTER
(London Plane and Elm Trees)

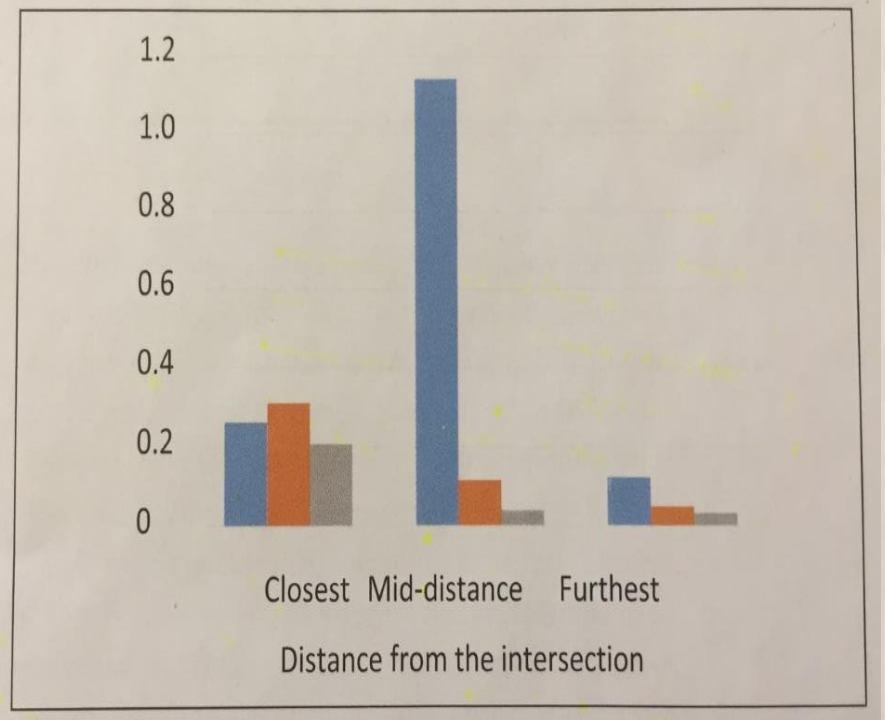

Figure 6. Relative amounts of particulate matter on London plane tree (blue), eucalypt (orange), and elm (grey) leaves growing on trees at various distances from a major road intersection, Melbourne (modified from Guo 2016).

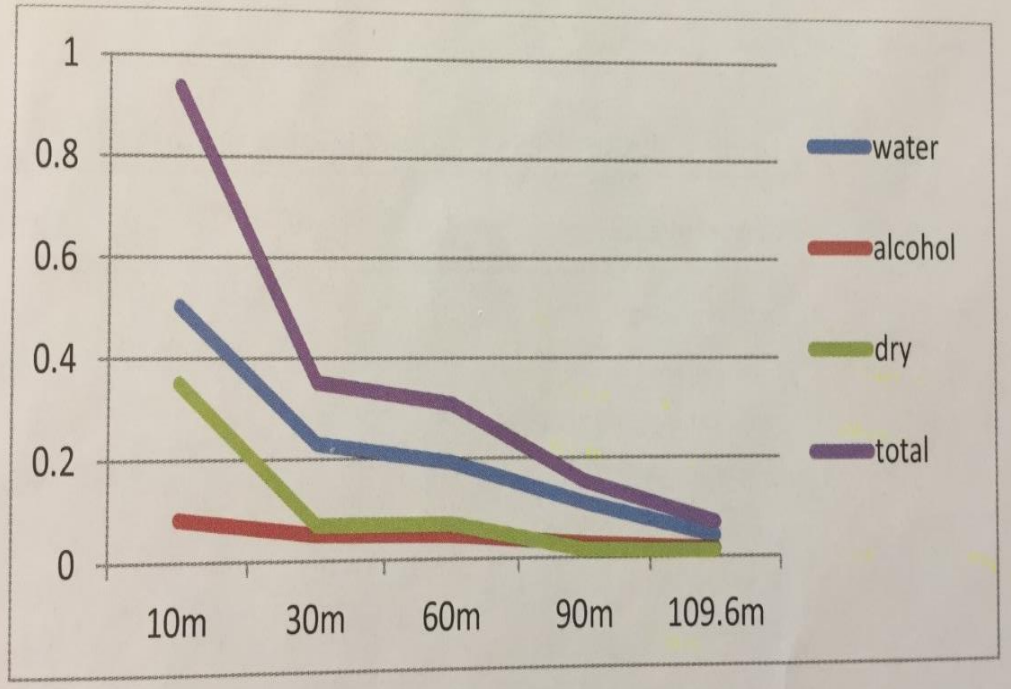

Figure 5. Relative amounts of particulate matter on elm leaves growing on trees at various distances from the intersection of Royal Parade and Grattan Streets, Melbourne (Guo 2016).

INTRODUCTION

- **Sensitivity to pollutants varies with:**
  - **Plant species** - evergreens remove more pollutants, but deciduous plants have a higher tolerance
  - **Season**
  - **Environmental conditions**
  - **Plant age**

Figure 8. Necrotic leaves on a white poplar (*Populus alba*) growing adjacent to the source of chlorine pollution in Melbourne, Australia.

TREE SPECIES - POLLUTION SENSITIVITY

• ***Gingko biloba***	• Tolerant
• ***Tilia cordata***	• Tolerant
• ***Fraxinus* spp.**	• Moderate
• ***Betula pendula***	• Moderate
• ***Pinus* spp.**	• **Sensitive**
• ***Acer campetre***	• Tolerant
• ***Abies* spp.**	• Tolerant
• ***Liriodendron tuliperum***	• Tolerant
• ***Platanus occidentalis***	• Tolerant
• ***Zelkova serrata***	• Tolerant

COMMON EXAMPLES OF POLLUTION DAMAGE TO TREES

- **Natural gas**
- **Particulate matter**
- **Chlorine**
- **Light**

Table 1. Major pollutants that cause damage to urban trees. The bolded pollutants occur more commonly in urban forests.

Pollutant	
Sulphur dioxide (SO_2)	**Chlorines**
Ozone (O_3)	**Fertiliser**
Peroxyacetyl nitrate (PAN)	**Herbicides**
Nitrogen dioxide (NO_2)	**Pesticides**
Ammonia	Cadmium (Cd)
Ethylene	**Lead (Pb)**
Particulate matter (PM)	Zinc (Zn)
Detergents	**Copper (Cu)**
Natural gas	Iron (Fe)
Petroleum and associated fuels	Nickel (Ni)
Salt (usually, but not always NaCl)	Magnesium (Mg)
Fluorides	

NATURAL GAS

- Contains hydro-cyanide, CO, sulfur
- **Not considered phytotoxic**
- Displaces O_2 in soils making them anoxic and methane may compete with other chemicals
- **Symptoms include**
  - General decline
  - Dieback of leaves and twigs
  - Bark cracking

PARTICULATE MATTER (PM)

- Dust, soot, smoke, grease, oil, or wildfires
- **Not toxic, but impairs leaf function by:**
  - Reducing light penetration
  - Clogging stomates
  - Reducing photosynthesis, respiration, and transpiration
- **More serious during droughts**
- **Smaller compound leaves, and leaves with complex shapes and large perimeters are more efficient**
- **Hairy (i.e. pubescent), sticky, and rougher leaves are accumulate more particulates**

CHLORINE

- Common ingredient in household cleaners, swimming pools, industrial applications
- **Symptoms include:**
  - Yellow mottling of foliage
  - Rapid chlorosis
  - Plants close to spills or leaks will show symptoms
  - May travel considerable distances with wind

Figure 9. Undamaged and necrotic leaves on an English oak (*Quercus robur*) growing within 200 m of the source of chlorine pollution in Melbourne, Australia.

LIGHT

- **Quality** (i.e. color or wavelength)
- **Quantity** (i.e. intensity)
- **Red and blue light are important for plant growth and function**
- **Phytochromes** (i.e. photoreceptors) absorb mostly red light
  - **P_r absorbs red light**
  - **P_{fr} absorbs far-red light**

LIGHT AND PHYTOCHROMES

- **Shading causes a shift to P_r and trees grow taller**
- **Direct sunlight causes a shift to P_{fr}**
  - Stimulates branching and reduces vertical growth resulting in a shorter-spreading tree (i.e. parkway and park trees)
- **Excessive light from street lights can be harmful**
  - Maples, plane, and birch trees – chlorosis
  - Interferes with flowering and leaf abscission

PETROLEUM-RELATED PRODUCTS

- Caused by tank-rollovers (i.e. trucks and tank cars)
- Accidental spills
- Gas, diesel fuel, and kerosene are highly toxic to plants
  - **Diesel fuel is highly toxic** and can kill a tree within 48 hours
  - Causes root death
  - Local bark necrosis (smooth bark trees are sensitive)
  - Leaf chlorosis, necrosis, wilting, death
  - Damage to roots is due to O2 depletion

MANAGEMENT OF POLLUATION DAMAGE TO TREES

- Identify the source
- Repair and eliminate the source
- Provide PHC practices for tree recovery
- Remove contaminated soil, if possible
- Follow up with PHC practices
- Remove the tree, if required

END OF PRESENTATION