THE EFFECT OF OIL SPILLS ON TREES[1]

by Richard Bartha

Bursting of storage tanks, pipelines and, on occasion, railroad or traffic accidents can spill large amounts of petroleum or petroleum products over land, causing damage or destruction of the vegetation, including ornamental and fruit trees. Appropriate damage claims and the subsequent rehabilitation of the land require some understanding of the nature of the oil and its interactions with soil bacteria and plant roots.

Crude petroleum is a complex mixture of hundreds of hydrocarbon components. These can be classified as straight chain and branched paraffins, cycloparaffins, aromatic hydrocarbons and asphaltenes. Low amounts of nonhydrocarbon components are also present. Refined petroleum fractions (gasoline, kerosene, diesel-, heating- and lubricating oils, etc.) are only slightly less complex hydrocarbon mixtures. An important characteristic is their boiling range. Low boiling hydrocarbons have high contact toxicity to plants but, because of their rapid evaporation, have no lasting effects on the top soil. Heavier (high-boiling) fractions have less direct toxicity to plants but affect the soil in a more lasting manner.

The mechanism of contact toxicity is the dissolution of lipids that are an integral part of the cell membranes. Petroleum ether, gasoline and solvent mixtures are the most likely ones to cause this type of damage. Kerosene, diesel, heating and lubricating oils have lower contact toxicity but are deadly to plant roots through their interaction with soil microorganisms. The biodegradation of hydrocarbon components by soil microorganisms exhausts the oxygen supply of the soil. The roots die due to a lack of oxygen and/or from the toxic hydrogen sulfide generated in the oxygen-depleted soils. Competition of the oil-degrading soil microorganisms for nitrogen, phosphorus and possibly other minerals was noted.

In comparison to methane damage, oil contamination is easy to detect and to document. Prompt photographic recording of the extent of the spill and the preservation of contaminated soil samples in sealed containers and under refrigeration for later analysis is helpful for presenting a damage claim. Small nursery stock can be saved by prompt transplanting into uncontaminated soil. When doing this, all contaminated soil should be hosed off the roots. There is no practical way to save large established trees. The full extent of the oil damage may not be apparent until 6-12 months after the spill incident.

The contaminated soil is rehabilitated by enhancing the biodegradation of the spilled oil. This requires liming, fertilization and soil aeration by frequent tillage. Depending on the nature of the spilled oil, the process will take from one to several growing seasons.

At this time, no data are available on the sensitivity to oil damage of individual tree species. On theoretical grounds, one would expect species adapted to poorly drained conditions to be more resistant than the ones requiring well-drained soils. Ability to fix nitrogen (e.g. alder) may also be helpful in surviving an oil pollution incident.

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[1] Presented to the National Arborist Assn. seminar on polution damage to trees, December 1976 at New Brunswick, N.J.