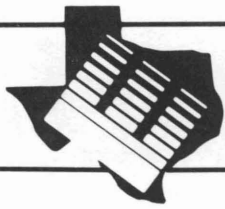


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Effects of Petroleum Product Spills on Plants and Soil

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Activities related to petroleum production and utilization affect every Texan in many ways. Most urban homes use natural gas to supply energy for domestic needs. Crude oil production required to make fuels and lubricants for automobiles occurs simultaneously with crop production in many areas of the state.

The transport of petroleum products through transmission lines and overland conveyance occurs with a remarkable degree of safety. Occasionally, however, leaks or spills occur and concerns develop when a foreign substance is deposited outside its desired location. When this happens, questions arise about short- and long-term effects on soil and plant growth.

There is considerable incentive on the part of all parties concerned to avoid accidental spillage of petroleum products. All producers and transporters of petroleum products lose economically when a portion of their investment is no longer available for sale or utilization. Property owners are disadvantaged when their plants are affected by the spill. All parties are concerned about environmental effects.

Three kinds of petroleum products can be involved in accidental spills – crude oil, refined petroleum products and natural gas. Effects of each on soil and plants are discussed in this publication.

Crude Oil

Crude oil is composed of a mixture of organic molecules commonly called hydrocarbons. When spilled or applied intentionally to soil, as in the case of road building, evaporation and biodegradation begin almost immediately. The evaporation process is detectable by odor and may last for hours or days. Biodegradation, on the other hand, occurs when soil microorganisms begin utilizing the oil as a food source. This process proceeds at various rates, depending on availability of oxygen, moisture and favorable temperatures. Organisms capable of breaking down hydrocarbons are present in all normal soils. Temperatures occurring in southern states are favorable for their activity throughout most of the year.

Fortunately, crude oil is not inherently toxic to plants even though its presence may affect their growth and

well-being. One only has to recall the many thousands of miles of oiled roads to know that they are not lined with dead trees. These roads are prepared by intentionally applying asphaltic-based crude oil or crude oil derivatives to soil. This mix is formed and packed to build all-weather roads. With time, the road surface deteriorates because of biodegradation.

Even though crude oil is applied to soil to achieve certain beneficial goals, it always is regrettable when this product is spilled on soil intended for plant growth. Questions about potential damage almost always arise and property owners want to know how the soil can be returned to its original condition.

Fortunately, much scientific effort has been expended to answer questions about the effects of crude oil on plants when applied to soil. It is known that crude oil spilled on soil creates unfavorable conditions for plant growth by:

- Repelling water
- Interrupting water movement and absorption both in the soil and in the plant
- Increasing the availability of minor elements (manganese and iron) to toxic levels
- Causing nutrient deficiencies (nitrogen and phosphorus) from microbial competition for these elements
- Excluding oxygen from the soil

The degree to which any or all of these factors occurs in any given situation depends on the amount of crude oil present, soil type and availability of moisture and oxygen. When initially exposed to soil, crude oil has a tendency to spread on the surface instead of soaking into the soil. This barrier loses its effectiveness with time, however, and oil penetration can occur if additional oil is supplied.

The resulting plant damage is almost never as severe as first suspected. Crude oil by its very nature can be easily seen, touched, smelled or even tasted, so its presence gains immediate attention. Generally, oil producers attempt to recover as much of the product as possible when large quantities are spilled.

Information from research studies indicates that crude oil applied to soil can be broken down by microbial action in 1 to 5 years, depending on oil concentration and the effort made to increase aeration

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through tillage and fertilization. No action should be taken, however, until a maximum amount of evaporation has occurred. Studies indicate that up to 30 percent of the oil may be dissipated through evaporation.

Because soil exposed to crude oil does not absorb water as it normally does, plants growing in the exposed areas may show drought stress symptoms when surrounding plants appear normal. The actual effect on plants, including trees and shrubs, depends on the amount and extent of soil affected. Localized spills may produce little, if any, effect while larger, concentrated spills may cause plant death. Each situation is different and must be evaluated independently.

Once a spill area has stabilized to the point that no more evaporation is likely to occur, one should apply a nitrogen fertilizer and till the area. This hastens microbial activity by furnishing additional oxygen and nitrogen to bacteria involved in the breakdown process. This procedure should be repeated in the spring and fall, preferably when soil moisture is favorable for tillage. Because crude oil is an organic substance, the soil will be more fertile at the end of the breakdown process than it was initially.

The previous discussion was based on crude oil's being the only material involved with a given spill. In the oil production process, salt solutions and drilling fluids also may be involved. When they are involved, dissipation with rainfall over time may be required for remediation to occur.

Refined Petroleum Products

One cannot generalize extensively about the effects of refined petroleum products on plant health because these materials and their effects are so varied. Some can be applied to plants with beneficial results while others are herbicidal. Some products such as gasoline are highly volatile and dissipate in a short time. Others such as refined motor oil break down more slowly than crude oil. Accidental spills of refined petroleum products generally are minor and require little remedial action.

Natural Gas Leaks

Natural gas leaks occur in the soil when lines corrode or break. These usually are detected by smelling the odorant placed in the gas or by noting effects on plant health. Anyone making these observations should notify the gas company immediately.

Natural gas (methane gas) is not toxic to plants. Its presence in soil can cause plant damage in an indirect fashion, however. It is moved under pressure through transmission and distribution lines. When a leak occurs, a portion of the gas is delivered at that point. Methane gas then replaces oxygen in the soil pore spaces. Once

the plant root system is deprived of oxygen, it ceases to function as it should. Affected plants may become unthrifty or die if the leak area involves a sufficient percentage of the root system for an extended period.

A simple procedure for detecting potential gas leaks is to dig in the soil with a spade to check for a darker than normal color and the presence of an anaerobic odor. The anaerobic odor produced when there is an absence of oxygen reminds one of a sewer odor. Once a leak site is detected, the damaged line should be repaired or replaced as soon as possible.

Affected lawn grasses usually recover quickly because they have a shallow root system. Trees and shrubs may be affected in varying degrees depending on the time and concentration of gas exposure. It is advisable to give plants a reasonable period of time for recovery before trying to assess damage and take action. Species differ in their response to anaerobic soil conditions.

Some people want to heavily water areas affected by natural gas. A better approach is to water moderately and aerate the soil to improve oxygen content. Excessive water occupies pore spaces and excludes oxygen in the same way that natural gas does.

Another tendency is to replace affected soil. This is not necessary because natural gas is not a toxic substance. Once the aeration process is completed, plants will grow well in the affected soil. Growth actually will be improved from the liberation of nitrogen by microorganisms feeding on the natural gas as a food source.

Gas companies make periodic surveys for leaks, but they may not always be able to detect leaks occurring on private property. Individuals should be informed about the potential for leaks, how to look for effects on plants, and appropriate action to take when such leaks occur.

Conclusions

Petroleum products, when appropriately utilized, make our lives more pleasant and productive. Even with extensive safety precautions, accidental spills may occur. When this happens, prudent steps should be taken to minimize damage to soil and growing plants. Cooperative efforts between petroleum producers or handlers and landowners usually result in the most effective means of damage control.

Crude oil and natural gas are the major petroleum products likely to be involved in accidental spills. Neither is inherently toxic to plants, but their presence in soil produces conditions that may adversely affect plant health. These conditions include interruption of water relationships and exclusion of oxygen from the soil. Once spills or leaks are discovered, steps should be taken to return the soil to its original condition.

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