Assessment of energy generating enzyme activities in seedlings grown in hydrocarb...

Science, Biology

The damaging potency of hydrocarbons on natural and cultivated crops is voraciously documented. This research investigated the noxiousness of hydrocarbons on aerobic and anaerobic enzymes in cowpea and maize seedlings. Viable seeds of these food crops were planted in soil treated with different concentrations of various hydrocarbons. Each group was prepared five times and six groups were constituted. The setup was watered daily. Thereafter the activities of succinate dehydrogenase (SDH) and lactate dehydrogenase (LDH) in the leaves of the cowpea and maize seedlings were determined using standard methods at four days interval up to twelve days after planting. The presence of the various hydrocarbons in soil decreased succinate dehydrogenase activity whereas the activity of lactate dehydrogenase was enhanced in the seedlings investigated. Kerosene exerted negative effects than the other hydrocarbons investigated. The response of cowpea seedlings was different from maize seedlings. The high point of the result is that hydrocarbons in soil predisposes plants to anaerobic energy production to enable them survive hydrocarbon toxicity.

Introduction

Petroleum compounds can enter the cropped lands through natural, mechanical and human activities. This can occur either accidentally or by design and eventually cause damaging effects on the biota. The harmful changes can disrupt metabolic activity at the biochemical levels. The exposure of organism to polluted environment causes physiological stress that predisposes it to more energy demand in a bid to overcome the toxic stress.

The adaptation to energy demand may trigger shift in energy metabolizing enzymes. One of the important enzymes in energy production in living organisms is succinate dehydrogenase which is a part of complex II of the respiratory chain. The enzyme pays an important role in the Krebs cycle. Succinate is an efficient energy source in living systems; hence, the activity of succinate dehydrogenase is an indication of the level of the tricarboxylic acid cycle (TCA) activity as well as one of the efficient methods of measuring the vitality of living organisms.

Another important enzyme involved in anaerobic energy generation is lactate dehydrogenase, an enzyme that catalyzes the conversion of pyruvic acid to lactic acid. It becomes imperative to understudy the strategy of energy production adopted by living systems under chemical stress to measure changes in the activities of enzymes involved in aerobic and anaerobic respirations.

Material and Methods

Maize was obtained from Delta Agricultural Development Project (DTADP) Ibusa Delta State, Nigeria. The International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria supplied the cowpea seeds. The soil was obtained from a vacant land in site II of Delta State University, Abraka. The soil was sieved using 2 mm-mesh after air drying. Warri Refining and Petrochemical Company supplied the petroleum hydrocarbons. Reagents used were analytical grade. The polybags were filled with the soil sample (1600 g). They were divided into six groups and each was replicated five times. The concentrations of hydrocarbons used were: 0. 1%, 0. 25%, 0. 5%, 1. 0%, 2.

0% and 0. 0% (v/w). These applications were prepared for each of the hydrocarbons.

Group 1 treatment was prepared by adding 1. 0 ml of kerosene, which is 0. 1%, to the soil and mixed properly with hand to homogeneity. The process was adopted for other concentrations and hydrocarbons. Floatation method was used to determine seed viability such that seeds that floated on water were discarded and those that remained at bottom of water were used. The planting involved three seeds per polybag which was sown to a depth of 2cm and kept under partial shade. Each treatment was watered daily (80cm3) to keep the soil moist. The entire set up was observed daily for up to twelve days for germination and any seed that failed to germinate was assumed dead. Preparation of extract and assay for succinate dehydrogenase activityThe extract for the determination of succinate dehydrogenase activity was prepared as described previously and the activity of the enzyme assayed for as reported by Sajan et. al.

Preparation of extract and assay for lactate dehydrogenase activity

The extract for the determination of succinate dehydrogenase activity was prepared as described previously and the activity of the enzyme assayed for as reported by Kaiglova et al. (2001).

Statistical Analysis

All data were compared with the control using analysis of variance (ANOVA) with the Graph pad Prism, version 5. 3. Significant differences were set at p <0. 01. All final results were expressed as mean + SEM.

Results

The existence of all the organic solvents in soil altered succinate dehydrogenase activity in the two seedlings. The result is inconsistent and varied, generally, at higher additions of the organic solvents to the soil, a significant (P <0. 01) decrease in succinate dehydrogenase activity was observed across all the organic solvents applied. The decrease stimulated by kerosene was more relative to the other solvents applied. On the other hand, treatment of soil with the organic solvents, on the whole, significantly(P <0. 01) increased lactate dehydrogenase activity in the two seedlings.

The Increase was generally more with kerosene treated soil as against other solvents applied, as was its effect on succinate dehydrogenase activity.

Discussion

Crude oil impacted soil suffers from displacement of air that creates hypoxic conditions in biotic lives in such environment. This gives rise to oxygen deficiency in plant cultivated in soil. And such plants try to adapt to the energy crises by either upgrading or down grading certain respiratory enzymes which may include lactate dehydrogenase and succinate dehydrogenase.

In this study, addition of the various hydrocarbons to the soil inhibited succinate dehydrogenase activity. This inhibition of succinate dehydrogenase activity indicates a decrease in rate of energy generation by the cell because the oxidation of succinate to fumarate as catalyzed by succinate dehydrogenase is the most efficient source of energy in living organisms.

The decrease in succinate dehydrogenase activity agrees with previous study on toxicant stimulated decline in succinate dehydrogenase activity. Moreover, kerosene was more toxic compared to the effect of other hydrocarbons. The high toxic capacity of kerosene had been documented. In addition, the higher toxic effect of hydrocarbon on cowpea seedlings is due to the ability to absorb hydrocarbon from the soil more than maize seedlings.

Hydrocarbons treatment of soil gave varied and inconsistent lactate dehydrogenase activity (LDH) in the tissues of cowpea and maize seedlings, though the effect was time dependent. However, the increase in LDH activity, especially at day eight, agrees with the report of Valarmathi and Azariah (2003) on the response of lactate dehydrogenase activity to the presence of chemical toxicity. The increase in lactate dehydrogenase activity is a reflection of an increased dependence on anaerobic carbohydrate metabolism by the leaves of the respective seedlings after sustained exposure to hydrocarbon toxicity. Kerosene in soil enhanced the activity of lactate dehydrogenase more than the other hydrocarbons in both cowpea and maize seedlings. Moreover, lactate dehydrogenase activity was more in maize relative to cowpea seedlings. This was attributed to the high degree of fermentative respiration in seeds with high starch content. Earlier reported indicated a reciprocal relationship between succinate dehydrogenase activity and lactate dehydrogenase activity. Thus, the inhibition of succinate dehydrogenase activity coupled with the elevation of lactate dehydrogenase activity may be predisposing the seedlings to anaerobiosis in the midst of chemical intoxicated soil.