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Axonopus, a potential plant for phytoremediation: A review

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Abstract
Phytoremediation is a new and promising approach that helps in restoring and reclaiming soils that are contaminated with noxious metals, with the help of plants and associated microflora. It is quite an innovative way to restore environment. Choice of the mechanism of phytoremediation and choice of plants depends on the tolerance capacity of the plant species. Different plant species have different tolerance capacity to accumulate heavy metals after which they detoxify them. Some plants are better accumulators of lead while others may be of zinc and still there may be some plants that can produce certain enzymes for detoxification. It can help to improve the overall ecological health of a particular affected site with minimization of negative impacts with thorough investigation and observation. *Axonopus compressus* belonging to the Poaceae family is one of the potent plants that can play an important role in the protection of the ecosystem due to its better adaptability and tolerance towards some of the heavy metals and crude oil. It cost-effectively helps in decontamination. They are biologically safe and provide aesthetic beauty.

Keywords: phytoremediation, restoring, *Axonopus compressus*, tolerance

Introduction

Plants with high potentials for extraction, stabilization and hyperaccumulation of toxic chemicals are generally chosen. With tremendous urbanization and industrialization, the rate of contamination has also increased. Since the 1940s with rapid industrial development, environmental pollution by potentially toxic elements has become a serious issue. These PTEs has since then started to cause pollution as they are non-biodegradable and can get accumulated within the ecosystem through the food chain. [1, 2, 3, 4] One of the major areas of contamination is the oil fields. Crude oil is an important raw material that is required for the production of petroleum, oils and other chemicals but sometimes during their extraction, production, storage, maintenance and transportation, an accidental release may cause considerable hazards to the environment and indirectly to human health. The microflora present in soil helps in degradation of organic matter while the removal of crude oil and heavy metals require physical movement. But with the help of phytoremediation, the pollution can be controlled to a certain extent. The plants and the microflora associated with them helps in the conversion of the hydrocarbons to nontoxic forms that are ultimately helping in the bioremediation of polluted soils [5].

Phytoremediation is cost-effective, uncomplicated, in-situ and environment friendly as they are a solar energy-driven process. In simple terms, they are simple green technology. Besides, they are also considered to be aesthetically pleasing in comparison to other conventional cleanup methods [6]. Studies have proved that the plants used for phytoremediation remove the pollutants directly by converting them or reduces the toxicity by degradation or immobilization [7, 8, 9, 10]. Besides this, the plants also help in binding soils and prevent soil erosion.

Choice of Optimal Plant Species

There are different mechanisms involved in the decontamination of the environment. These approaches include phytoextraction, phytostabilisation, phytovolatilisation [11, 12]. Phytoextraction comprises of uptaking of pollutants into plant biomass, phytostabilisation involves limiting the mobility and bioavailability of chemicals in soils by plant roots, phytovolatilisation involves the conversion of pollutants into some volatile non-toxic form and finally releasing them to the environment.

The choice of a particular plant for phytoremediation depends on their capacity to tolerate the toxicity and allowing the only minimal concentration of the potentially toxic pollutants inside the sensitive compartments of plants cells [13]. Different plants have different capacity to accumulate heavy metals and hydrocarbon.

Axonopus as Potential Phytoremediation Plant

Axonopus belongs to the family Poaceae and comprises about 100 species. Axonopus compressus commonly known as carpet grass is an important warm seasoned perennial grass that is distributed around the whole world. It is often used as ground cover. It is better known for its adaptability to various environmental conditions that make it a good candidate in phytoremediation as it has got high tolerance capacity which is also been proven by various studies and still investigation are carried out. Besides that, Axonopus plant can also be used as a source for bioenergy via thermochemical conversion. It can potentially aid the country in achieving the renewable energy target by minimizing the greenhouse gas emissions and the negative impact of biodiversity [14].

One of the studies suggested that A. compressus is suitable for phytoremediation of the soils contaminated with crude oil. The

study was carried out with potted plants for about 360 days. A. compressus grown in contaminated soil showed reduced growth, biomass and root growth but the results were significant in terms of degradation and thus were suggested to cultivate in the oil fields [15].

In another study conducted in an abandoned steel industry showed variations. The results showed that the concentrations of heavy metals in soils with the plant A. compressus were different. Except for iron (Fe), zinc (Zn) and copper (Cu) which had higher concentrations in Axonopus compressus the levels of the heavy metals were remarkably higher in soil samples than in the plant in some locations of the industrial environment than in soil [16,17].

In an investigation, it was found that A. compressus can be used to achieve phytoremediation of heavy metals. In the investigation, it was demonstrated that an oil spill increased the acidity and heavy metal content of the soil. It also reduced soil organic carbon and exchangeable bases. A. compressus along with Calopogonium mucunoides and Sida acuta were identified from oil spill impacted land and contained Pb, Cd, Zn in the different plant parts which made them conclude that these plants can be used in phytoremediation of heavy metals in contaminated soil [18].

From a similar comparative study conducted with Axonopus compressus, Sida acuta, and Andropogon gayanus, it was concluded that they can survive up to 2300, 1150 and 1150 mg of zinc contamination per kg of soil respectively. The experiment implied that the studied plants have great potential in stabilizing and recolonizing soils which are heavily polluted with zinc. However, to ascertain the metal accumulating capabilities of the studied plant species further investigation and research could be useful [19].

In a study, it was demonstrated that Cyperus sp. and Axonopus sp. can be used as a phytoremediation technique for the reclamation of oil impacted soils. Their usage was found to be more effective when applied together with organic and inorganic manure. From the study, it was recommended that Axonopus sp. and Cyperus sp. can be used in phytoremediation to restore the environment to its natural state apart from physical clean-up of oil spills sites [20].

The findings from a study implied that A. compressus has the tenacity to withstand the deleterious effects of waste engine oil contamination and the capacity to phytoremediate hydrocarbon concentration in soil effectively in any geographical region of the world. The plant remains resilient at three different levels of contamination [21].

An experiment was undertaken to investigate the comparative potential of Panicum maximum and A. compressus to bioremediate zinc polluted soils, the impact of Zn on the antioxidant defence system of the plant, assaying for activities of antioxidants proteins. A. compressus showed a higher reduction level of Zinc in the soil. Axonopus compresus and Panicum maximum both significantly reduced a greater percentage of Zn in the polluted soil. The study suggested that Axonopus compressus have greater impacts on Zn polluted soil than Panicum maximum and also A. compressus is a better removal of Pb than P. maximum which concluded that both the plants can be used as phytoremediator [22]. A compressus although is a good remover of Pb and Zn, in another study it was found that it showed the lowest values of Hg accumulation among the three plants studied [23].

Another investigation compared A. compressus, Cynodon dactylon and Eleusine indica. The investigation suggests that A. compressus was able to sustain growth at 20% crude oil conditions by modifying the pH of the soil from acidic to neutral conditions while the other two plants failed to exhibit this. Thus, the study indicated that A. compressus had more withstanding capacity for soils with crude oil [24].

Conclusion

Different experiments and studies conducted unveils the ability of inexpensive, readily available local plants with significant potential for crude oil and soil phytoremediation depending on the level of contamination [25].

Thus, providing an insight to A. compressus being a potential plant for phytoremediation of soil. Besides A. compressus there are many plants with the properties of being a measure for phytoremediation. Moreover, there are also some aquatic plants that helps in remediation of the contaminated waterbodies. Along with the plants study on the associated microorganisms can also be useful as the plant-microbe interaction is found to be quite effective and can increase the efficacy of phytoremediation. Phytoremediation not only help in pollution control but also provide aesthetic beauty. Axonopus compressus and other bio agent plants planted with some ornamental plants can provide a pleasing environment. They are biologically safe. They can be helpful in cleansing the air too. With the further research in this regard will be useful for the future and us.

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