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Short Communication

Phytoremediation, When Plant Species Biological Cycle is the Key to Success

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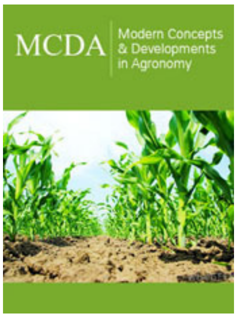

Abstract

The contamination of different substrates with diverse types of substances urgently requires the application of processes that allow them to be completely removed or, at least, greatly reduced. The application of phytoremediation systems is a viable option in many cases. Plant species present different characteristics throughout their life cycle which, if used appropriately, allow the extraction process to be more efficient. Studying and interpreting phytoremediation species as complex systems is key to the success of the process.

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Introduction

Due to the global need for application of clean and environmentally friendly technologies, the use of plants for remediation of different substrates (soil, water, air) is a very important option [1,2]. This technology, called phytoremediation, presents certain limitations, the main one being that it constitutes a long-term solution, that is, it generally requires a process of months, or even years, particularly to treat moderately to highly contaminated environments [2,3].

When prospecting plant species for use as remediators, various characteristics are taken into account that allow this capacity to be assessed: high growth rate and biomass generation, large leaf surface for greater evapotranspiration capacity and therefore translocation of contaminants, good radical development, etc. However, some general qualities may not be met in particular species that still show great potential as extractors, so species prospecting must be meticulous work to not leave aside species with possibilities of use. It is also likely that other characteristics, until now not considered diagnostic of remedial species, should be analyzed and taken into account in this process, in general characteristics that are related to the life cycle of the species and the relationship with its environment, understanding thus the plant as a system and not just as an individual. For example, it has been shown that the habitat where plants develop influences the accumulation capacity of the compounds they extract, so plants that naturally inhabit submerged areas present higher rates of extraction of contaminants than those that are emergent or purely terrestrial plants [4]. Another characteristic that was shown to be of interest is evaluating the habit of the species: herbaceous, grassy, woody, shrubby, etc. It has been shown that herbaceous species are more efficient than tussocks (grasses) under certain extraction circumstances [5]. This does not mean that other species are not efficient, but rather that it is advisable to evaluate the environment and the pollutant to be extracted in relation to the time of application of the technology in order to make an accurate decision in the choice of species.

In general, it is assumed that it is in the vegetative stage of the life cycle when plant species present the highest percentage of extraction of contaminants from the soil or water, since it is the time in which the greatest amount of biomass is produced, which favors the accumulation of the compound to be extracted. However, some species have shown that during the reproductive stage they achieve good or even greater uptake and accumulation of the compounds, translocating them to the floral scapes [6] or even to their diaspores [7].

The importance of the vegetative stage of the life cycle of most plant species is that it is the moment in which they produce a large number of vegetative organs (roots, stems, leaves). Many species use their roots as accumulation organs for the pollutants extracted from the environment. Others can translocate contaminants to aerial organs, and it is in those cases where the large production of stems and leaves is relevant since they act as sink organs. This is why, as each plant species reacts or acts in a different way in the remediation process, specific studies must be carried out to understand the dynamic functioning of the species that is intended to be used in order to generate the best conditions for the correct development of the accumulating organs. For example, in the case of *Pteris vittata* L., the greatest accumulation occurs in leaves and not in roots [8].

Vegetative organs such as roots, stems and leaves in many works are mentioned together as underground and aerial organs. It is important to highlight the need for precision and specificity regarding the organ in which the accumulation of interest is generated since this data provides relevant information for the cultivation and management of the species to be used. For example, underground organs are roots, rhizomes, tubers, bulbs, etc. and each one has a different accumulation capacity, the specific identification of the accumulating organ being important, especially in those that may be involved in the vegetative reproduction of the species. The same happens with the aerial organs, among them are stems, leaves, flowers, fruits, seeds, and each one has a different role in the life cycle of the plant and therefore their identification is essential. For example, if the accumulation in seeds is high, management practices must be considered so that they are not disseminated and thus the extracted contaminant returns to the environment.

It must also be taken into account how the remedial action affects the life cycle of the species, since this will directly affect the maintenance of the applied remedial system. In the case of herbaceous species, a shortening is usually seen due to the absorption of certain chemical compounds. This shortening may be due to both the accumulating action and the cultivation method designed for the extraction of the contaminant, which is why it must be carefully evaluated at the time of designing the remediation system [6]. As a last point, we must highlight the importance of analyzing the changes that occur in the anatomy of plants due to their remedial action since some characteristics may be of functional importance for plants, for example the reduction in the quantity and diameter of the conductive elements of xylem and phloem [9], seriously affecting the ability to extract contaminants.

Conclusion

Phytoremediation as a technology must be approached in a comprehensive manner where engineers, agronomists, botanists and microbiologists participate in its implementation [10], because more than a simple technology it is a system that must be coordinated from different areas of study to be able to interpret the complexity of the processes involved in it.

The biology of plants is very diverse and that is why all the aspects that cover it (morphology, anatomy, life cycle, habitat, size, etc.) must be analyzed and studied in detail in order to make an appropriate choice, use and management of the species in relation to the specific substrate and environment to be treated.

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