Introduction

The civilization of mankind and the agriculture sustainability rely on two precious bio-resources namely land and water [1,2]. So, the two last ones have been subjected to an hyper exploration and they were severely polluted by kinds of contaminants having its origin from various anthropogenic studies [2,3].

The potentially toxic elements can occur naturally in soils at various amounts depending on the source rock geochemical compositions and soil formation processes like weathering sedimentation and volcanic eruptions. Meanwhile, anthropogenic activities such mining and smelting operations, industrial production, oil and gas production, agricultural activities and military practices can also result in elevated soil contaminant amounts. Indeed Figure 1 illustrates the potentially toxic element sources in soil ecosystems [4,5].

It is crucial to note that the majority of contaminants get accumulated in plants and either directly or indirectly, find their way into food web thus cause severe consequences [3]. In addition, the plants undergo several abiotic stresses such as salt, drought and heavy metal which are known among the most limiting ones [6-10]. Indeed, it is crucial to signal that as much as one-half of the world irrigated areas are affected by the high salinity level [7,8,10,11], the drought and also the excessive soil metal amount [6,7,12]. The last cited one pose significant hazard to human, plant, animal and health, hence to the ecosystem [7,13,14]. We indicate in this case that soil contamination by toxic metal has often resulted from human activities, such as those related to application of sewage sludge to agricultural soils, industrial emissions, mining, leakage and/or disposal of industrial wastes and also the pesticide use [12,15]. It is basic also to signal that the phytoextraction is one of the metal phytoremediation technologies as illustrated in Table 1 [16].

Due to the potential toxicity and the high metals persistence, those facts constitute a serious environmental problem that requires an affordable solution [15,17]. Hence, phytoextraction seems to be the most promising technique and has received increasing attention from researchers since it was proposed by various research teams such as [18] as a technology for reclaiming metal polluted soils [3,7,12].

The metal phytoextraction from the soil relies on the use of plants to extract and translocate metals to their harvestable parts [3,16,19,20]. The phytoextraction aim consists on the reduction of the metal concentration in contaminated soils to regulatory
levels within a reasonable time frame. This extraction process depends directly on the able duality of the selected plants to grow and accumulate metals under the specific climatic and soil conditions of the site being remediated [16,20].

In another case, it is fundamental to note that the Brassicaceae plant family represents hundreds of plant families reported so far for their potential use in the remediation of varied environmental contaminants including toxic metals and metalloids. The most of the members of the Brassicaceae plant family well represent the metal hyperaccumulation among 0.2% of all angiosperms and thus, have key role in phytoremediation technology. Many of the plant species within Brassicaceae family such as Alyssum, Arabidopsis, Bertheya, Bornmuellera, Cardamine, Cochlearia, Crambe, Peltaria, Stanleya, Thlaspi including oilseed Brassicas grow fast, yield high biomass and are well adapted to a range of environmental conditions [19,20,21].

**Metal extraction process**

The heavy metal extraction process is due to two approaches that have currently been used to reach this purpose: the first one results in the exploration of plants with exceptional, natural metal-accumulating capacity, so called hyperaccumulators [22], and the second one is the use of high-biomass crop plants with a chemically enhanced phytoextraction method [6,12,21-25]. So, the basic properties of those two phytoextraction strategies of metals from soils are illustrated as followed in Table 2. In addition, the analysis of the Table 2 content and based on some of other’s investigations give birth to a fundamental conclusion summarized on the fact that the natural metal-accumulating capacity seem to be the most one because of the negative repercussion of the chemically enhanced phytoextraction method [26-28].

**Metal hyperaccumulation and tolerance in plants**

The metal hyperaccumulation capability is a rare phenomenon in plants. Occurring ≈4,00 vascular plant species
in which vast majority of those ones discovered so far was being Ni hyperaccumulators. The plant species having the ability to accumulate Zn, Cd, Pb, Cu and Co are much less numerous [23]. The hyperaccumulation concept has been extended to a plant growing in its natural habitat in that those metal concentrations have been caged in the dry matter of any above ground tissue. This more detailed definition includes plants which accumulate metals in their aerial tissues other than leaves, that might be useful to phytoextraction as well, and disqualify any species that hyperaccumulate metals under synthetic conditions like massive metals addition to the soil or the nutrient solution [13].

The correlation and also the relationship between metal hyperaccumulation and tolerance is still a subject of discussion. Some authors suggest the non-correlation between those traits, while others suggest that hyperaccumulators possess a high degree of metals tolerance. [6] compiled a number of studies in that the metal accumulation meaning tolerant and non-tolerant plants had been compared [29]. Those funding’s led to conclude that there is no pattern regarding accumulation and tolerance [6]. Both shoot and root concentrations are equally variable even when only one particular metal is [7,30,31]. However, at least in some cases, it is clear that the increased tolerance give birth to greater metal amount. Plants may use two strategies to deal with high metal amounts adjacent to their roots: (i) exclusion mechanisms by which the uptake and/or root to shoot transport of metals are restricted; and (ii) internal tolerance mechanisms which immobilize, compartmentalize or detoxify metals in the symplasm through production of metal binding compounds. Given that the phytoextraction purpose is to maximize metal accumulation efficiency in plant tissues, mechanisms of internal tolerance are likely to be crucial and [6,19,32].

Stress-associated protein provides tolerance to heavy metals

The boom in industrialization over the past few decades has led to the onset of long-term pollution by heavy metals as well as serious environmental and also ecological problems for humans, plants and animals. In addition, we signal that some heavy metals have a crucial role during various physiological processes in plants [33,34]; Yet, when present in excessive concentrations in the soil, they can inactive biomolecules, block functional proteins, or displace other essential metal ions and, hence, become toxic causing serious ecological problems. We recently showed that overexpression of LmSAP, a member of the stress-associated protein (SAP) gene family isolated from Lobularia maritima, in transgenic plants lead to enhanced tolerance to metal stresses (Cd, Cu, Mn and Zn). Indeed, LmSAP expression increased after 12 h of treatment with those metals, suggesting its involvement in the plant response to metal stresses (Cd, Cu, Mn and Zn). Indeed, LmSAP expression increased after 12 h of treatment with those metals, suggesting its involvement in the plant response to metal stresses (Cd, Cu, Mn and Zn).[34]. LmSAP transgenic tobacco plants subjected to these stress conditions were healthy, experienced higher seedling survival rates, and had longer roots than non-transgenic plants. However, they exhibited higher tolerance towards cadmium and manganese than towards copper and zinc [7,30,33,35,36].
application on plant growth and the phyto-extraction potential. Indeed, the pot experiment was conducted to evaluate the phyto-extraction capability of heavy metals by Sorghum. The last one was grown in soil artificially contaminated with a range of heavy metals at various concentrations like lead (300, 350 and 400 mg/kg), chromium (50,100 and 150 mg/kg) and cadmium (100, 150 and 200 mg/kg). In this case, 5 mM EDTA was applied, as chelating agent to the plants after 4 weeks of sowing. Plants were grown for a total of two months and fresh weight and dry weight of shoot and heavy metal accumulation were analyzed at 6 and 8 weeks after sowing. The findings revealed that the described heavy metals application and EDTA adversely affected shoot length, fresh weight and dry weight of the biological matrix used at both time intervals. Hence, heavy metals uptake increased with the increment of heavy metal by the used plant. The use of 5mM EDTA upgrades the uptake of heavy metal [40-42]. It has been reported that EDTA enhances the availability of heavy metal to plants and thus increases the accumulation in their shoots [43-45].

Final Remarks and future research outlook

Basic and fundamental advances have been made in those last decades in understanding the processes implicated in metal phytoextraction from the contaminated soils. In the case of the chemically-assisted phytoextraction, the metal chelates dynamics in the rhizosphere have to be examined, either to overcome the risks associated with the low synthetic chelators degradability, or to optimize the use of more biodegradable compounds. In addition, researchers and policy makers have also to look for into the chemical pools of metals in soils and identify which ones are the targets for phytoextraction. A complete understanding of plant metal tolerance will be crucial to develop strategies to ameliorate the plant metal accumulation capacity. This will have significant involvements for phytoremediation. Since most of the known hyperaccumulator species are slow-growing and have small biomass, expressing their metal-accumulating genes in fast-growing, high biomass plants, is a promising approach for developing plants that can be used as novel tools in phytoextraction.

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