According without affecting topsoil, thus conserving its utility

Engineering

According to Mahar et al. (2016), several biological, physical and chemical approaches have been used over the last 20 years but these approaches have limitations such as intensive labor, high cost, disturbance of indigenous soil micro flora and irreversible changes in soil physicochemical properties. The conventional remediation methods include in situ vitrification, soil incineration, excavation and landfill, soil washing, soil flushing, solidification, and stabilization of electro-kinetic systems (Ali, Khan and Sajad, 2013).

The remediation of soil contamination by conventional engineering techniques often costs between $50 and $500 ton? 1 and certain specialized techniques can exceed costs of $1000 ton? 1 (Purakayastha and Chhonkar, 2010). Therefore, the researchers need to develop the method that cost-effective, efficient, environment friendly and eco-friendly. In previous research, various approaches of physical, chemical and biological techniques can be used to remediate metal contaminated soils. However, phytoremediation has been recognized as cost-effective method for remediation of metal contaminated soils (Sarwar et al.

, 2016). Phytoremediation as an alternative remediation method is investigated since low treatment costs make it feasible even for such sites (Willscher et al., 2016).

“ Phytoremediation basically refers to the use of plants and associated soil microbes to reduce the concentrations or toxic effects of contaminants in the environments” (Ali, Khan and Sajad, 2013). Plants generally handle the contaminants without affecting topsoil, thus conserving its utility and fertility and also they may improve soil fertility with inputs of organic matter.

According to Pandey, Pandey & Singh (2015), Plants can remediate pollutants through several processes like adsorption, transport and translocation, hyper-accumulation or transformation and mineralization. In addition to remedying the polluted soil, phytoremediation provides other benefits, such as soil erosion mitigation, carbon sequestration, biodiversity protection and biofuel production (Luo, He, Polle and Rennenberg, 2016).

According to Mahar et al. (2016), the term phytoremediation was formed by phyto come from Greek phyton which is mean as related to plant and remedium means to cleanup. Phytoremediation with native plants is an emerging technology and is considered one of the best methods to remediate metal contaminated soils because of its visual advantage, extensive applicability, and cost effectiveness (Tauqeer et al., 2016). Phytoremediation is the use of plants to extract, immobilize, contain and/or degrade contaminants from soil, water or air (Gerhardt, Gerwing and Greenberg, 2016).

Consequently, the low technology, in situ approach of phytoremediation is attractive as it offers site restoration, partial decontamination, maintenance of the biological activity and physical structure of soils, and is potentially cheap, visually unobtrusive, and there is the possibility of bio-recovery of metals (Pulford and Watson, 2003). Phytoremediation technology is a relatively recent technology with research studies conducted mostly during the last two decades which is 1990 onwards (Ali, Khan and Sajad, 2013). Yanqun et al. (2005) state that phytoremediation defined as the use of plants to remove, or destroy hazardous substances from soil environment and this

method become a topical research field in the last decades as it is safe and potentially cheap compared to traditional remediation techniques.