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Review Article

ROLE OF RHIZOBACTERIA IN PHYTOREMEDIATION OF HEAVY METALS

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Abstract: *Rhizobacteria, a plant growth promoting rhizobacteria (PGPR) as beneficial microorganism which helps in defense from abiotic and abiotic stresses, colonizes in rhizosphere and played a major role in promoting plant growth and also provides enhance soil fertility. In the highly contaminated soil, the content of metal exceeds the limits of plant tolerance. It is also possible that treatment of plant with PGPR, here increasing the biomass of plant, stabilizing and the remediation of metal polluted soil. The use of rhizobacteria plays and important role in increasing the tolerance of plant towards toxic effects of heavy metals like arsenic, sulphur, mercury, chromium, cadmium, nickel, lead and copper etc. Heavy metal accumulation results in deterioration of soil fertility while PGPR helps to restore soil fertility. The process of phytoremediation has been proved to be the best way to remediate heavy metals from soil. The use of rhizobacteria with plants provides highly efficiency phytoremediation. However, there is still need to understanding the concept of microbial ecological study in rhizosphere and mechanism of detoxification of heavy metals form rhizosphere.*

Keywords: rhizobacteria, heavy metals, plant growth promoting bacteria, phytoremediation, abiotic stress

Introduction

Heavy metals may be defined as elements which have metallic features like conductivity, ligand specificity, stability, etc. Metals have been present naturally in the soil with a lot of heavy metals ions accumulated in the form of compounds, or as simple ions and which are essential for plants as micronutrients (Rahmaty and Khara, 2011; Sharma *et al*., 2003; Tahir *et al*., 2020). Due to industrial revolution the pollution increased intensely by the toxic heavy metals due to human activities such as electroplating, fuel production, manufacturing and mining of metals, pesticide application etc (Almaroai *et al*., 2012; Arroyo *et al*., 2002; Babarinde *et al*., 2006). Metal pollution has become the most severe problem among the environmental problems nowadays (Cao *et al*., 2004; Khalil *et al*., 2020; Seregin *et al*., 2004; Zubair *et al*., 2016). Rhizobacteria is plant growth promoting (PGPR) beneficial microorganism which helps in defense from abiotic and abiotic stresses, colonizes in rhizosphere and played a major role in promoting plant growth and also provides enhance soil fertility (Lugtenberg and Kamilova, 2009; Vessey, 2003).

Rhizosphere bacterial species play an important role in phytoremediation from heavy metals in contaminated soil, through releasing of chelating agents heavy metals mobility affect the microbial population and also availability to plant, release of redox changes, phosphate solubilization, acidification and promote phytoremediation (Iqra *et al*., 2020; Lugtenberg and Kamilova, 2009; Mazhar *et al*., 2020b; Vessey, 2003). In phytoremediation process rhizobacteria metal adapted able to received extra attention. We need to increase our understanding about mechanisms involved in mobilization and transfer of heavy metals in the contaminated soils (Antoun, 2013). Soils which are polluted with heavy metals cause environmental problems the reason behind is the effects of metals which is highly toxic. There have options for sediments polluted due to metals and reclamation of soil is ex-situ and in-situ techniques (Bååth, 1989; Pamukcu and Kenneth Wittle, 1992; Ross, 1994). The in-situ aims for remediation from soil is that enhance the maintenance of metals either in soil particles. The other methods work on plants to reduce bioavailability or potential mobility of toxic metals from environment. The purpose of ex-situ techniques is that separating and extracting of metals from the soil over series of biological, physical and chemical methods with the help of specifically designed reactor (Dixit *et al*., 2015; Jansen *et al*., 1994; Nouri *et al*., 2009).

Phytoremediation method offers detoxification and removal of contaminants which involved the use of plants to sequester and it is very effective,

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ecologically gentle, less expensive and also a socially standard technology specifically for pollution elimination (Memon *et al*., 2001; Schröder *et al*., 2008). Phytoremediation depends upon the tolerance and ability of plant to accumulate HMs (high concentrations) and also to obtain yield from a large plant biomass (LeDuc and Terry, 2005; Mench *et al*., 2009). Heavy metals mostly biologically non-degradable but persist indefinitely mostly in under developed and developed countries as contaminations in the environment. Presence of heavy metals in plants harshly effects on growth and crop yield, symbiosis due to high concentrations of heavy metals (Felix, 1997; Giordano *et al*., 1975; Grytsyuk *et al*., 2006). The heavy metals are harmful for soil because the heavy metals cannot be degraded biologically but it is likely to transfer from one oxidation state to the alternative state which is less toxic form of the compound (Chu and Wong, 1987; Schmidt, 2003). Degrading capacity of rhizobacteria has been increased the spectrum by using or introducing new techniques such as genetic engineering. phytohormones major chemical which are involved in the uptake of metal. Rhizobacteria plays very important role in phytoremediation and also release essential hormones for plant growth (Garrido *et al*., 2005; Prasad *et al*., 2011).

The heavy metal stress caused important impact on plants that's why the plants have to avoid it through some of the mechanisms such as.

1. At root surface metal ion adsorbed.
2. Root cells transversely membrane metals ions help to move into the root cells.
3. In vacuole metal ion immobilized in small proportion.
4. Movement of the metal intracellularly through the vascular tissue of root
5. The accumulation of metallic ions through the root-to-shoot transfer and also from leave tissue.

Mobilization and immobilization of the heavy metals is one of the important roles of rhizobacteria which provide tolerance to heavy metals. Soil pollution is the significant and serious environmental problem and cause negative effect on agriculture as well as also on human health (Gadd, 2000; Lahori *et al*., 2017; Unz and Shuttleworth, 1996). The significant interface of plant and soil is rhizobacteria, which plays vital role in the phytoremediation of polluted soils through remediating the heavy metals. Extreme gathering of the heavy metals in several plants species has been found highly toxic (Grytsyuk *et al*., 2006; Krantev *et al*., 2008; Lahori *et al*., 2017). Presence of heavy metal ions at high level in the atmosphere absorbed from root and transferred to the shoot which effect on plant growth and reduced metabolism. Contamination of soil and water due to heavy metals is also a major problem. Moreover, high concentrations of metal in the soil have become the reason of many problems such as decrease in soil fertility, microbial action and also effect on yield production (Henning *et al*., 2001; Iqra *et al*., 2020; Ma *et al*., 2003). Cadmium is a toxic and non-essential heavy metal which is able to reveal the problem and also inhibits shoot and root growth, nutrient uptake disturbs and accumulated rate of important crops. The crop plants which are usually rich in Cadmium and consumed by human and animals causes many harmful diseases. On the other hand, if Cd concentration not controlled then the overtime soil may be ultimately become unstable for the production of crop plants (Das *et al*., 1997; Hasan *et al*., 2009; Hou *et al*., 2007). Heavy metals cause contamination in environment treated by conventional technologies which is based on the physicochemical principles but these technologies are uneconomic and inefficient. On the other hand, removal of metals from aqueous solution is carried with the addition of reagents in the solution which increase the pH and soluble form of metals converts into the insoluble form which causes precipitation in the solution (Cuypers *et al*., 2011; Martelli *et al*., 2006; Nagajyoti *et al*., 2010).

Interactions of rhizobacteria

Interaction between plant and bacteria

Root zone of plants colonize with dense population of microorganisms. Rhizosphere is very attractive habitat as compare to bulk soil, organic carbon which is gained from the plant roots (Etesami, 2018; Van Loon, 2007). In Rhizosphere more than 85% organic carbon can be originated from the tissues and sloughed off the root cells. Relationship between plant and bacteria is always naturally symbiotic in this interaction both of them get benefit from each other. In this relationship roots of plants are mainly involved to give benefit to the bacteria (Antoun and Prévost, 2005; Chen *et al*., 2000; Persello-Cartieaux *et al*., 2003). Similarly, bacteria help plant in the maintenance of nutrient supply in and in recycling process. Rhizobacteria also maintain soil fertility and also detoxified harmful chemicals which usually released due to toxicity of heavy metals. Plants provide carbon source to the bacteria which reduce phytotoxicity (Requena *et al*., 1997; Zahran, 1999).

Plant bacteria interaction with respect to soil

Composition of root and soil conditions plays an important role in the interactions with respect to specificity. Rhizobacteria called as soil tolerated

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bacteria because it inhibiting rhizosphere. Some of the bacterial species also colonized around the surroundings and to the surface of root such as the endobacteria (Barea *et al*., 2005; Nadeem *et al*., 2014; Requena *et al*., 2001). The interaction can be specific as well as non-specific. Toxic metal inhibits the growth of plant but other factors like water, low-soil fertility, beneficial nutrients, harsh and dry conditions may also be responsible for the inhibition of plant growth (Bhattacharyya and Jha, 2012; Haas and Défago, 2005).

Removal of heavy metals and PGPR interaction

The removal of heavy metals is very important due to their toxicity. Release of phosphate solubilization, acidification process, chelating agents and redox changes enhance the potential of phytoremediation. There is a need to progress understanding about mechanisms which are involved in the mobilization and also in the transfer of heavy metal so, we can be able to reduce the heavy metals from soil (de Oliveira Mendes *et al*., 2014; Goldstein, 1995; Halder and Chakrabartty, 1993; Khan *et al*., 2009). Heavy metals disturb the metabolic processes of plant and animals. Interaction of bacteria with plant affected from these following conditions which are very important for plant and bacteria.

1. Improper supply of water.
2. Harsh climate changes.
3. Deficiency of soil fertility.
4. Lack of nutrients.

Heavy metals effect on plants

For plant uptake heavy metals present in the soil as soluble components. Some heavy metals require for growth of plant and also for maintenance but if those metals present in high range than it become toxic for plant (Dubey, 2010; McIntyre, 2003; Reichman, 2002). And cause cytoplasmic enzymes inhibition due to oxidative stress damage cell structures. If heavy metals cannot remove from plant than ultimately plant died due to its toxic effects. Copper is important metal for development and growth of plant. The plant growth promoting rhizobacteria (PGPR) are beneficial for the plants and helps to reduce the toxicity level. The higher concentration and long term presence of heavy metals plant become chloric and cause deficiency of iron (Khalid *et al*., 2015; Sayyed *et al*., 2013; Tank and Saraf, 2009).

Mechanism

Rhizobacteria secretions

Rhizobacteria secretion could play a key role for phytoremediation which is assisted by rhizobacteria. Direct mechanism contains nitrogen fixation synthesis of siderophores or indirect mechanism contains inhibiting phytopathogens from plant growth then development (Kloepper *et al*., 1980; Van Loon *et al*., 1998). The microbes promote the plant growth under stress conditions and help in degradation of contaminants. The PGPR has been mostly used for an extensive period assisting plant to uptake large amount of nutrients from soil or preventing plant diseases (Glick, 2012; Saharan and Nehra, 2011; Schippers *et al*., 1987). PGPR application has been prolonged to bioremediation of organic metal pollutants. Rhizobacteria create metal chelating agents called siderophores and some heavy metals they have main part in acquisition. Organic matters have the result of scavenging Fe^{3+} increase the bioavailability of soil bound iron (Falkowski and Raven, 2013; Hughes and Poole, 1989; Schroth and Hancock, 1982). Lived in the metal polluted soils are often iron deficient in plant growth, the microbial siderophore are used in iron chelating agents they set the accessibility of iron in the plant rhizosphere (Bruins *et al*., 2000; Gavrilescu, 2004; Raffi *et al*., 2010). The plants required minor iron concentrations for the normal growth than do microbes but binding affinity of Phyto siderophores for iron is less than affinity of microbial siderophores. Root growth stimulated by different species of plants and has 1-aminocyclopropane-1-carboxylate (ACC) deaminase enzymes which control the amount of ACC by decreasing or hydrolyzing and ethylene a plant hormone precursor biosynthesis of plant by ethylene (Hontzeas *et al*., 2006; Ma *et al*., 2003; Madhaiyan *et al*., 2007). Removal of ACC from seeds or roots is taken up through the bacteria and cleaved by ACC deaminase to ammonia. The inner and outer level ACC the plant need exude increase amount of ACC (Jia *et al*., 2000; Nascimento *et al*., 2014).

Transform toxic heavy metals

The decrease in growth due to heavy metals among 25% to 40% depending on the type of metal both in root tissue as well as shoot when plants have ability to create a very significant diminution of accumulation for heavy metals particularly in the plant roots while than 50% decrease in addition of Cd, Pb and Zn in the roots (Hansda *et al*., 2014; Mushtaq *et al*., 2020; Saleem *et al*., 2007; Singh *et al*., 2019). The bioavailability of metals in soil to plant is also influenced the phytoremediation to productivity of plant. Bacteria can convert toxic heavy metals to form that are additional readily taken up into plant roots. Bacteria can increase the concentration of Selenium and organ selenium forms such as Smet are known to be taken at faster rates (Khan and Bano, 2018; Ojuederie and Babalola, 2017). The comparative change of organic bound with Cu, Pb and Zn were separately +5% +3% and

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+23% while in the infected rhizosphere 0.8%, -2% and -3% in the non-infected rhizosphere respectively. So, a huge amount of Cu, Zn and Pb bounded by organic matter in the infected rhizosphere (Abbaszadeh-Dahaji *et al*., 2016; Guarino *et al*., 2020). Chemical properties like pH of organic matter are directly affected the metal bioavailability through moving their soil rhizobacteria. The *Pseudomonas melophilia* reduced the mobile and toxic Cr^{3+} into nontoxic Cr^{6+} and also to reduce environmental mobility for additional toxic ions Hg^{2+}, Pb^{2+} (Jeevanantham *et al*., 2019; Li *et al*., 2019).

Inhibition of plant pathogens

PGPR provides different ways to suppress plant viruses. It involves the competition of nutrients and an anti-bacterial environment for the manufacture of antibiotics and the production of siderophores that reduce the availability of the iron needed for bacterial growth (Glick and Stearns, 2011; Ma *et al*., 2011; Tak *et al*., 2013). Another mechanism similar to the production of lytic enzymes B-1,3-glucanases and chitinases plays a vital role in the reduction of glucan and chitin in the fungal cell wall. PGPR showed resistance to heavy metal during phytoremediation process. It has been shown that inoculating plants with plant growth that promotes rhizobacteria or by treating microbes with plant microscopic plantings may be effective in promoting plant growth (He and Yang, 2007; Kong and Glick, 2017; Nie *et al*., 2002).

Stimulation of transport protein

Transport protein participating in the passage of ions. The protein might support in the change of substances by means of facilitated diffusion. Plants flourishing in tiny pots are usually considerably smaller than those expanding in large, at the same time when they have superficially suitable sources of water and nutrients (Salt *et al*., 1998; Singh *et al*., 2003; Zhao and McGrath, 2009). Bacteria persistence and propagation in the atmosphere furthermore within numerous hosts are censoriously reliant on the uptake and appropriation of conversion metals like zinc, iron, and manganese. For instance, cells might rigorously standardize intracellular zinc concentration while the elevated concentration of zinc is always noxious for cellular purpose which developed numerous types of protein implicated in attachment and transfer of zinc ions (Hall, 2002; Pilon-Smits, 2005; Wuana and Okieimen, 2011). The bacteria might also accelerate sulfate move proteins placed in the root cell or plasma membrane which similarly stimulates selenite mineral. The inorganic Hg absorbance elevated in plants has not been correctly inspected but has been associated to the inactive acceptance of lipophilic chloride facilities in phytoplankton (Hutchinson, 1973; Thomas *et al*., 1980).

Speciation versus bioavailable of heavy metal in soils

Soil rhizobacteria can also directly affect the melting of iron by altering the specificity of heavy metals in rhizosphere. The mycorrhiza played an important role in iron deficiency from the rhizosphere and it has impact on increasing plant tolerance in trapping heavy metals from soil (Li *et al*., 2015; Marschener, 1998; Watteau and Berthelin, 1990). Although high heavy metal concentration is usually harmful to microbial physiological aspects, therefore the tracking of heavy metals amount and number of different heavy metals is very necessary for the normal bacterial growth for reducing redox and cellular activity. Bacterial interactions with heavy metals depend on metal forms and the availability of bioavailability (González-Guerrero *et al*., 2016; Xie and Tang, 2019). The interaction of plant bacteria can promote the production of chemicals that can alter the chemical properties of the soil in rhizosphere and improved the accumulation of heavy metals in the plants body. The availability of bioavailability depends on a variety of factors such as soil pH, cation exchange rate, soil content of organic matter, mineral and iron content, water and heat content, biological properties of soil, chemical properties of metals and microbial activities under soil and climate conditions. In addition, the availability for heavy metal ions increases under low anaerobic oxidizing pH condition (Joshi and Juwarkar, 2009; Marsh Jr *et al*., 1963; Ullah *et al*., 2015).

PGPB mechanisms to control heavy metals stress

The heavy metals cannot be decomposed which can be harmless to bacteria. A few microorganisms have evolved to develop ways of removing toxins from the towards combat the harmless effects of these inanimate metals (Sgroy *et al*., 2009). Heavy metals such as Al, Pb, Cd, do not production any role in nature and are harmless to living organisms. There are several ways to protect against heavy metal resistance by microbial cells. These processes are the outer barrier of cells, the outer division of cells, and the active transport of metallic ions, the inner cell structure, and the reduction of metallic ions (Ahemad, 2019; Begum *et al*., 2019). Metal filtration that exceeds biological requirements prevents the growth of bacteria or bacteria that react to high levels of metals through various forms of resistance against heavy metal toxicity. Bacterium which increase the growth of plants such as Rhizobium, Brad rhizobium and Pseudomonas have been exposed to Co^{2+}, Cu^{2+}, Zn^{2+}, Mn^{2+}, Fe^{2+}, Mo^{2+} and the sensitivity of these metals has been tested in vivo which has shown that Rhizobium legumin Sarum spots are very sensitive to Cu^{2+} and Co^{2+} as compare with rhizobium (Islam *et al*., 2016; Rajkumar and Freitas, 2008). This flexible metal resistance method was tested by examining the areas exposed to anthropogenic or natural metal contamination for a long time. Acquisition of heavy metals by microorganisms occurs by bioaccumulation which is an active process or by adsorption which is a synthetic process (Bashan and De-Bashan, 2010; Dodd *et al*., 2010; El-Meihy *et al*., 2019). Many micro-organisms such as fungi, bacteria and algae have been used to clean contaminating areas by heavy metals. Bacteria use two types of heavy ion detection methods. The initial mechanism of chemiosmosis gradient throughout the cytoplasmic membrane is rapid and undetectable. Another method is a specific substrate, which slows down and undergoes ATP hydrolysis. The most important methods are physical isolation, exclusion and difficulty (Bunow, 1978; Lane *et al*., 2010; Silver and Phung, 2005; Taj and Rajkumar, 2016).

When heavy metals attached to the extracellular cell material, they can immobilize metals and blockage of its intake with the help of bacterium cells. On the cell surface, most of metals bind to the functional group that is anionic. By forming the effective barrier around the cell, heavy metals bind to extracellular polymers i-e proteins, polysaccharide etc. which helps to detoxify them. Siderophores minimize the bioavailability of metal here performs the toxicity reducing. Specific production metabolites result in precipitation of heavy metals (Ahemad, 2015; Pajuelo *et al*., 2011; Sher and Rehman, 2019; Zubair *et al*., 2016). Different types of bacteria manifest efflux for the transporters with higher level of substrate affinities because of which they can expel toxic metals with high concentrations which expelled outside of the cell. The plasmid encoded energy dependent system which involves chemiosmosis ion pumps. Along with the ATPase that are reported for acceptance of cadmium and chromium (De la Torre *et al*., 1999; Lakra *et al*., 2006; Pratap and Bonga, 1993). There is another method for toxicity of heavy metals in which ions may be converted into innocuous form which follow the entry into bacterial cells. This whole mechanism is known as mechanism of cytosolic sequestration. This allows the uptake of heavy metals with high concentration; for instance, metallothionein's synthesis. They have low molecular weight. The metal binding protein that is cysteine has high metal affinity e.g., copper, cadmium, silver and the mercury (Canli *et al*., 2001; Tanwir *et al*., 2015; Tiwari *et al*., 2009). As an alternative, some of the bacteria utilize methylation method that involves the methyl group which is transferred to the metal and metalloids. There is a limitation that only a few metals can be methylated. There is also a method used for the toxicity of heavy metals is decontamination of soil which involved the heavy metals reduction (Bordajandi *et al*., 2004; Karadede-Akin and Ünlü, 2007). The species of bacteria responsible for the reduction of heavy metals referred as dissimulator of metal reducing bacterium. Those bacterial strains help in detoxification of chromium which involves the reduction of Cr by the strains of bacteria which plays a significant role in the acquisition of severely heavy metals (Liu *et al*., 2006; Viti *et al*., 2003; Wang and Shen, 1995).

Significance of rhizobacteria in phytoremediation

For improving the growth of plant e.g., wheat, we have to screen PGPR. The study has suggested that the potential for biosynthesis of auxin through rhizobacteria which could be used as a tool for screening the effective PGPR strains (Deshwal and Kumar, 2013; Wani *et al*., 2009). A new combination of in vitro screening method which include microplate assay with plant i-e strawberry seedling to test the PGP strain which have more efficient potential biological controlling agents which has been developed successfully. To screen the effective PGPR strain ACC deaminase trait could be used as an efficient tool. It could be successfully used as bio-fertilizers which increase the growth of inoculated plants (Mazhar *et al*., 2020a; Wani *et al*., 2015). In the soil, the high levels of heavy metals decrease the microbial activity and it affects the production of crop by getting accumulated in plant organs. Metal ions are present in the soil and these are absorbed by the roots which transported to various plant organs. The enzymes and proteins in the cells which have higher affinity of heavy metals they rendered them inactive and also lost their function (Hansda *et al*., 2014; Liu *et al*., 2015). When they interact with heavy metals the structure of protein change and affect the plant growth by photo-system inactivation. At the end the free radicals produced oxidative effect that has adverse effect on biochemical and the physiological processes of plants. Reduction in growth and also development happens due to the disturbance in photosynthetic and also respiratory mechanism (Chaudhary and Khan, 2018; Qi *et al*., 2018; Tirry *et al*., 2018). The mechanism of PGPB to overcome the metallic stress, bacteria including the PGPB have several resistance mechanisms they can be immobilize, transform the metals, as well as reducing the toxicity which tolerate the uptake of heavy metal ions. PGP Bacteria help the plants to grow and these bacteria grow in soil or on the roots of plant. Pant will grow by helping the certain nutrients, modulating the hormone levels of plant and also protecting the plant from any type of pathogen (Saharan and Nehra, 2011; Zhu *et al*., 2015).

The quality of bacteria that respond to heavy metals plays an important role in utilization for bio-remediation of accumulation of toxic metals in plants. In agronomic processes, these bacteria express the unique ability of metal detoxification along with the growth promoting agent's property (Ayangbenro and Babalola, 2017; Zaidi *et al*., 2009). Researchers had reported many applications of bacteria i.e., sphingomonas macrogoldabidus, micro bacterium lique-faciens and the micro bacterium arabino-galactanolyticum inoculated to the plants; the A-murale which gives significant results by increased of Ni-uptake by plants as compared to the untreated plants. Carrillo-Castaneda reported that the potential of PGP in the protection of alfalfa (*Medicago sativa*) seeds from the accumulated copper due to the absorption by the roots to the shoots in the seedlings of these plants (Silver and Phung, 2005; Vacheron *et al*., 2013). It has been reported that Hydroxamate siderophores shown that besides the presence of heavy metals which increase the iron uptake by plants. Iron is the essential micro-nutrients for plants and also for microbes. Under anaerobic conditions such as flooded soil, high concentration of Fe^{2+} ions which are generated through reduction of Fe^{3+} ions and due to excessive uptake of iron leads to iron toxicity for plant cells. In aerobic conditions solubility of iron is low here limiting the supply of iron for different forms of life (Van Loon, 2007; Watteau and Berthelin, 1990). Bacteria can overcome the limitation of nutritional iron by using the chelatoragentsis known as siderophores. Through various ways the PGPB play a beneficial role in the growth of plant. For example, from PGPB siderophores prevent some pathogens from sufficient amount of iron hereby limiting the ability to proliferate. Nitrogen fixation is another important role of PGPB in the field of biology. Under the conditions of low soil moisture, the rhizobia are sensitive to drought stress resulting the decrease in nitrogen fixation. These studies gave an insight to the role PGPB, under the heavy metals stress increasing the biomass of plants (Saleem *et al*., 2007; Salt *et al*., 1998; Sayyed *et al*., 2013).

Transformation and the uptake of heavy metals

The mechanisms which are involved in transformation of metal ions in soil leads to wards the loss of heavy metals (uptake of plant, leaching and the volatilization reactions). The most of the metals do not undergo the volatilization related losses. Actually, the fate of metalloids in soil totally depends upon its properties and its environmental factors (Khan and Bano, 2018; Marschener, 1998; Ross, 1994). The availability and the mobility of metals in soil affected by microbes and they can be done through certain steps, acidification, changes of redox, production of iron chelators and the siderophores, mobilizing the metal phosphates. Actually the heavy metal in soil which are bound to both organic and inorganic substances or these are present as insoluble precipitates that are not available for root uptake, siderophores of bacteria produce (Sayyed *et al*., 2013) PGPB which have the ability to solubilize the heavy metals having Fe and make them available for roots of plants to take up. These PGPR helps to reduce the metals toxicity by bio-sorption method because of the bacterial cells absorb high amount of heavy metals. The environmental factors that affect the growth of plant include water, light, and the temperature, nutrition and also humidity. Soil hardness affects the growth of roots (Gadd, 2000; Haas and Défago, 2005; Khan and Bano, 2018).

Approach by genetically engineered

Various genetically engineered approaches have been developed and these are used to optimize the enzymes, organisms that are relevant for bio-degradation, and also metabolic pathways. With the molecular method allow the characterization of structure of microbial community and the activities. There are a large number of proteins which bind to different heavy metals with whole range with greater affinity (Saharan and Nehra, 2011; Vessey, 2003; Zaidi *et al*., 2009). The metal binding proteins are at the outer membranes in plants and microbes where they will interact with metal ions in environment here ensuring the transport of metal ions to cytosol. And by the metal-cochaperones these are transferred to suitable receptor proteins. Plants respond high levels of heavy metals by synthesizing (Abbaszadeh-Dahaji *et al*., 2016; Ayangbenro and Babalola, 2017). Heavy metals are being accumulated in soil through sewage disposal and the industrial wastes. Among various traditional soil remediation technologies phytoremediation use to clean up the metal contaminated sites has increasing the attention as co-friendly as well as inexpensive. Improvement of metal accretion plants traits like genetic engineering necessary perspectives of certain many biological processes implemented in it by roots from the soil sap and then transferred to shoots. Metal contaminated soil by phytoremediation can be done by different forms of genetically engineered rhizobacteria (Canli *et al*., 2001; Dodd *et al*., 2010; Joshi and Juwarkar, 2009). Phytoremediation is an eco-friendly and the emerging technology that has gained the wide acceptance by, any regulatory authorities. Its use is limited time taken to achieve the clean-up goal (Cuypers *et al*., 2011; Lahori *et al*., 2017; Li *et al*., 2015). Currently it is the area of the active research in plant biology. Number of metal accumulated by plants has been identified as the potential candidates to Phytoremediate the metal polluted soil. Various types of strategies have been applied to generate the plants that are help to grow in environmental conditions and to transfer the number of metals (Dubey, 2010; Halder and Chakrabartty, 1993). The use of genetic engineering helps to modify the plant for enhanced efficacy of phytoremediation strategies. Plants are involved in this process and there are many chances of food chain being distributed.

Conclusion

When evaluating the rhizobacteria effects in phytoremediation of toxic metals from contaminated soil, the process carried out both by bacteria and plants while to protect plants from heavy metaltoxicity. Certain bacteria use special developmental processes for phytoremediation of heavy metals. Scientist are working to access the role of PGPR but still not understanding the concept of phytoremediation. There are of few questions which needs to be answered yet,

1. There is need to investigate the microbes induced changes in rhizosphere of plant related to accumulation of metal, and also the contaminated soil.
2. There is need to quantify the effect of phytoremediation process on phytoavailability of heavy metals.
3. There is need to examine the accumulation and the distribution of toxic metals.
4. The role played by the bacteria from solution of soil in plant and the uptake of cadmium is poorly understood yet.
5. There is need to understand the mobilization and the transfer of metals. Here we develop the strategies and the optimization of phytoextraction process. There is more need to understand the role of soil rhizobacteria for phytoremediation.

Conflict of interest

The authors declared absence of any conflict of interest.

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