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3. A Review on the Effects of Pernicious Arsenic Element and Its Phytoremediation

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Abstracts:

Arsenic (As), a group 15 elements of periodic table, is a heavy metal that becomes worldwide thread for the great arsenic pollution both in agricultural land and drinking water. The arsenic salts accumulates the soil particles that cause soil pollution and by heavy rain fall arsenic enter into ground water and contaminates it that ultimately cause a huge agricultural pollution by irrigating this contaminated ground water. This arsenic causes a lot of agricultural damage which can cause economic loss.

For the presence of arsenic plant growth and crop production are redacted and its main causes are uncontrolled industrialization, excess amount of coal burning and also some natural cause as volcano.

In this review it is trying to discuss the removal of arsenic by phytoremediation and it is processed by some plants as sunflower, date, palm, willow, poplar and a grass named vertiver. These plants can absorb both organic and inorganic form of arsenic by their roots and convert the toxic arsenic to non-toxic arsenic that is used their metabolism.

Keywords: Arsenic, Heavy metal, Microbiology, Botany, Soil biology, Pollution.

3.1 Introduction:

Arsenic is one of the most effective and pollution causing heavy metals that has become a matter of great concern to the people in mainly agricultural field because of its fatality to both crops and human health. Arsenic is a natural contaminant and it can enter in the agricultural fields by irrigating ground water that in many cases acts as a natural source of arsenic. In the ground water arsenic is present as a dissolved salt form. The presence of high concentration arsenic in the ground water is normally connected with the geothermal environment of volcanic deposits, geothermal systems and basin fill deposits alluvial lacustrine origin.

In ground water arsenic comes from the oxidative or reductive products of iron oxides or sulphides and organic matters and present as dissolved form as arsenates or arsenites. Another source of arsenic in agricultural fields is pesticides because in pesticides arsenic is used to protect plant from rotten and decay and also as weed killer. But now the arsenic became a great concern for the cause of effective in crop production and death of plants.

Fig 3.1: Arsenic (As)

Fig 3.2: Arsenic affected rice

3.2 Sources:

There are many sources of arsenic in nature that's why it is abundantly found in agricultural lands. Many natural incidences can produces arsenic volcanoes, weathering of rocks, natural oxidation, reduction of metal ions and etc.

But uncontrolled industrialization and use of huge amount of chemical fertilizers and pesticides play the major role in arsenic consumption in land. Besides this huge amount of coal burning, mining can produces a lots of arsenic as their byproduct primarily in the atmosphere arsenic spread out as arsenic trioxide, then it binds onto the surface of any particles which are scattered into the ground water level by rain fall and the ground water became arsenic contaminated.

The three most effective arsenic bio-transformative ways are redox transformation between arsenic and arsenate, the reduction and methylation of arsenic and bio-synthesis of organo arsenic compounds. Both natural and artificial sources of arsenic high up the arsenic level in soil from normal to extreme level that causes severe plant damages and degradation in crop production.

3.3 Characteristics of Arsenic:

Arsenic is one of the 20th most plentiful minerals in the Earth's count and it also the position holder among the 12th most abundant minerals in human body. In all of the natural media it is found in low concentration.

a. Physical Characteristics:

The three allotropes of arsenic those are most common are grey, yellow and black arsenic among which grey is the most common. Normally arsenic is formed in two oxidation states the trivalent state arsenic (III) and the pentavalent state arsenic (v). Besides this arsenic is also present in 3 states in arsenides which are alloy like intermettalic compounds. Grey arsenic is a semimetal but can be converted into semiconductor. The density of gray arsenic is 5.73g/cm3.

b. Chemical Characteristics:

Arsenic can for content molecules by binding with non-meals. Arsenic is stable in dry air but it can produce a golden-bronze tarnish upon exposure to humidity that in the end becomes a black surface layer, and arsenic get heated in atmosphere, oxidation occurs and produced arsenic trioxide. Arsenic react with metals to form arsenides and however it does not react with water, alkalis and non-oxidizing acids.

c. Toxicity:

The toxic effect of various forms of arsenic depends on their oxidative states and chemical structures. When the inorganic forms of arsenic, presenting in soil is taken up and transported through the food chain it turned out to be toxic. The oxidation state as (v) is less toxic than As (III) and mostly present in immobile mineral forms, where As (III) form gets mobilized into water and enter living cells. Normally plants contains low level of As (<3.6mg/kg). High concentration of arsenic can cause toxic effect in plant and results inhibition of seed germination, decrease in plant growth, decrease in crop productivity and etc. For its high toxic effect arsenic is also called 'The King of Poison'.

3.4 Forms of Arsenic in Soil:

In the soil arsenic is found in both organic and inorganic forms where in it inorganic forms are present as mineral. Arsenic posses about 300 inorganic minerals including arsenates, sulphides, sulfosalts, arsenates etc.

These inorganic forms of arsenic gets methylated at the time of entering into food chain and produce less toxic organic forms as mono-methylarsine (MMA), dimethylearsine (DMA) and trymethylarsine (TMA).

3.5 Effects on Plant and Crops:

a. Effect on Plant Growth:

Presence of Arsenic in agricultural fields can make many disturbances in plant metabolism, plant growth and crop productivity. Presence of high conc. of arsenic reduces the root length, sooth length, and number of leaves, leaf area and dry mass of plant. It hampers the bio-chemical and metabolic process of plant which ultimately causes death of plant.

b. Effect or Photosynthesis:

Arsenic causes negative effect or photosynthetic apparatus. It occurs severe injuries in membrane of chloroplast and destroys the fundamental photosynthetic process. Besides this arsenic can retreat the fixation of CO2 and Ps-II functions.

Besides this contamination of arsenic results in interaction of functional groups of enzymes, plants water status, replacements of essential ions, reduction of the level of essential amino acids those ultimately cause in lower fruit production, wilting, curling and necrosis of leaf blades.

c. Phytoremediation:

Heavy metals as arsenic cannot be destroyed but can be transformed from their one oxidation state to another. These are various plants that can act as hyper accumulator of arsenic such as alfalfa, sunflower, willows, poplars and several types of grasses.

It is reported that the mine soil which is an abundantly accumulator of arsenic, can also be cleaned up by phyremediation. These plants take up arsenic through their roots by active and passive transport and converted it to nontoxic organic matter that is used in their metabolism. These plants are low in cost and also available. So they can be easily used for phytoremediation.

Besides this there are also some microorganisms such as Pseudomonas putida, Methylibiumpetroleiphilum can synthesize siderophores that act as washing agent of arsenic. These microbes able to remove upto 92.8% of arsenic from contaminated soil after five washes.

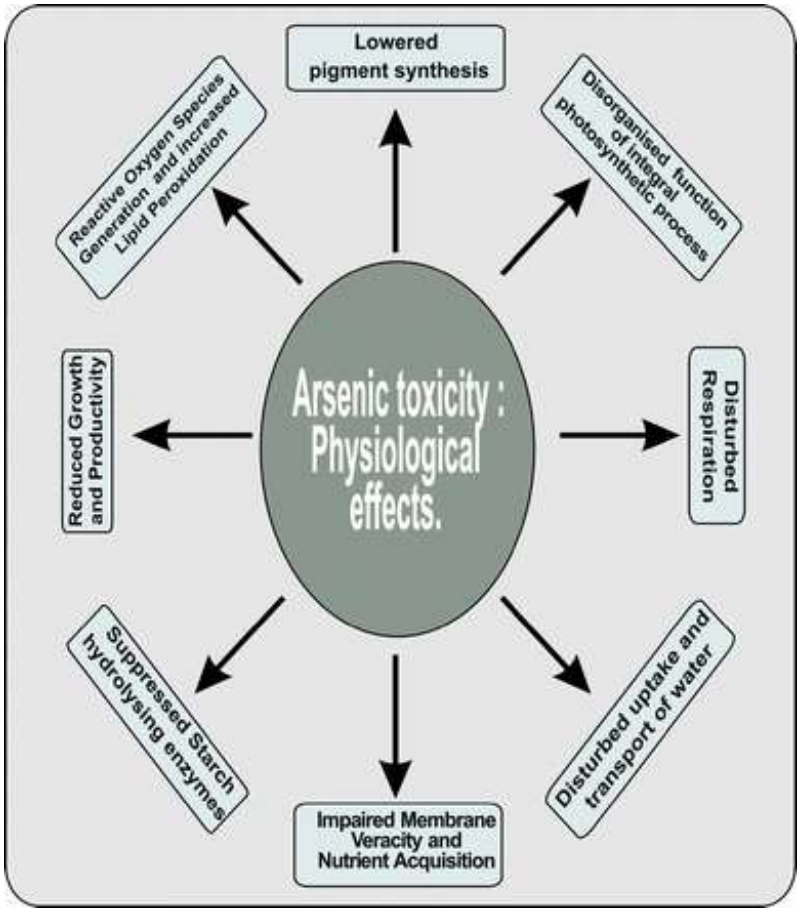

Fig 3.3: Effect of arsenic on plants

Fig 3.4: Effect of arsenic poisoning in the rice

Fig 3.5: Arsenic affected decay in rice plants

3.6 Conclusion:

Arsenic is one of the toxic chemical elements present in soil in both inorganic and organic form. It is worstly impact of environment, causes soil pollution, effect on human health. Arsenic is reacts with other soil element, result poor growth of agricultural crop. It is a heavy metal has high risk to contaminate groundwater. The toxicity of arsenic is depends on its oxidative state and chemical structure. There are few eco-friendly and easy approaches to detoxify arsenic contaminated soil and water. Phytoremediation, a process in which several plants like willow, poplar, alfalfa, sunflower, corn, date and several grasses can detoxify arsenic. These plants can accumulate arsenic like heavy metal and absorb it from environment. So, we can this simple and easily affordable process to improve soil quality and cleaning up our environment. Pollution free life is healthy and wealthy life.

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