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Mitigation of arsenic problem through bio-remediation and agricultural practices for sustainable agriculture

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Abstract
Adoption of agricultural practices is cost effective bioremediation techniques to mitigate arsenic problems and may contribute substantially to the explanation for removal of arsenic and other heavy metal contamination of soils and water thereby quality enrichment in marketable agricultural produce resulting in increased crop productivity within the area of intensive cropping under irrigated eco system. Though the farmers are already practicing some traditional techniques to mitigate the arsenic problems in soils and water, like cultivation of crops which are less affected to arsenic and heavy metals pollution, growing hyper accumulating crops then many practices wherein the fashionable methods aren't prevalently employed by the farmers thanks to the shortage of scientific validity of those techniques, particularly within the context of prevailing socio-economic conditions. Moreover, acceptance of those improved practices by the tiny farmers of this region is an evolutionary process and will be intensively proved. Hence, extensive studies need for bio or phyto-remediation of heavy metals including arsenic contamination for quality marketable agricultural produce, which ultimately can realize better crop productivity.

The general objective and goal of such study aims to guage the effectiveness of advanced bioremediation techniques as compared with traditional system towards improving the standard of water for irrigation vis-à-vis soil and crop quality improvement in diverse soil types through on-farm field experiments.

Arsenic in elemental form is insoluble in water and it's soluble in oxidized.WHO’s maximum permissible limit is 0.05 mg/L in India and 0.01 mg/L in USA. All the tube wells in 17 blocks of Nadia in West Bengal had been analyzed and 89% tube wells contained arsenic above 0.05 mg/L as reported.

The level of arsenic in edible plants is usually low, often being on the brink of the limit of detection, even when the crops are grown on contaminated land. the info indicated that when each soil type contains similar As concentrations, lower levels are found in plants grown on clays and silts, with their higher clay mineral and Fe/Al oxide content, than in plants grown on lighter soils, e.g. sands or sandy loams. This reflects the sorption characteristics of soils. during this context, the proposed study administered (i) to develop more efficient hyper accumulator from the chosen species using biotechnological tools and (ii) to pick the cultivated crops and cultivars of local origin having immune to heavy metal accumulation without impairing crop yield and economy of the farmers.

In common with most trace elements, the degree of uptake varies widely from species to species. Unlike some marine and water organisms where very high concentrations (over 1000 mg As/kg fresh weight, almost like those within the sediments, are found in some macrophytes), the amount in terrestrial plants remain well below the extent within the soil. Pot and field trials on the effect of applying sewage sludge, containing arsenate, to a sandy loam (pH 6) and to a calcareous loam (pH 8) indicated enriched factors that were 3-4 times greater within the lettuces and rye grass grown on the calcareous loam. the very best level of As reached within the crops was 2 mg/kg dry weight in lettuce.

There are some reporting from the research findings that application of FYM and P_2O_5 could resist the release of native arsenic and could be lowering down to moderate toxic effect in soil-plant system. Application of Zn has reportedly been reduced the concentration of arsenic in summer rice. A large number of other significant findings have ensued from the extensive research at Bidhan Chandra Krishi Viswavidyalaya. The application of FYM and phosphate was found to have opposing effect on release of native and applied As in the contaminated soils, with FYM reducing such release, thereby tending to moderate the toxic effect of As in the soil–plant system. The crop with less water requirement also might be helpful to lowering down the effect of arsenic and its severity. In these backdrops, water productivity of summer rice with differential sowing and transplanting dates as its relation with exploitation of groundwater with arsenic contamination are to be quantified and to be established. The research results also showed that the incorporation of pulse crop(s)/legume(s)/green manure coupled with organic/compost in crop sequence(s) would also be helpful in moderating the effect of arsenic. BGA (*Anabaena sp. and Nostoc sp*.) and some bacteria were shown the effect having decontamination ability. The tube wells with activated alumina are being used to get arsenic free drinking water to mitigate the severity of the problem in these areas. Surface water is free from arsenic contamination and safe for use in crop cultivation. The efficient of judicious application of intermittent irrigation water in summer rice was found effective as integral part of water saving technologies. A number of microbial species has been reported to possess varying degrees of arsenic accumulating abilities (Sanyal and Nasar, 2002). Several weed species, identified by the present authors, normally found along with crops like rice, potato, jute, mustard, etc., growing on arsenic contaminated soils and subjected to irrigation with arsenic contaminated groundwater, were noted to accumulate considerable amounts of arsenic in their biomass. However, it is worthy to note in this context that such accumulation of arsenic does *not* necessarily lead to its

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detoxification *per* se (Sanyal, 1999; Sanyal and Dhillon, 2005) unless the plant- accumulated toxin is effectively detoxified within the plant body by its metabolic processes. Hence, the success of such phytoremediation technique would depend on establishing a desirable plant community. A systematic search for phytoaccumulating or phytoexcluding plant species is necessary for this. Some of the techniques in this field, that may prove useful, include phytodegradation, phytovolatilization or biotransformation, rhizofiltration, etc. (Das *et al*., 2005). This would certainly be a useful tool for remediating arsenic contamination in an effective manner. A comprehensive approach is necessary to combat the present arsenic crisis. Some of the potential remedial options aimed at reducing the toxic effect of arsenic in agricultural systems include developing low arsenic accumulating genotypes, optimum conjunctive use of ground and surface water (e.g., use of harvested rainwater) irrigation with pond-stored excess rainwater and groundwater, recharge of the groundwater resource with rainwater, and enhancing water use efficiency for the agricultural crops by way of adopting appropriate soil and irrigation water management strategies.

Keywords Arsenic; mitigation, bio-remediation, agriculture, sustainability