Effects of Arsenic on Leguminous Crops in Murshidabad District

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Abstract: Arsenic is harmful to most plants in high concentration as it obstructs the metabolic activities and inhibits plant growth and reproduction. It is a toxic metalloid released into environment by both natural as well as anthropogenic activities. It also affects the leguminous crops which is widely grown these arsenic affected regions of West Bengal, particularly lower Gangetic plane. However, a little is known about the arsenic accumulation on these crops, when these crops are grown in the arsenic contaminated soils. Murshidabad district of West Bengal is one of the most arsenic contaminated areas in the world.

Keywords: Arsenic, leguminous plant, Murshidabad.

Introduction: Arsenic is found naturally and exists both organic and inorganic forms in the environment. Arsenic contamination has been a matter of concern worldwide and is considered as risk factor in many countries including Bangladesh, Taiwan, India, Mexico, China, Chili, Argentina and USA. In India, the states of West Bengal Bihar, UP and Assam are reported to be most affected by arsenic contamination of groundwater about the permissible level. In West Bengal particularly Murshidabad district have been reported to be suffering from groundwater arsenic toxicity for long period (Chakraborty et al., 2004; Pal et al., 2007). Between contaminated districts, Murshidabad district is the most affected in term of level of arsenic contamination and area coverage (Samal 2005; Bhattacharya et al. 2009). Arsenic contamination by irrigation from groundwater has posed the serious health problem in West Bengal. Long term irrigation of agricultural soils with arsenic contaminated water can lead phyto-accumulation and food chain contamination of the food crops with arsenic and other toxic metals. Therefore, an effort has been made to study the effect of arsenic toxicity on the pulses production and health of the consumer.

Arsenic in legume plants: Among the legume crop, Lentil and Chickpea are one of the majorities grown and consumed pulses in the Murshidabad district of West Bengal. Lentil is one of the most ancient cultivated crops and is grown in India, Bangladesh, China, Nepal, Canada and USA. Lentil is rich in protein, fiber and other vitamins and minerals like iron, zinc folate and magnesium. Further, tannins and saponins are also found in lentil having antioxidant and anticarcinogenic properties. The arsenic element is not essential and generally toxic to most food crops. It is reported that root parts of lentil are the first tissue to be exposed to arsenic, where the metalloid hinders root extension and proper growth. Arsenic also inhibits the normal physiological growth. Arsenic stressed plant shows reduced plant growth and pigment content. Total chlorophyll, ascorbic acid and catalase content dramatically reduced in food crops in response to arsenic exposure (Alam et al. 2019).

Chickpea growth on the arsenic contaminated soils is also not normal and it has been reported that Chickpea plants when exposed to arsenic contaminated soils and studied for arsenic uptake, distribution and effects of growth, yield and quality of the seed. The roots accumulated the highest arsenic followed by shoot and seed. Arsenic reduced the growth of roots and shoots 60-65% respectively. A clear damage on membrane, reduction in chlorophyll and relative leaf water content were observed in arsenic treated plants (Jahid A Malik et al. 2011). Shamim and Pandey (2019) also reported that morphological characters of all most all thirty-two black gram genotypes were significantly decreased with increased concentration of arsenic in supplied nutrients, shoot length; root length was less affected whereas shoot weight, root weight and total biomass were significantly decreased under arsenic stress condition.

Effects of Arsenic in different plant growth stages: In soil, water and air arsenic available in many chemical forms with variable degree of toxicity. The factors which affect these parameters include the arsenic concentration in soil, the type of plant species and other soil properties which controls arsenic accumulation, accessibility and fate in soils, micro-organisms and plants. Inorganic arsenic is more lethal than organic form. Arsenic contamination has an adverse effect on the morphological, physiological and biochemical response of plants. Studies on lentil crop under arsenic contamination are illustrated with different plant growth stages i.e. dry weight of lentil plant, arsenic accumulation in lentil root, arsenic accumulation in grain and in all stages, the treatment and lentil varieties both showed significant differences on the effect of dry weight.

In general, the potential of some vegetables to accumulate heavy metals with concentration of Lead is greater than Cadmium. The concentration of arsenic and cadmium were higher in vegetables than the rice and pulses crops. The total arsenic concentration on food crops ranged between 0.001 to 1.451 mg/kg of dry weight. The highest mean concentration of arsenic was found in potato (0.452 mg/kg) followed by rice grain (0.426 mg/kg), where as the total mean arsenic content in pulses and oilseeds varied between 0.073 to 0.165 mg/kg, in tuber crops ranged from 0.241 to 0.451 mg/kg, in spices ranged from 0.032 to 0.177 mg/kg, in fruits ranged from 0.021 to 0.0143 mg/kg and in vegetables ranged from 0.031 to 0.408 mg/kg respectively. Thus, arsenic...
accumulation in cereals, pulses, oilseeds, vegetables, spices and fruits crop might not be safe in future without any sustainable mitigation strategies to control the potential arsenic toxicity on the human health in the contaminated areas.

**Recommended intake of arsenic and its toxicity:** Permissible limit of arsenic in food crops is 1.0 mg/kg. In drinking water, arsenic permissible limit is 0.01 mg/liter and in irrigation water limit is 0.01 mg/kg. Tolerable limit of arsenic is 3.0 µg/kg body weight/day. By World Health Organization, the safe limit for arsenic in drinking water has been prescribed to be 10.0 µg/liter.

**Conclusion:** Ground water has been a major source of irrigation in arsenic affected areas. For many decades, excessive exploitation of the ground water and indiscriminate use of agricultural chemicals have been carried out for the extensive cultivation of rice, wheat, pulses and vegetables to ensure food security. Therefore, the potential contamination source of arsenic is increasing every year in the ground water. Screening of the crops under arsenic toxicity and their arsenic uptake level should be studied to check the potential genotypes which might be having low level of arsenic concentration and then further their use in the breeding programme should be done for developing arsenic tolerant genotype for cultivation in those areas.

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**Reference:**