



# Toxicological Effects Of Arsenic In Pigeon Bean (*Cajanas Cajan L.*) From Murshidabad District, West Bengal

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## Abstract:

Arsenic is found naturally and exists in both organic and inorganic form in the environment. The toxicity of arsenic in soil and ground water is one of the most important environmental problems particularly in Murshidabad district of West Bengal. It affects the leguminous crops like lentil and pigeon pea which is widely grown in these arsenic affected regions of Murshidabad district. Indo-Gangetic regions is one of the most arsenic contaminated points in the world. Long term irrigation of agricultural soils with arsenic contaminated water can lead phytoaccumulation and food chain contamination of the food crops specially leguminous plants.

**Key words:** Arsenic toxicity, pigeon pea, Murshidabad.

## Introduction:

Arsenic (As) is a carcinogenic metalloid released into the environment from both natural and anthropogenic sources. The transfer of As in soil-plant systems represents one of the principal pathways for human exposure to As. In particular, As contamination in food crops through irrigation water poses a serious threat to food safety. A recent study showed that daily consumption of 500 g cooked rice containing As content above 200 µg/kg can result in genotoxic effects on human. The scale of this environmental poisoning has been expanding year after year, and is greater than any other hazards. The impact of As poisoning is thought beyond the catastrophe relating to the accidents at Bhopal, India, in 1984, and Chernobyl, Ukraine, in 1986. Although the first As-poisoned (Arsenicosis) patient was seen in 1983 in West Bengal, India. At global scale, more than 100 million people have been estimated to be chronically exposed to As from drinking water. Obviously, the situation is devastating in Bangladesh, India and Pakistan. This toxic element (As) is found naturally in all soil throughout the world.

Pigeon pea is one of the most ancient cultivated legume crops. Bangladesh, Canada, China, India, Iran, Nepal, Syria, Turkey and USA are the major Lentil growing countries in the world. The total cultivated area in the world is around

4.6 million hectares producing 4.2 million tons of pigeon pea with an average yield of 1.095tonha<sup>-1</sup>. Lentils provide protein and fiber, as well as many vitamins and minerals, such as Iron, Zinc, Folate, and Magnesium. In addition, the phytochemicals, saponins and tannins found in lentil possess antioxidant and anti- carcinogenic properties, indicating that pigeon pea may have significant anti- cancer effects.

Among all pigeon pea growing regions, many of pigeon pea growing countries are highly contaminated by As. specially, West Bengal and Bangladesh combined rank the second largest As contaminated region in the world. About 8% of the area in the United States of America is As affected. Despite this, the As element is not essential and generally toxic to many food crops including pigeon pea crops. pigeon pea roots are typically the first tissue to be exposed to As, where the metalloid inhibits root extension and proliferation. This metal translocated to the shoot and grain and it can be rigorously constrained of physiological growth by slowing or arresting growth and biomass accumulation, as well as compromising plant reproductive capacity.

## Results:

### Dry weight of root, shoot and pod.

Dry weights of pardina roots were found 0.333, 0.389 and 0.264g in 0,3 and 6mg kg<sup>-1</sup>As treated pots, respectively at week 6. Similarly, dry weights of red chief roots were found 0.349, 0.497 and 0.301g at 0,3 and 6mgkg<sup>-1</sup>As treated pots, respectively. Chronologically, average dry weights of roots, shoot and pod were found lower in 6mg kg<sup>-1</sup>As treated lentil cultivars at week 6, 10 and 13. On the other hand, average dry weight of red chief roots, shoot and pod at 0,3 and 6mgkg<sup>-1</sup>As treated condition were found significantly higher than other lentil genotypes at week 6, 10 and 13. Treatment and lentil variety both showed significant differences on the dry weight of root at week 6. Similarly treatments and varieties both were found significantly different on the effect of dry weight of lentil shoot at week 6, 10 and 13. In week 10, treatment and varietal effects on the dry weight of pod were found statistically different. On the other hand, only treatment effect was found significantly different on the pod dry weight at week 13.

### Arsenic accumulation in root:

Treatment, interaction result of variety and treatment on As uptake in root of lentil genotypes were found significantly different at week 6 and 10. On the other hand, only treatment effect on As accumulation in root was found significantly different at week 13. Arsenic accumulation in root was found significantly higher at A<sub>6</sub>(6mgkg<sup>-1</sup>) treated pardina, red chief and precoz lentil genotypes than control(0mgkg<sup>-1</sup>) and A<sub>3</sub>(3mgkg<sup>-1</sup>) during week 6, 10 and 13. Based on the treatment period, accumulation of As in root of control, A<sub>3</sub> and A<sub>6</sub> treated lentil genotypes were found statistically different. For instance, As uptake in root of pardina, red chief and precoz lentil genotypes at week 6 was found significantly higher than week 10 and 13. However, As uptake was found at similar rate during week 6 and 10 in root of these lentil genotypes. In week 13, As uptake in red chief genotype was lower than precoz and pardina. Arsenic uptake in roots in A<sub>6</sub> treated lentil genotypes was more than other As treatment.

### Arsenic accumulation in shoot:

Treatment effect on As accumulation in shoot of lentil genotypes was found statistically significant during week 6, 10 and 13 according to significance test. On the other hand, varieties were found statistically different for As uptake in shoot at week 6 rather than week 10 and 13. Arsenic accumulation in the shoot was found higher at A<sub>6</sub> treated pardina, precoz and red chief lentil genotypes during week 6, 10 and 13. On the other hand, accumulation of As at week 6 and 13 in the shoot of the pardina and red chief genotype was found significantly different between A<sub>6</sub> and control, and A<sub>6</sub> and A<sub>3</sub> treated lentil genotypes. According to week, accumulation of As in shoot of control, A<sub>3</sub> and A<sub>6</sub> treated lentil genotype was found statistically different. Red chief was found significantly different at week 13 for uptake of As in its shoot from week 6 and 10. Arsenic accumulation in shoot of pardina, red chief and precoz genotypes were found statistically insignificant at week 6 and 10. Arsenic uptake in shoot with A<sub>6</sub> treated lentil genotypes was more than other As treatments.

### Arsenic accumulation in grain:

Treatment and varietal effects on As accumulation in grains of lentil genotypes were found statistically significant during week 10 and 13. Arsenic accumulation in grains was found statistically insignificant between control A<sub>3</sub> and A<sub>6</sub> treated pardina and precoz lentil genotype during week 10 and 13. At week 10 and 13, As accumulation in grains of red chief genotypes was found statistically different between the control and A<sub>6</sub> treatment. According to week, accumulation of As in grain between control and A<sub>6</sub> treated lentil genotype was found statically dissimilar. This uptake in the grains was found statistically insignificant between A<sub>3</sub> and A<sub>6</sub> treatment. Arsenic uptake in grains of red chief was found significantly

lower than pardina and precoz at week 13. Arsenic uptake in grains showed insignificant difference between pardina and precoz. Arsenic accumulation in grains was found lower than root and shoot during week 10 and 13. Arsenic in grains increased by 20% and 40% in red chief and precoz with 6mg As kg<sup>-1</sup> peat moss as compared to 3mg As kg<sup>-1</sup> peat moss after 13 week of growth. Arsenic in grain was found 17% higher by the treatment of 6mg As kg<sup>-1</sup> peat moss in comparison to 3mg As kg<sup>-1</sup> peat moss after week 13. Red chief genotype was found low As accumulator in contrast to pardina and precoz.

## Discussion

Arsenic (As) is a lethal metalloid. Its accumulation in plant tissues and associated health risk with the consumption of As contaminated grains are matters of huge public concern. Among food crops, rice as well as pigeon pea is also grown in As contaminated areas in Murshidabad and other contaminated areas in the world. Arsenic is translocated from soil to root, shoot and grains of lentil and other food crops. As a result, As reduces the biomass accumulation of pigeon pea genotypes. Lentil seedlings showed normal growth in As free pots. The seedling growth was negatively affected by increasing the rate of As contamination in Pardina, red chief and precoz genotypes. Similarly conducted research on As toxicity in food crops. They found a high concentration of As decreased the plant growth and development by inducing phyto-toxicity. Due to the Astoxicity, germination, plant height, number of roots and shoot growth were negatively affected which might eventually lead to the death of food crops. The transportation and accumulation of As in plants followed the order, roots>shoots>grains. Arsenic contamination in growing media (0.2 mg kg<sup>-1</sup>) causes negative effects on food crops. Similarly, 0.6 mgkg<sup>-1</sup>As in soil affected soybean growth. Likewise, biomass of 3 mgkg<sup>-1</sup>and 6 mgkg<sup>-1</sup>as treated pardine, red chief and precoz pigeon pea genotypes significantly decreased compared to the control plants grown in As free medium.

## Conclusion:

Pigeon pea is an important leguminous crop that provides protein to human diets. Arsenic accumulated in tissues of lentil genotypes and its reallocated to grains enhance health risk with the consumption of contaminated tissue. In this study, we found that concentration of As transport significantly increased from soils to root and shoot tissues and grains in lentil genotypes. Due to such high As transport, biomass of the crops was negatively affected in their entire life cycle. As a result, root and shoot mass of pigeon pea genotypes was found significantly affected. Pardina, red chief and precoz pigeon pea genotypes responded remarkably in terms of As uptake from soils to their root, shoot and grains. Arsenic in grains was increased 17% by the treatment of 6mg As kg<sup>-1</sup> peat moss in comparison to 3mg As kg<sup>-1</sup> peat moss after 13 week of growth. Thus, the toxic metalloid (As) might transfer to the human body through the consumption of grains, thereby increasing health risks. Therefore, development of As mitigation technologies that could improve plant growth by restricting As transport to plant tissue is urgently needed to expand pigeon pea production in the As contaminated regions throughout the world as well as the reduction of health risk with the consumption of this food crop.

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