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Title of thesis- Study of Nitric Oxide Signaling Molecule in Crop Plants under Arsenic Stress

ABSTRACT

Title: Study of Nitric Oxide Signaling Molecule in Crop Plants under Arsenic Stress

Arsenic (As), a toxic metalloid occurs naturally in the environment and has been a huge problem for South East Asian countries. As contaminated water and food results accumulation of As in living organisms, causing health risk of about 65 million people (Abbas et al. 2018). Nitric oxide (NO) is a cell signaling molecule, easily diffusing across the plant cells, and plays an important role in signal transduction pathways by interacting with different cellular compounds and radicals. NO interacts with many pro-oxidants, antioxidants, ROS, and neutralize heavy metals generated ROS *via* two ways, either in free radical form by directly reacting it or as a signaling molecule leading to the gene expression change in molecular cascades (Praveen et al. 2019). In the present study *B. juncea* and *O. sativa* genotypes were selected to study the protective role of NO during As stress as Indian mustard is a hyper accumulator of heavy metals and rice is more efficient in As uptake, as compared to other cereals crops.

The results are summarized under following headings:

(1) Study of Arsenic accumulation and phenotypic alteration in rice and mustard genotype

- Interactive effect of As^{III} and NO was observed on As^{III} exposed rice and mustard varieties. By observing both the varieties, we found that concentration of As content was more in mustard than that of rice. Other morphological parameters were almost equally improved in both plant genotypes after SNP supplementation along with As^{III}.

(2) Role of nitric oxide in mitigation of As toxicity by modulating nutrient profiling, biochemical responses, and gene expression of auxin & nutrient transporters in O. sativa.

- Adverse effect of As^{III} was observed on basic physiological parameters and SNP supplementation increased content of these parameters. Increase in the activities of

antioxidant enzymes and stress related parameters were observed under As stress which were further decreased during SNP application due to less production of ROS. Nutrient contents were reduced after As^{III} exposure generally. However SNP improved the nutrient content in rice plants.

- As^{III} negatively affected the inorganic nitrogen contents as well as nitrogen metabolism related enzyme activities. Co-application of SNP along with As^{III} play protective role and improved these parameters. As^{III} exposure downregulated the transcript level of auxin transporter genes. While, supplementation of SNP along with As^{III} upregulated these genes expression. In As^{III} exposed rice seedlings N, P, K related genes had downregulated expression, and after SNP addition these genes were upregulated.

(3) Nitric oxide alleviates the toxicity of As^{III} in Brassica juncea by altering the nutritional status, nitrogen metabolism, oxidative stress, and transcript analysis.

Similar trend has been observed in *Brassica* also except nitrogen related parameters which showed opposite trend than that of rice plant.

(4) Interactive effects of As and nitric oxide on amino acid profiling in rice and mustard genotype.

- In rice seedlings, AAs contents reduced in leaves and enhanced in roots during As^{III} stress. In mustard seedlings, generally AAs content increased both in leaves and roots during As^{III} exposure. SNP mediated reduction/enhancement of AAs content can be strategies of plants, to reduce the toxicity of As^{III} and provide tolerance to plants.

In conclusion, this study highlights protective role of NO on As accumulation and metabolism in leaves and roots of crop plants. Supplementation of SNP reduced the As accumulation inside the crop plants. Improved growth performance was analyzed by studying several morphological, physiological, biochemical, stress & nitrogen related parameters, nutrients & amino acid contents, and transcripts level during co-application of As^{III} and SNP. Results revealed the toxic effect of As^{III} in both the genotypes through inhibited morphological, physiological and altered biochemical responses. Further, influence of exogenous NO on nitrogen metabolism, and involvement of auxin in nitrogen signaling as phytohormones gives indirect signals to coordinate growth and development with nutritional, amino acids status of the plant. Thus, NO supplementation could be an important tool for managing the nutrients, amino acids availability in plants under stress.