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Effect of Chromium on Stomata Structure of Pigeon Pea (*Cajanus cajan* (L.) Millspaugh)

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A B S T R A C T

Contamination of environment due to release of pollutants such as chromium may influence the life on earth. Exchange of gases takes place through stomata into a leaf is influenced by several factors. The present study is focused on to determine the effect of heavy metal chromium exposure on the changes of stomatal structure of Pigeon pea (*Cajanus cajan* (L.)) using pot culture. The present study shows that the growth of the pigeon pea genotypes is significantly reduced when compared with the control with increasing concentration of Chromium. The Scanning Electron Microscopic (SEM) studies showed changes in stomatal structures of the 10th leaf of both control and chromium treated pigeon pea plants.

***Key words*:** Heavy metal, Pollution, Chromium, Pigeon pea, SEM

Environmental pollution in India is growing rapidly due to Industrialization and largescale extraction of natural resources. Huge amounts of toxic waste have been deposited in thousands of contaminated sites spread across our country. Indiscriminate disposal of organic and inorganic wastes from different sources to soil and water bodies has led to disastrous consequences to the natural resources. Organic wastes can be degraded easily but inorganic wastes cannot be removed completely because of containing heavy metals (US Environmental Protection Agency, 2000). Among heavy metals the common toxic metals [1], are As (Arsenic), Al (aluminium), Zn (zinc), Mn (manganese), Cr (chromium), Cu (copper), Cd (cadmium), Pb (lead) and Hg (mercury) are detected in polluted areas. The presence of heavy metals in soils may be beneficial or toxic to the plants. Chromium is considered as one of the environmental contaminants due to its huge industrial use especially in the textile, tanning, polishing, painting and steel manufacturing industries [2-4]. Chromium contaminated soils show a sharp decline in crop yield.

Toxicity of Cr to plants depends on its valence state, among various valence states, Cr (III) and Cr (VI) are the most stable forms. Soil represents in major sink for heavy metals Ions, which can then enter into plants and drastically reduced the crop yield upto 40% over the years and the total cropped area decreased significantly [5]. Chromium compounds are highly toxic to plants and are very harmful to their growth and development. Cr accumulates mainly in the roots and small part translocated to the shoots [6]. Chromium toxicity disturbs several metabolic processes causing reduced seed germination or early seedling development [7]), root growth and biomass, chlorosis, photosynthetic impairing and finally plant death [8].

Most of the leguminous crops are being affected by metals present in the soil and due to this, various plant physiological activities like seed germination, nutrition distribution, enzymes activity, alternation of the membrane permeability, nitrogen fixation, photosynthesis and respiration are adversely affected. The pulses are very importance for vegetarian people of the world because it is a major source of dietary protein. Pigeon pea (*Cajanus cajan* (L.) Millspaugh) is one of the most important food crops after rice and wheat in India. Main constituents of pigeonpea (per 100 g seed) are, protein (21.9g), carbohydrate (72.7g), oil (1.5g) etc. Pigeon pea is an important pulse and belongs to the family Fabaceae. Visakhapatnam is one of the most important industrial areas and developing cities in Andhra Pradesh, India. Due to industrialization and the production and emission of heavy metals have increased enormously. The present study is to evaluate the effect of Chromium in pigeon pea were investigated in relation to Stomatal variations.

MATERIALS AND METHODS

In the present experiment the certified seeds of 13 genotypes of pigeon pea was procured from ANGRAU GUNTUR Ap. pigeon pea seeds were surface sterilized with 0.1% $HgCl_2$ solution and rinsed thoroughly with distilled

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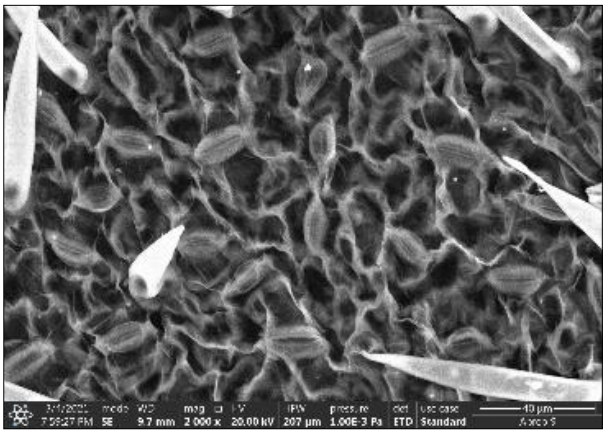
water before sowing. In my previous experiment all the seeds of pigeon pea were germinated in Petri plates with the Six chromium concentrations viz., 0.5%, 1.0%, 1.5%, 2.0%, 2.5%, 3.0 and calculated the percentage of germination, shoot length, root length, fresh and dry weight of seedlings. Based upon the data out of the 13 genotypes 1 genotype was used for the present study, LRG 160. The seeds of LRG 160 were grown in pots treated with different concentrations of chromium viz., 0.5%, 1.0%, 1.5%, 2.0%, 2.5%, 3.0% and one pot without chromium is taken as control.

SEM studies

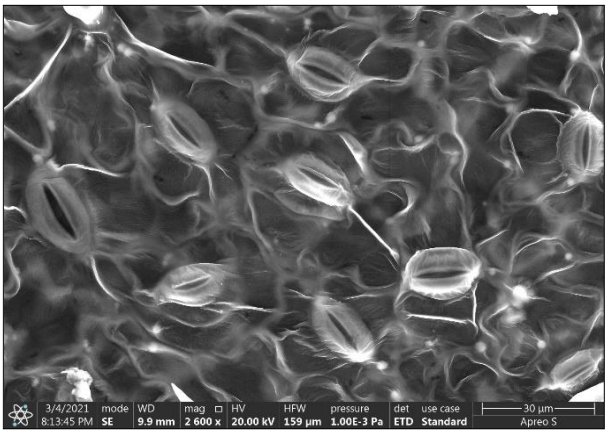
The 10th leaf of each plant in all the seven pots was collected for scanning electron microscopic studies. The epidermal surface was studied with Scanning Electron microscope for which the samples were covered by gold then scanned the samples under Scanning Electron microscope at various magnifications.

RESULTS AND DISCUSSION

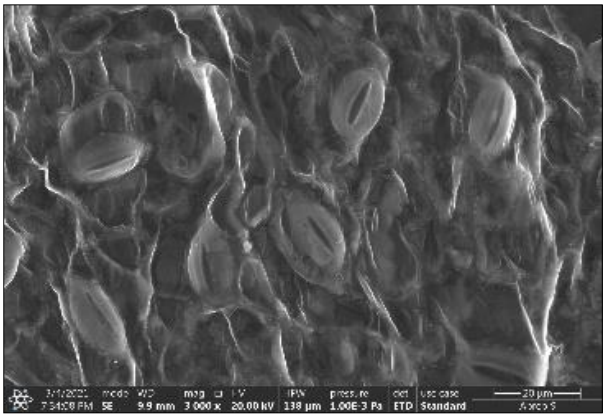
In the present study it was observed that the growth of plants was decreased with increase in the concentration of chromium. The growth analysis data were observed in control pot and as well as in the other six pots treated with different concentrations of chromium. plants with an initial slow growth of the plants in control pot up to 30 days and followed by a rapid increase. In other pots the growth of the plants was very slow when compared to control pot. There is a significance of reduction in growth rate in six pots treated with chromium with increasing concentration was recorded when compared to their control. plants in pots with chromium treated show a sharp decline in crop productivity.



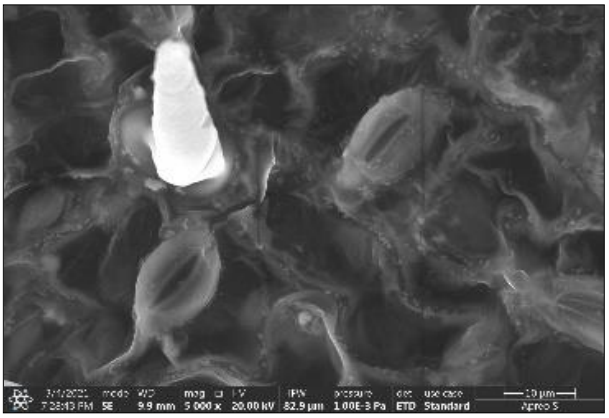
A. Control pigeon pea stomata upper surface



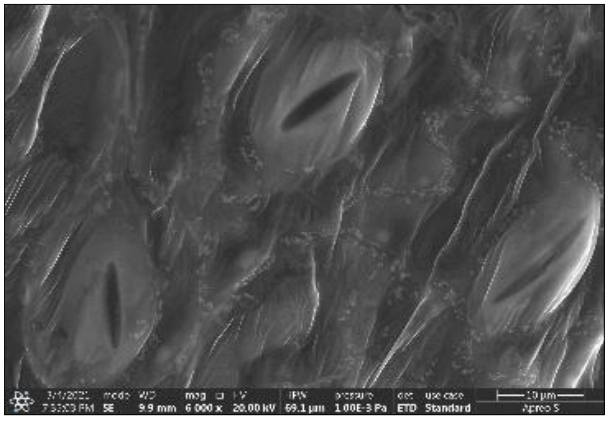
B. Control pigeon pea stomata lower surface



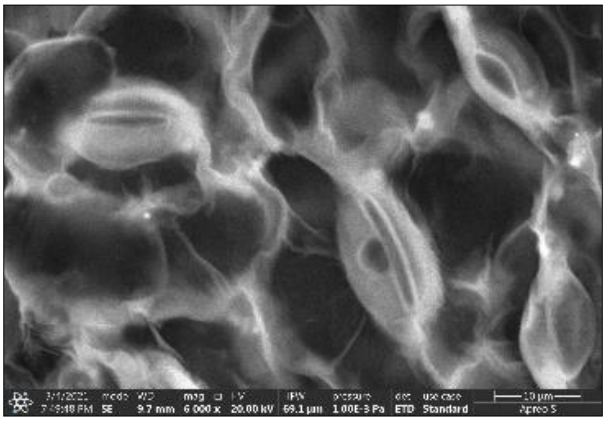
C. Pigeon pea Stomata treated with 0.5% chromium



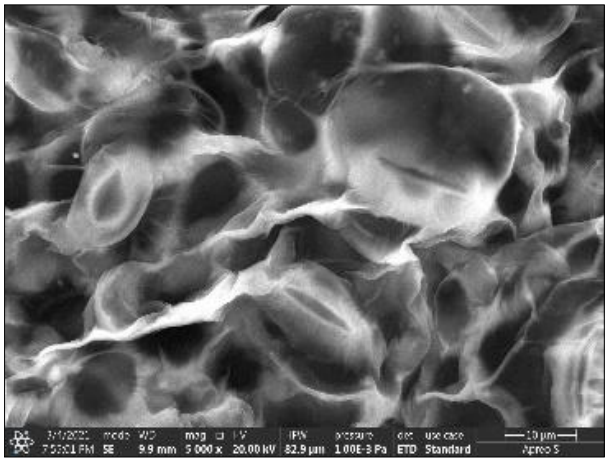
D. Pigeon pea Stomata treated with 1% chromium



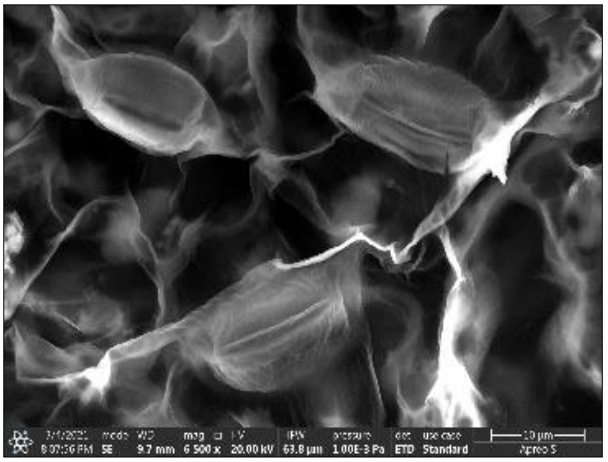
E. Pigeon pea stomata treated with 1.5% chromium



F. Pigeon pea stomata treated with 2% chromium



G. Pigeon pea stomata treated with 2.5% chromium



H. Pigeon pea stomata treated with 3% chromium

Fig 1 Scanning Electron Microscopic images of pigeon pea leaves showing stomata in control (A & B- Upper Surface & Lower Surface) and treated with different concentrations of chromium (C - H lower surface)

Scanning electron microscopic studies

The scanning electron microscopic studies of pigeon pea stomata were carried out on10th leaf of both controlled and pots with chromium treated. In the controlled pot the stomata of the 10th leaf were fully grown with the well-developed borders and edges. In the leaf treated with 0.5% Cr defective, abnormal, small and undeveloped stomata with narrow stomatal pore is observed. Undeveloped with partially opened and closed stomata was observed in the leaf treated with 0.3% cr. Similar study was observed that high Cr concentration induces oxidative stress and initiates the degradation of photosynthetic pigments which results the decline in photosynthesis and growth [9]. Stomata play an important role in regulation of plant water balance and gases exchange. Stomatal parameters can be used as a stressful condition, depending on stress changes can be observed in stomata density and size depending on stress [10]. In potato and Brinjal Trichome length as well as stomata size showed reduction with the increasing level of chromium [11].

CONCLUSION

The result concluded that the physiological (SEM) studies for stomatal apparatus, structure and behaviour in the plants treated with the different concentrations were more affected by chromium. Finally, this research work is a significant reference for future studies of these areas and other regions as well.

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