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# Does jasmonic acid regulate photosynthesis, clastogenecity, and phytochelatins in *Brassica juncea* L. in response to Pb-subcellular distribution?

Ashish Agnihotri, Chandra Shekhar Seth*

*Department of Botany, University of Delhi 110007, India*

## HIGHLIGHTS

- Lead exposure negatively affects physiological aspects of *Brassica juncea* L.
- Lead causes DNA damage and has partial aneuploidogenic effect.
- Jasmonic acid inhibits plant growth under non-stress but promotes growth under lead stress.
- Jasmonic acid positively regulates photosynthesis, AsA-GSH cycle and phytochelatins.

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## ABSTRACT

The present experiment unravels how exogenous jasmonic acid regulates photosynthesis, clastogenecity, AsA-GSH cycle and phytochelatins in *Brassica juncea* L. in response to Pb-subcellular distribution. The plants were evaluated for leaf gas exchange parameters, *Fv/Fm*, lipid peroxidation, leaf epidermal structures and ABA content. Besides lead accumulation in root, shoot and its subcellular distribution pattern, its role as clastogen and/or aneuploidogen via DNA damage, genome size and ploidy variations, AsA-GSH cycle and quantification of $PC_2$ and $PC_3$ were performed as well. Results revealed that Pb inhibited plant growth, disturbed epidermal and guard cells and consequently worsen leaf gas exchange parameters (E, $GH_2O$, A), $F_v/F_m$ and photosynthetic pigments. For clastogenecity, results revealed considerable DNA damage and analysis for genome size showed that differences between unstressed, Pb-stress and JA application were not significant ($P \leq 0.05$), however, ploidy ratio analysis proved partial aneuploidogenic role of Pb. The highest Pb exposure affected AsA-GSH cycle negatively but increased $PC_2$ and $PC_3$ contents uniformly in roots and leaves. Surprisingly, exogenous JA inhibits plant growth under non-stress but positively regulates growth, photosynthesis, AsA-GSH cycle, $PC_2$ and $PC_3$ contents and DNA damage but has no significant effect on variations in total genome size and ploidy under Pb-stress.


## 1. Introduction

Heavy metals (HMs) refers to any chemical element that has a relatively high density and is toxic to plants and animals even at low concentrations. The density of more than 5 g $cm^{-3}$ is considered as a most common factor for defining HMs (Jarup, 2003). Lead is one of the oldest known metal and ranks fifth after Fe, Cu, Al, and Zn in the overall industrial production of metals and is one of the five most toxic HMs (Zhong et al., 2017) which acts as a carcinogen and causes various disorders related to central nervous system, urinary system, blood system and also affects reproductive system (Boskabady et al., 2018). The average concentration of Pb in normal uncontaminated soils in the Earth's crust is approximately 15 mg $kg^{-1}$. Lead-contaminated soils contain Pb in the range of 400–800 mg $kg^{-1}$, whereas in industrialized places, it can reach up to 1000 mg $kg^{-1}$ (Xalxo and Keshavkant, 2019). Other than natural weathering of rocks and volcanic eruptions, major sources of Pb-contamination are intensive anthropogenic activities such as battery manufacturing, metal mining and smelting, emission from automobiles, paints, pesticides, etc. (Clemens and Ma, 2016). Lead occurs mostly in inorganic form, highly persistent in soil and has a low solubility at pH > 5 and thus, only a small proportion of total Pb

* Corresponding author.
*E-mail address:* csseth52@gmail.com (C.S. Seth).

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