

## *Review*

### *PHYTOTOXICITY OF ATMOSPHERIC PARTICULATE MATTER*

PhD dissertation

Selenge Tumurbaatar, PhD Candidate

The chosen research topic is actual and of undeniable importance, as the impact of anthropogenic air pollution on plants remains insufficiently researched.

The Candidate conducted her own research in close collaboration with a research team. Mainly, this research group's previous results provided the basis for her planned studies, and the experimental methods employed were appropriate for the research objectives. The Candidate's series of tests, conducted in accordance with a standard protocol of the No. 227 OECD Test Guideline for the Testing of Chemicals (Terrestrial Plant Test: Vegetative Vigour Test), as modified by Teke et al. (2020), aimed to detect phytotoxic effects of air-pollution components from traffic-related particulate matter and the open burning of household waste. She used various arable and horticultural plant species for these experiments.

The Candidate has four published scientific articles in Q2 papers; she is the first author in two of them. One additional manuscript has already been submitted, and one more is being submitted. She also attended a Scientific Conference abroad. All of her publications are closely related to her Dissertation.

The dissertation is well-structured, meets the formal requirements, is easy to read, and is written in acceptable English. Many of the changes I proposed during the pre-defence were accepted in the final version. Her investigations and results, presented in four separate chapters, facilitated understanding of the experiments carried out on the four topics mentioned in the summary. The dissertation comprises the necessary main chapters on 112 numbered pages; the ratio of the introductory chapter to the four separate parts is 1/3:2/3. There are some editing errors (e.g., text written vertically on pages 52 and 61; missing years in cited studies on page 40). The author provides 28 Figures and 12 Tables in the Dissertation, most of which are unambiguous; their placement is appropriate in relation to the surrounding text, and the titles

are expressive. The references to the shown Figures and the number of Tables in the text are incorrect in some cases (e.g., references to Fig. 14, Fig. 2, or Fig. 3 on pages 80 and 81; references to Table 7 on page 43 and to Table 5 on page 45; references to Table 4 on pages 69 and 73, reference to Table 10 on page 70, reference to Table 11 on page 76).

The Introduction section provides a good overview of the research topic, although it remains somewhat broad and lacks in-depth critical analysis. The author cited 240 relevant sources throughout the paper, nearly a third of which were published between 2020 and 2025. She could have provided a more detailed explanation of the formation and mechanism of action of the peroxidase enzyme in plants, given that her studies also involved measuring this enzyme's activity. The references are formatted correctly, with only one duplicate found.

Although the descriptions of Materials and Methods in the experimental chapters contain the most critical information, in some cases, it would be difficult to repeat them. We do not get a specific description of the process of applying the extract in chapter 5.1.3. and 6.1.3., or whether the 5mL extract dose mentioned in chapter 3.1.3. as the treatment was used on an occasion or in total? It would have been good to provide the dry mass in addition to the % material composition of the incinerated waste. The concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) differed by an order of magnitude across the extracts. What could be the reason for this? The Tables presenting the examined composition of the extracts should be placed in the Materials and Methods section, not among the Results. The BCF calculation equation is described in Chapter 3.1.9; however, it is not included in the statistical analysis. The author reports the results of the stomatal surface area test on tomatoes only as summary statements, providing no factual data. What is your opinion, whether in the case of *Gaillardia aristata*, *Calendula officinalis*, or *Ipomoea purpurea*, the resulting significant difference in peroxidase activity could also be caused by differences in concentration resulting from species differences? How can you explain the POD reduction in response to stress in these three species, in contrast to the results of your previous studies with lettuce and mustard, and even though all other examined parameters showed typical symptoms of stress?

The Candidate presents most of her experimental results clearly in informative Tables and Figures and discusses their comparison with the literature. Her conclusions drawn from her results are reasonable. Interpreting Table 1 is challenging without the internal dividing lines. It would be easier to analyze the graphs (box plots) if the Author had marked statistically significant differences between treatments. Generally, I miss the deeper interpretation of the

results and the clarification of the relationships in the dissertation. Some of the general statements cited are more appropriate for the Introduction chapter than for the Discussion (e.g., on pages 59 and 70).

***Questions:***

The four-true-leaf stage described in the OECD guidelines probably corresponds to different ages across plant species, as developmental rates vary among species. *Were plants of the same age used in the lettuce and mustard experiments, and was there a difference in the treated leaf surface area? Could the higher PAH bioaccumulation seen in lettuce be caused by the larger leaf area absorbing more PM extract during treatment? Based on your results and the health limits, could the treated lettuce from your study be safe to consume?*

***New scientific results:***

The Candidate summarized her new scientific results in five points.

I accept the **new scientific result No. 1** as is.

The content of **the new scientific result No. 2** does not match the information in the description of the white mustard (*Sinapis alba*) experiment (in Chapter 3 of the dissertation: waste incineration extract; 21-day test period). The information on the bioaccumulation study of PAHs from diesel emissions conducted with white mustard is only available in Table 1 of the thesis booklet. This is acceptable after harmonization with the new scientific result number 2 in the thesis booklet.

The **new scientific result No. 3**, on the investigation of the movement of PAHs within the plant and their accumulation in specific plant parts, is an essential component of the work. It's acceptable, but I think the findings should be written for specific PAH compounds or groups. *I ask the Candidate to add the missing information about soil treatment to the description of the experiment in her presentation.*

**The new scientific result No. 4** is too broad, and I can only accept it if it specifies the effect of the extracts of the applied composition.

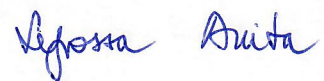
**The new scientific result No. 5** is too general to qualify as a new result.

The Candidate's thesis booklet is a document prepared in accordance with formal requirements that summarizes the research background and experimental results in 12 pages. In Chapter 6 of the thesis booklet, the content of thesis point No. 2 does not align with the content presented as the new scientific point No. 2 in the Dissertation.

I declare that the doctoral dissertation by Selenge Tumurbaatar is an independent work of her own, which can be submitted to a public defense.

In the event of a successful defense, I recommend that the dissertation be accepted (“elfogadásra javaslom”) and that the PhD title be awarded to Selenge Tumurbaatar.

Keszthely, 2 January 2026



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