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Germination and Physiological Responses as Early Biomarkers of Xenobiotic-Induced Phytotoxicity in *Triticum durum*

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INTRODUCTION & AIM

The increasing use of xenobiotics in agriculture has improved crop productivity but also raised concerns regarding their persistence and unintended effects on non-target plant species. Sulfonylurea herbicides are highly effective compounds that inhibit amino acid synthesis in plants. However, residual contamination may alter plant development, physiology, and ecosystem functioning. Early developmental stages, especially seed germination and physiological activity, are considered highly sensitive indicators of environmental stress. *Triticum durum* is an economically important cereal crop and an excellent biological model for evaluating phytotoxic effects.

OBJECTIVE: To evaluate the phytotoxic effects of sulfonylurea herbicides on *Triticum durum* and determine whether germination and physiological responses can be used as early biomarkers of xenobiotic-induced stress.

METHODS

Experimental Design

The phytotoxic effects of sulfonylurea herbicides were investigated on *Triticum durum* during germination and early seedling development under controlled laboratory conditions. The experimental approach was based on the use of germination and physiological responses as early indicators of xenobiotic stress.

Plant Material and Herbicide Treatment

Durum wheat (*Triticum durum* Desf.) seeds were exposed to increasing concentrations of sulfonylurea herbicides to evaluate concentration-dependent effects during the early stages of plant development. Herbicide selection and exposure strategy followed approaches commonly applied for evaluating herbicide-induced phytotoxicity in cereals (Kaur and Brar, 2014; Azimi et al., 2014).

Germination Assessment

Seed germination was evaluated using standard germination parameters:

Germination Percentage (GP)

Germination Index (GI)

Germination Rate (GR)

These indicators were selected because germination performance is recognized as a sensitive endpoint for evaluating environmental stress and phytotoxicity in wheat.

Physiological Analysis

Physiological responses were assessed using complementary indicators of plant stress:

Relative Water Content (RWC) to evaluate plant water status according to approaches used for drought and physiological stress studies in durum wheat.

Chlorophyll content (chlorophyll a, chlorophyll b and total chlorophyll) to estimate alterations in photosynthetic activity and stress-induced pigment degradation.

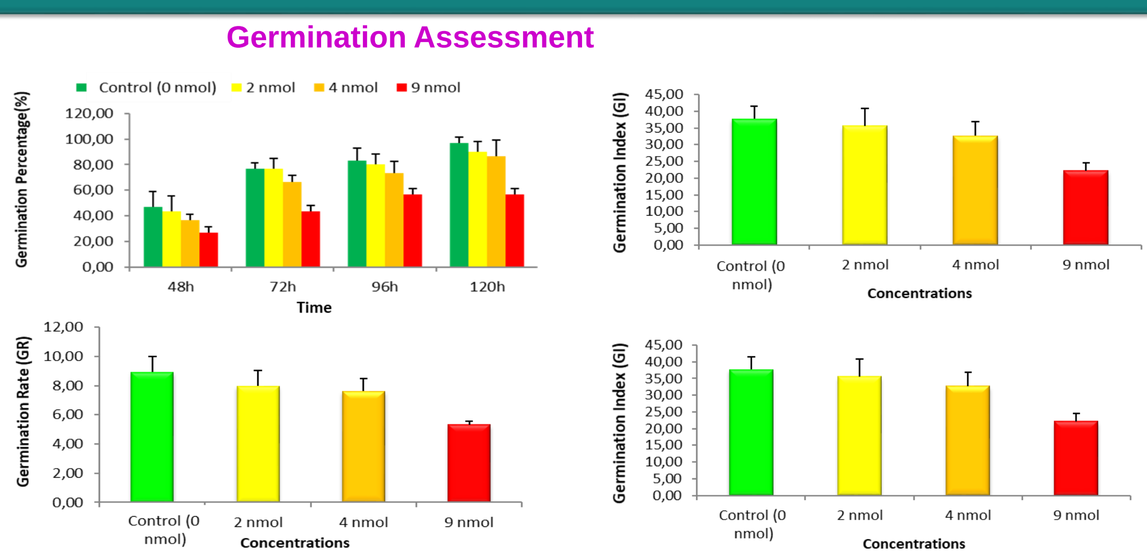
Root respiratory activity as an indicator of metabolic disturbance associated with xenobiotic exposure and stress responses.

Data Analysis

Results obtained from germination and physiological measurements were comparatively analyzed among treatments to identify early phytotoxic responses and determine the sensitivity of selected biomarkers.

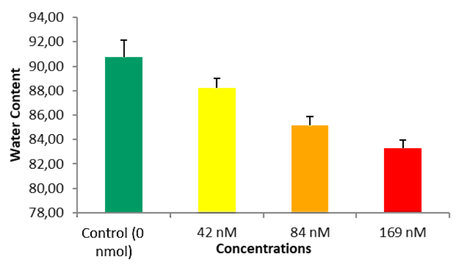
RESULTS & DISCUSSION

Germination Assessment

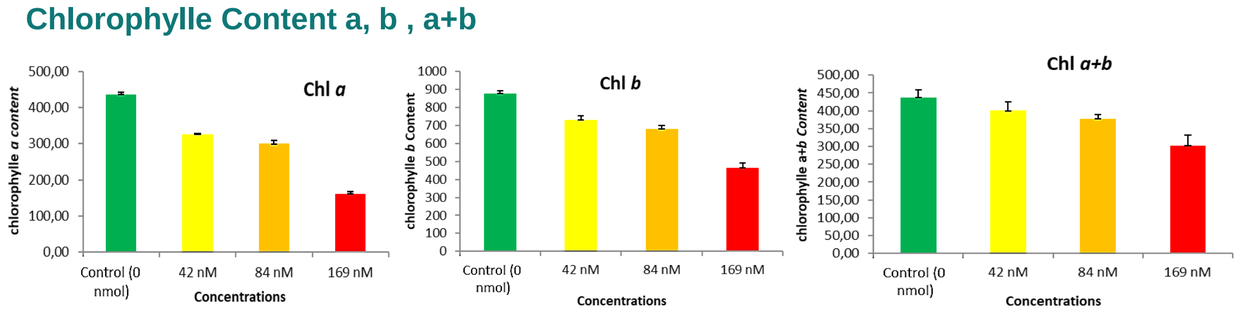


Physiological Analysis

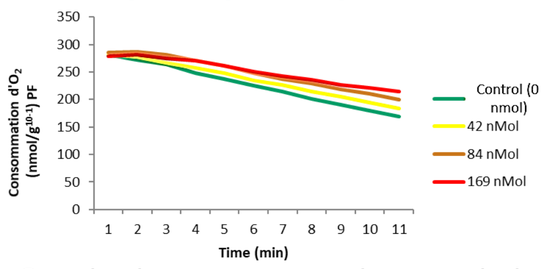
Water Content



Chlorophylle Content a, b , a+b



Root respiratory activity



- Germination parameters decreased significantly with increasing herbicide concentrations, demonstrating a strong dose-dependent phytotoxic effect.
- Reduced relative water content indicates impairment of plant water balance and physiological regulation under xenobiotic stress.
- Significant chlorophyll depletion reflects damage to the photosynthetic system and reduced photosynthetic efficiency.
- The inhibition of root respiratory activity suggests disruption of energy metabolism and cellular respiration.
- These responses collectively demonstrate that germination and physiological traits are reliable early biomarkers of sulfonylurea herbicide toxicity in *Triticum durum*.

CONCLUSION

Germination and physiological responses of *Triticum durum* provide sensitive early-warning biomarkers for detecting and assessing sulfonylurea herbicide phytotoxicity in agricultural environments.

FUTURE WORK / REFERENCES

Future Work

- Oxidative stress biomarkers (MDA, CAT, POD, SOD)
- Herbicide residue bioaccumulation studies
- Genotypic comparison of wheat cultivars
- Long-term growth and yield assessment
- Environmental risk assessment in agroecosystems

Selected References

- Azimi, S., Ebrahimzadeh, H., & Saadatmand, S. (2014). Physiological responses of wheat seedlings exposed to herbicide stress. International Journal of Agriculture and Crop Sciences, 7(9), 623–629.
- Kaur, S., & Brar, L.S. (2014). Herbicide residue effects on succeeding crops: A review. Indian Journal of Weed Science, 46(2), 153–160.