

Assessing *Ridolfia segetum* Aqueous Extract as a Plant-Based Bioherbicide

Growth and Seedling Responses of *Sinapis alba* (White Mustard)

Babur Ali Akbar

Centre of Agricultural Biochemistry and Biotechnology, Faculty of Agriculture, University of Agriculture Faisalabad, Faisalabad 64101, Pakistan

Contact: baburbiochemistry@gmail.com

Background

Synthetic herbicides dominate weed management but can accelerate resistance and environmental risk. Allelopathic plant extracts offer biodegradable, low-residue suppression. *Ridolfia segetum* (Apiaceae) contains phytotoxic metabolites (coumarins, phenolics, volatile oils) that can inhibit early weed growth.

Objectives

- Quantify dose-response effects of aqueous *R. segetum* extracts on germination and seedling vigor of *S. alba*.
- Connect growth inhibition to physiological stress (photosynthesis and oxidative balance).
- Summarize practicality: storage stability and field variability across soils.

Methods at a Glance

Plant material: Fresh aerial parts collected at flowering.

Extraction: 1:10, 1:20, 1:40 (w/v); 25°C, 50°C, 80°C; 24, 48, 72 h.

Bioassays: Laboratory + greenhouse; doses 25–100% (v/v).

Endpoints: Germination, radicle and shoot length, fresh biomass; chlorophyll; MDA; CAT, POD, SOD.

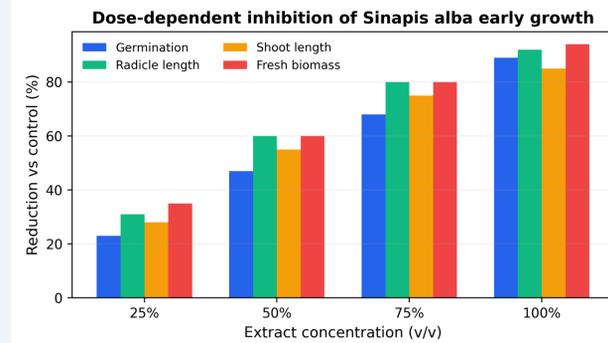
Stability: Storage at 4°C up to 60 days.

Field plots: Sandy loam, clay loam, silty clay; biomass at 14 days after treatment.

Experimental design

Ratios (w/v)	1:10, 1:20, 1:40
Temperatures	25°C, 50°C, 80°C
Durations	24 h, 48 h, 72 h
Test doses	25%, 50%, 75%, 100% (v/v)

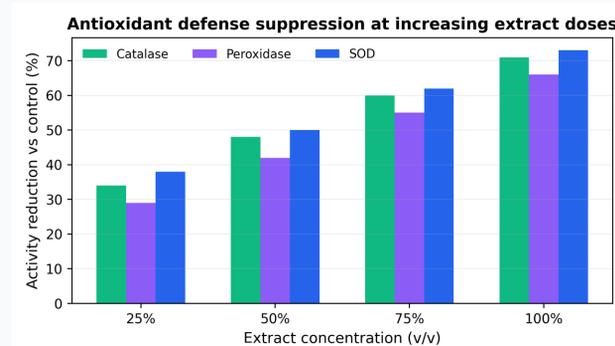
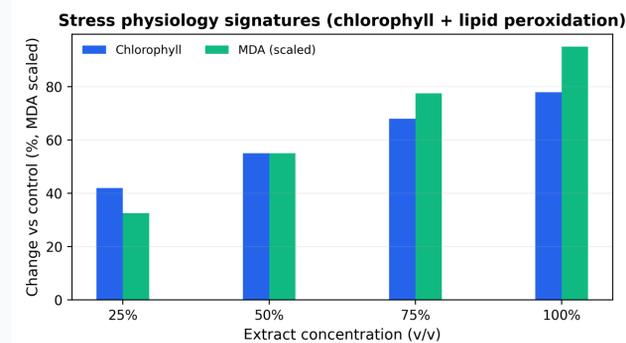
Key Findings: Growth Suppression



Clear dose-response inhibition across early growth stages.

- Germination reduced 23%, 47%, 68%, and 89% at 25–100% (v/v).
- Radicle length suppressed up to ~92%; shoot length up to ~85%.
- Fresh biomass reduced up to ~94% versus controls.

Mechanistic Evidence



Photosynthesis: Chlorophyll declined 42–78%, consistent with reduced photosynthetic capacity.

Oxidative damage: MDA increased 2.3–4.8-fold, indicating lipid peroxidation.

Antioxidant defenses: CAT, POD, and SOD activities decreased 29–73% at higher doses.

Stability and Shelf-Life

At 4°C, potency remained high over short storage:

- Up to 15 days: ~8–12% activity loss.
- 60 days: ~45–60% activity loss due to component degradation.

Practical note: Use fresh extracts for peak performance or stabilize formulations for longer storage.

Field and Benchmarking

Benchmarking: Suppression reached 82–91%, comparable to reported commercial bioherbicides (74–86%).

Soil-dependent efficacy (14 days): biomass reductions of 56% (sandy loam), 68% (clay loam), and 71% (silty clay).

Drivers: soil texture, moisture regime, and weed growth stage at application.

Conclusions and Impact

- R. segetum* aqueous extract is a strong candidate plant-based bioherbicide for early-stage suppression of *S. alba*.
- Evidence supports photosynthetic inhibition and disruption of oxidative homeostasis as key mechanisms.
- Field performance varies with soil and moisture; standardized extraction and field-scale validation are priorities.
- High potential for conservation agriculture and organic systems to reduce synthetic herbicide reliance.