

Toxic Effects of Diatomaceous Earth Treated with Citrus Peels on the Granary Weevil
(*Sitophilus granarius* L.) [Coleoptera: Curculionidae]
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INTRODUCTION & AIM

Wheat is a globally important cereal crop, yet it suffers significant post-harvest losses due to storage pests, particularly *Sitophilus granarius* (granary weevil). It is estimated that insect pests are responsible for 10–30% of post-harvest grain losses worldwide, depending on storage conditions and management practices. Conventional chemical control methods, while not entirely effective, have raised concerns over pest resistance, environmental pollution, and food safety . There is an increasing interest in alternative pest control tactics. Physical methods, especially the use of inert dusts such as diatomaceous earth (DE), offer promising, non-toxic solutions by disrupting insect cuticles and causing desiccation. Recent research also highlights the potential of dust materials derived from agricultural wastes—such as citrus peels—as sustainable method.

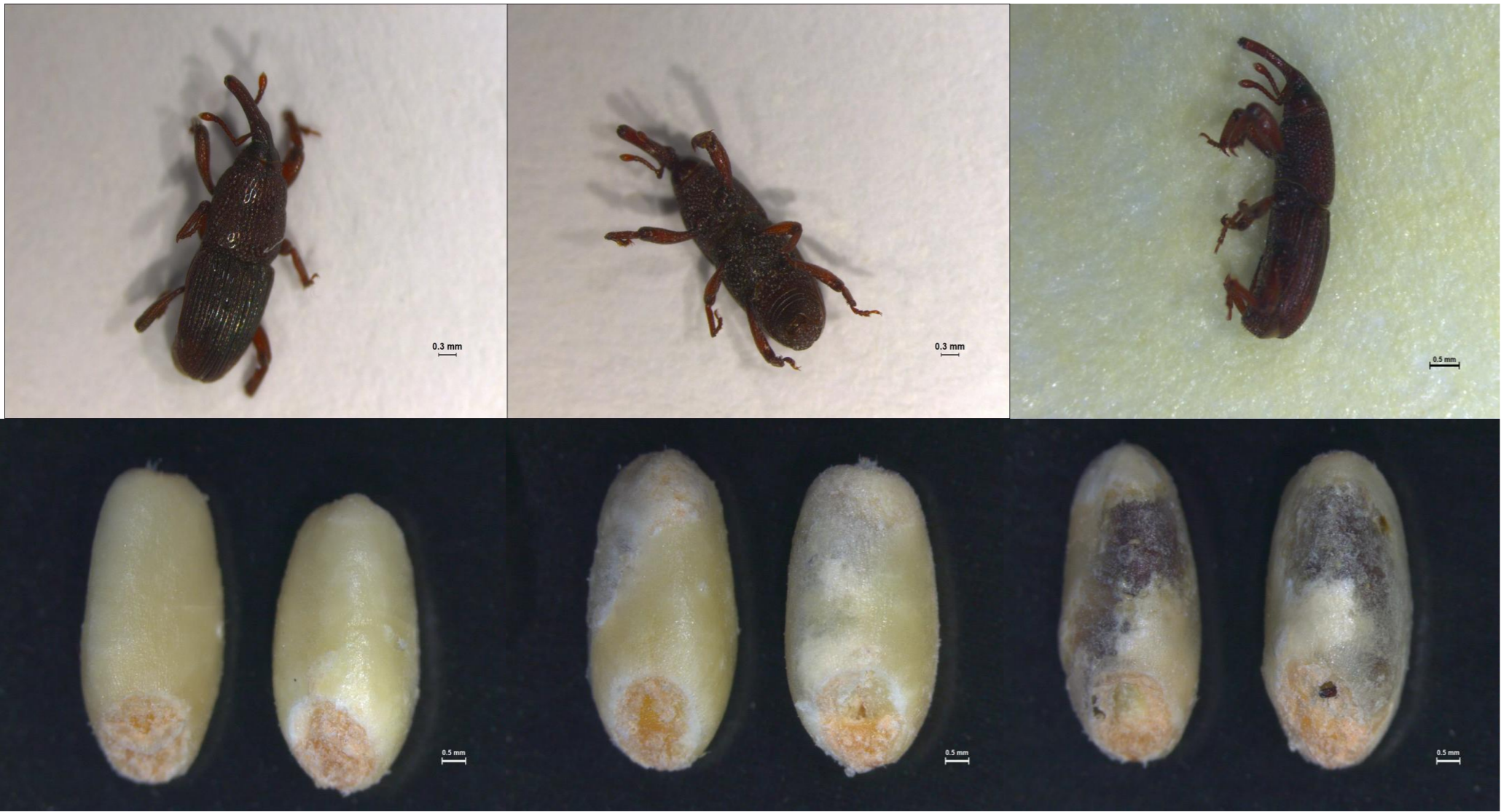


Figure 1. Dorsal, ventral, and lateral views of *S. granarius* with its damage progression and growth in wheat grain

In this study it is aimed to evaluate the efficacy of DE combined with citrus peels against *S. granarius* on stored wheat in laboratory conditions

MATERIAL AND METHOD

Materials
Sitophilus granarius L. (Coleoptera: Curculionidae) adults were used as the target pest species.
Lemon (*Citrus lemon*, Rutaceae) peels were used due to their bioactive compounds including γ-terpinene, terpinolene, d-limonene, citral and organic acids.
Diatomaceous earth (Detech® 95 WP) an inert dust, that contains 80.6% SiO₂, has a median particle size of 3.061 µm.

Table 1: Some physical and chemical properties of Detech® inert dust used in experiments

Diatomite soil formulation	SiO2	Median	pH value ±	Bulk	Color
	ratio (%)	particle size (µm)	S.error	density ± S.error (g/l)	
Detech® 95 WP	80.6	3.061	8.25±0.01	248.1±5.3	yellowish- white

Methods

Sitophilus granarius adults were obtained from a laboratory culture and reared on wheat. For oviposition, approximately 20–25 adults were placed in half-filled glass jars and incubated for 3–5 days to have nearly the same age individuals for bioassay. The jars were then kept under controlled conditions (28 ± 2 °C, 50 ± 10% RH, complete darkness) until newly emerged individuals were obtained for experiments.

For the single-dose test, 2000 ppm of Detech®, lemon peel powder, and a 50% (w/w) mixture of lemon peel and Detech® were each applied to 10 g of wheat grains placed in glass vials. Subsequently, 10 adult *Sitophilus granarius* individuals were introduced into each vial. The vials were maintained under controlled laboratory conditions (27 ± 2°C, 60% relative humidity) in complete darkness for 7 days.



Figure 2. Stages of conducting experiments, starting from single-dose bioassays and progressing to dose-response bioassays.

In the dose-response experiment, different concentrations of the lemon peel + Detech® mixture (1:1, w/w) were applied to wheat grains to estimate the lethal concentration values (LC₁₀, LC₃₀, LC₅₀, and LC₉₀) against *S. granarius*. All vials were monitored daily, and insect mortality was recorded throughout the experimental period.

RESULTS & DISCUSSION

The combination of **lemon peel + Detech®** achieved nearly **100% mortality** after 120h of exposure which comparable to the efficacy of **Detech® alone**. Based on this high activity, a **dose-response bioassay** was conducted with **lemon peel + Detech®**. The calculated lethal concentrations were: **The LC10, LC50 and LC90 were 200, 1400 and 9100 ppm.**

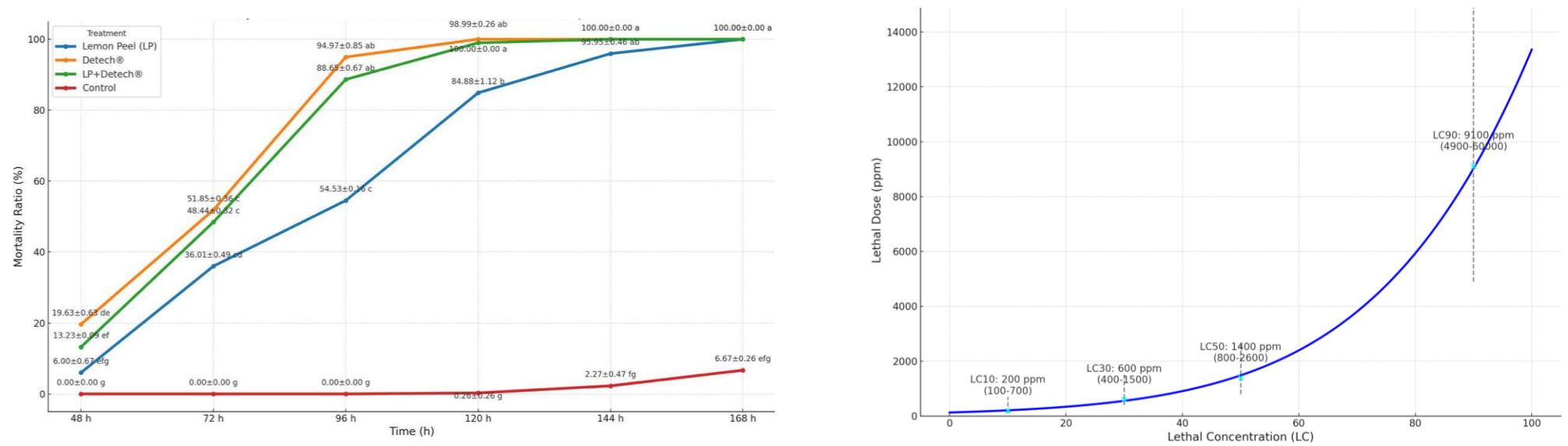


Figure 3. Impact of lemon peel (20mg), Detech® (20mg) and LP+Detech® (10mg+10mg) on mortality rates of *Sitophilus granarius* at various day intervals (left) and dose-response test results with DE and Lemon Peel on *Sitophilus granarius* after 7d of exposure (right)

CONCLUSION

The management of stored grain pests, including *Sitophilus granarius*, remains a significant challenge; however, this study demonstrated a very high adult mortality rate in both single-dose and dose-response assays with the potent toxicity of the lemon peel + Detech® mixture. These findings support its potential as a promising component of environmentally sustainable pest control strategies in grain storage systems, offering viable alternatives for sustainable agriculture.

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