The neurophysiological effect of deltamethrin in the nesting behaviour of *D. gazella* (Fabricius, 1787) (Coleoptera: Scarabaeidae)

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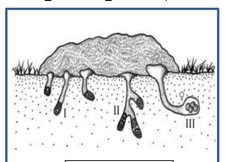
Introduction

➢Dung beetles are a diverse group of detritus feeding insects that have several ecological functions. **(Gullan and Cranston, 2010)**

➢4 types: **Telecoprid (rollers), Endocoprid (dwellers), Paracoprid (tunnelers) and Kleptocoprid (brood parasites)**. **(Gomez-Cifuentes et al., 2019)**

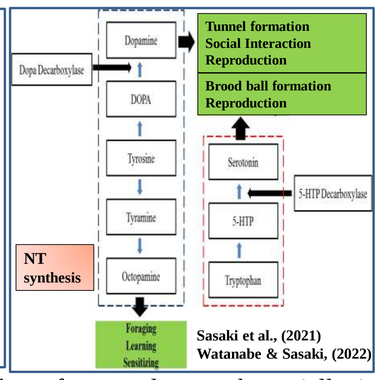


Tunnelers

•Dig tunnels below the dung pile, move dung into tunnels and lay their egg.

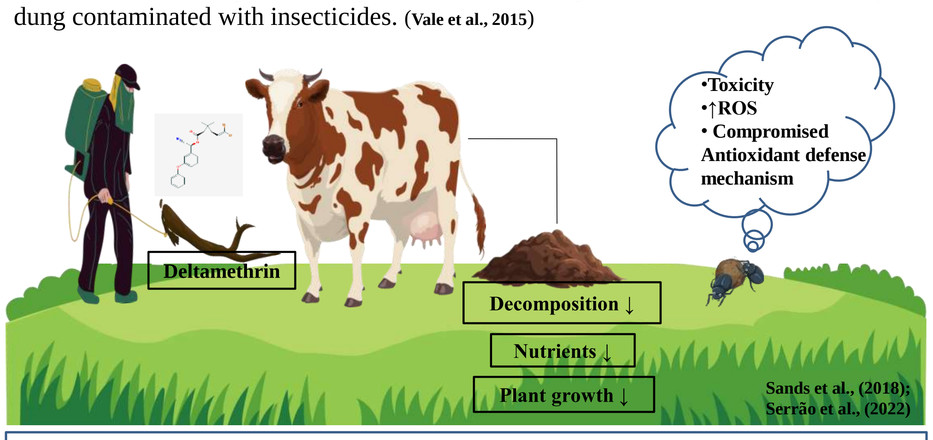
➢ **The nesting behaviour:**

- **Tunnel formation**
- **Social interaction**
- **Brood ball formation**
- **Reproduction**
- **Brood parental care**



Sasaki et al., (2021)
Watanabe & Sasaki, (2022)

➢The survival or reproductive performance of dung fauna reduces substantially in dung contaminated with insecticides. **(Vale et al., 2015)**



Sands et al., (2018);
Serrão et al., (2022)

➢**Aim: To assess the neurophysiological effect of deltamethrin in the nesting behaviour of *D. gazella***

Methodology

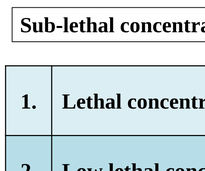
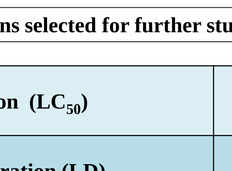
To determine LC_{50} Value →  → **0.005, 0.01, 0.05, 0.5, 1.0 ppm/ 250 g dung** (Sands et al., 2018) → **10 Dung Beetles** → **3 Replicates** → **Probit Analysis**

Earthen pots
5 males
5 females

Deltamethrin
Sigma 45423-250MG,
Deltamethrin Perstanal 250MG

Sub-lethal concentrations: LD, MD, HD

No. of broodballs

To estimate the NTs →  → 

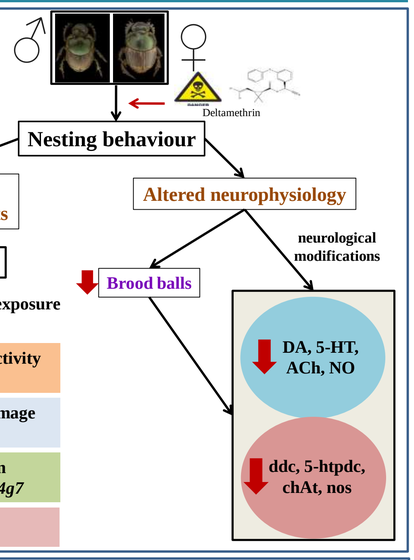
Dopamine (DA)
5-hydroxytryptophan (5-HT)
Acetylcholine esterase (AChE)
Nitric oxide (NO)

(Ellman et al., 1960; Schlumpf et al., 1974; Miranda et al., 2001)

DCFDA STAINING	ANTIOXIDANT ACTIVITY	CYP P450 GENE EXPRESSION	ORGANO-SOMATIC INDEX, HISTOLOGY
Reactive Oxygen Species Ronny et al., (2016)	➢ Superoxide dismutase Sinha, (1972) ➢ Catalase Sinha, (1972) ➢ Glutathoine Beutler et al., (1963) ➢ Lipid Peroxidation Beuge and Aust, (1978)	Phase I Reaction •cyp4q4 •cyp6bq9 •cyp4g7 Brain Tissue- adult RNA Isolation cDNA synthesis RT-PCR	BSI Brain Histology Mishra, (2019)

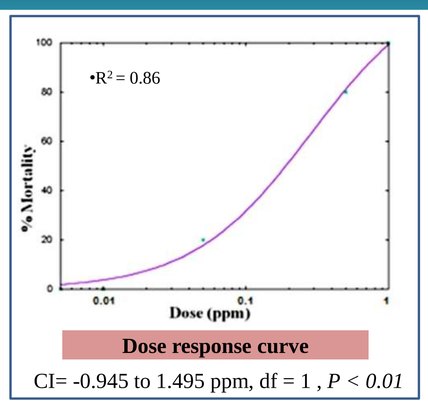
➢**Statistical analysis: Graphpad prism 9.0. Two-way ANOVA was done for two factors: concentration (LD, MD, HD) and duration (10, 20, 30 days of nesting) with respect to control.**

Discussion and Conclusion



- **Deltamethrin exposure at sub-lethal concentrations over 30 days caused significant adverse effects on dung beetles compared to the control group.**
- **The neurotoxic properties of deltamethrin led to decreased conduction velocity along axons, impairing neural transmission.**
- **Enhanced oxidative stress and histological changes in brain highlight the toxic potential of deltamethrin.**
- ***These findings contribute data for evaluating the ecological consequences of deltamethrin use and emphasize the need for careful management in agricultural applications to mitigate potential risks to beneficial insects and overall ecosystem health.***

Results



Dose response curve

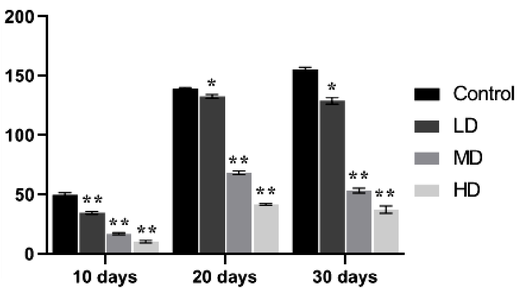
CI= -0.945 to 1.495 ppm, df = 1 , *P < 0.01*

Marked behaviour of *D. gazella* after 48 hours of exposure to deltamethrin. Here, *(-)→normal movement, (+)→ mild, (++)→ moderate, (+++)→maximum behavioural changes*

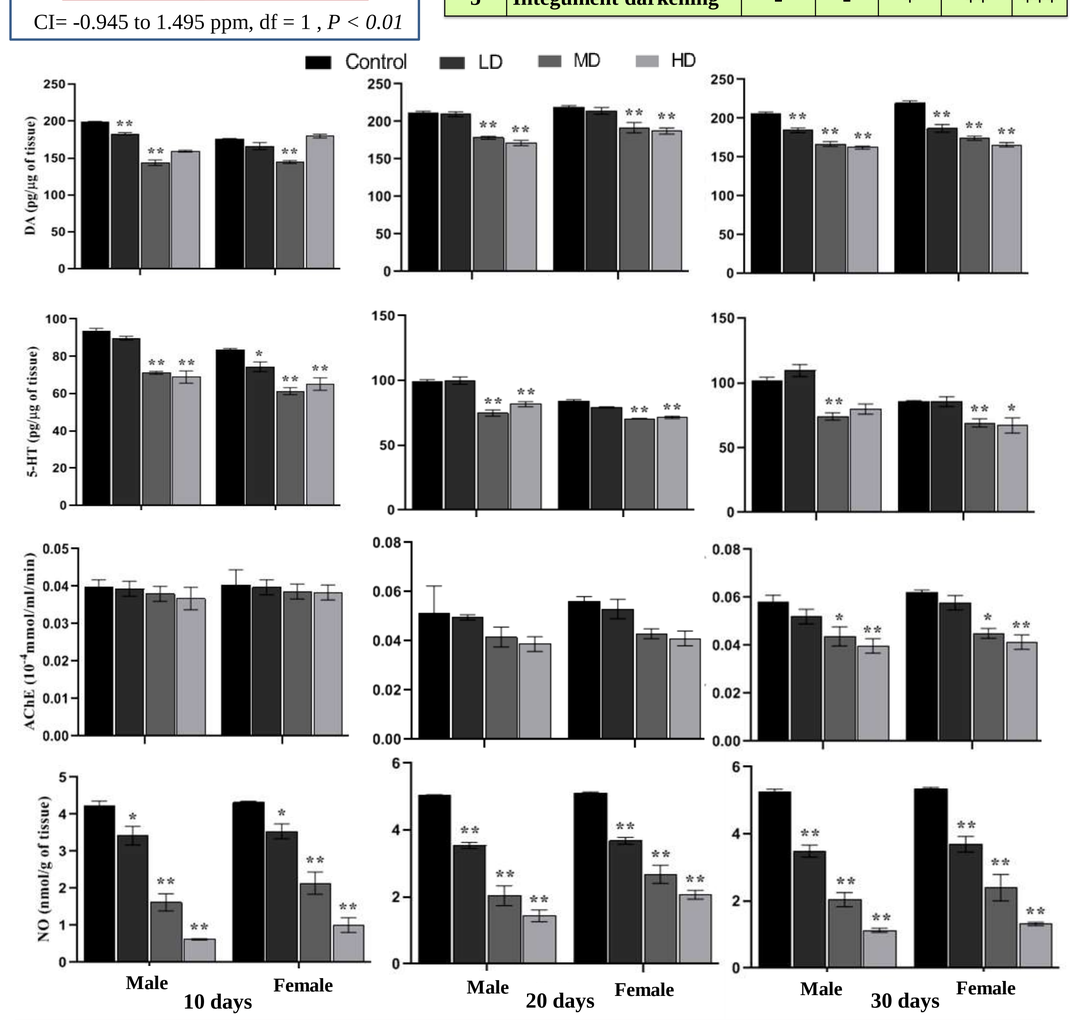
Sr. No.	Behaviour	Concentration (ppm)				
		0.005	0.01	0.05	0.5	1.0
1	Jerky movements	-	+	+	++	+++
2	Loss of Equilibrium	-	-	-	++	+++
3	Tremor	-	-	+	+	++
4	Immobility	-	-	-	++	+++
5	Integument darkening	-	-	+	++	+++

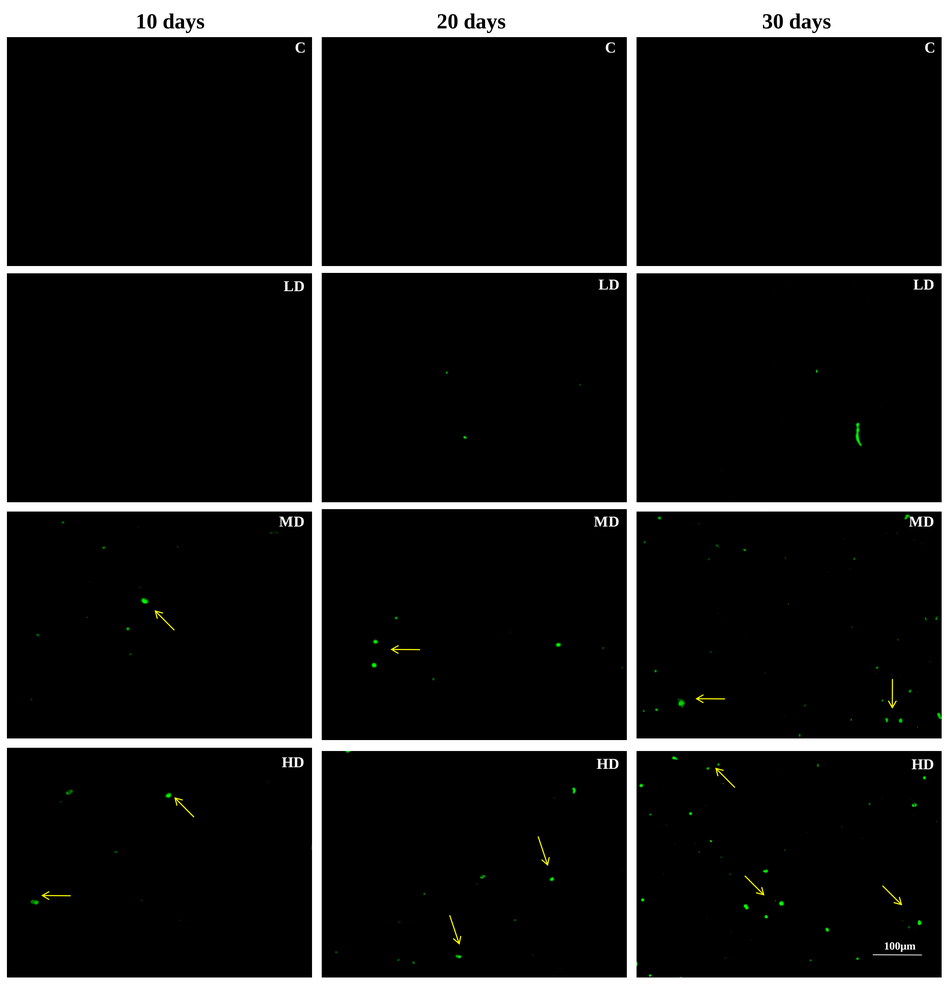
Sub-lethal concentrations selected for further studies

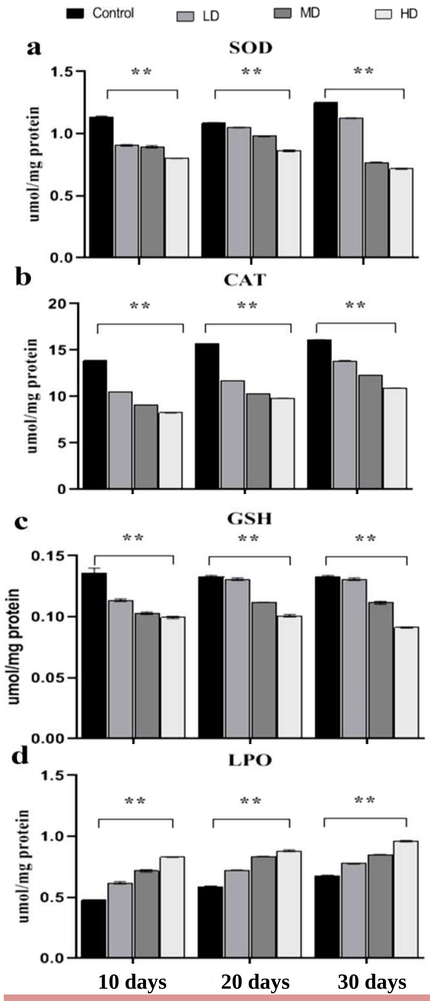
1.	Lethal concentration (LC_{50})	0.275 ppm
2.	Low lethal concentration (LD)	0.014ppm
3.	Medium lethal concentration (MD)	0.028ppm
4.	High lethal concentration (HD)	0.055ppm



Number of brood balls formed



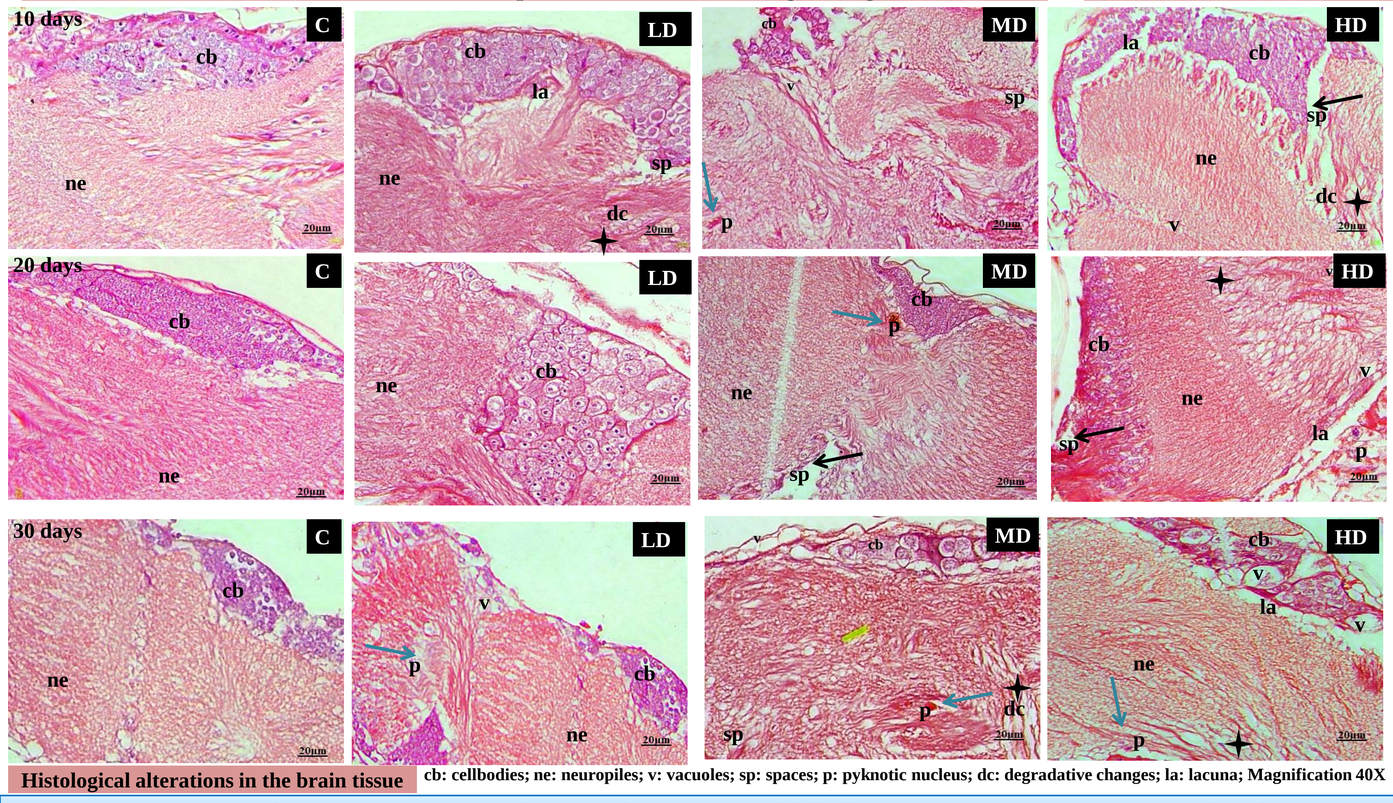




Alteration in neurotransmitter levels on exposure to insecticide during nesting behaviour

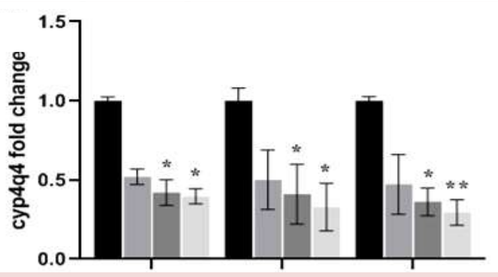
DCFH-DA staining in the single cell suspension of the brain tissue

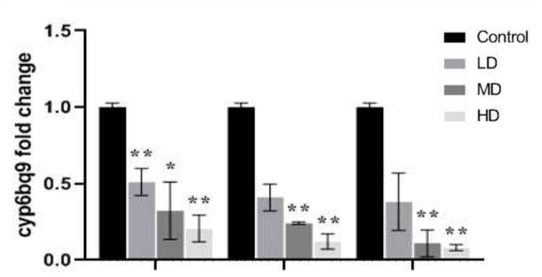
Antioxidant activity

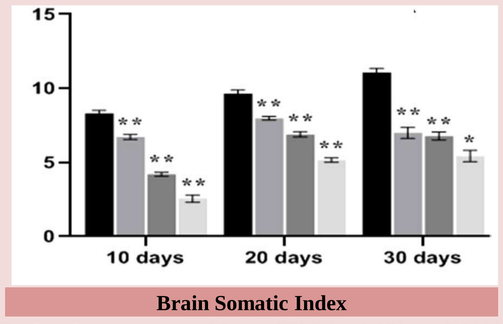


Histological alterations in the brain tissue

cb: cellbodies; ne: neuropiles; v: vacuoles; sp: spaces; p: pyknotic nucleus; dc: degradative changes; la: lacuna; Magnification 40X

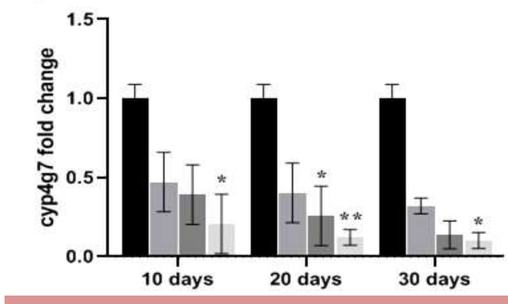






Brain Somatic Index

Each value represents Mean±SEM *(p<0.05*, p<0.01)***



cyp gene expression

References

- Gómez-Cifuentes, A., Gómez V. C. G., Moreno C. E., and Zurita G. A. (2019). Tree retention in cattle ranching systems partially preserves dung beetle diversity and functional groups in the semi deciduous Atlantic forest: The role of microclimate and soil conditions. Basic and Applied Ecology, 34: 64-74.
- Sinha, A. K. (1972). Colourimetric Assay of Catalase. Analytical Biochemistry 47(2), 389-394
- Sands, B. (2018) Sustained parasiticide use in cattle farming affects dung beetle functional assemblages. Agriculture, Ecosystems & Environment. 265, 226-235.

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