WEED CONTROL WITH LASER

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WEBINAR, 27-9-2023

The aim of the presentation:

- Why use laser beams as a new weed control methods?
- Principles of how to measure the effect on weeds and crops
- Show examples of the effect of laser on different organisms
- Conclusion

Herbicide application

Negative impact of mechanical weed control

- Soil erosion
- Dry out soils
- Increase mineralisation of organic matter
- Harm beneficial organisms (e.g., earthworms, spiders, predator beetles)
- Harm birds and bird nests

The skylark is a bird of open farmland

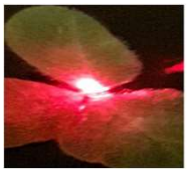
Reducing the impact of weed control on the environment

Using a 2 µm fibre laser beam with a diameter of 2 mm:

With 150 weeds m^{-2} the exposed area is

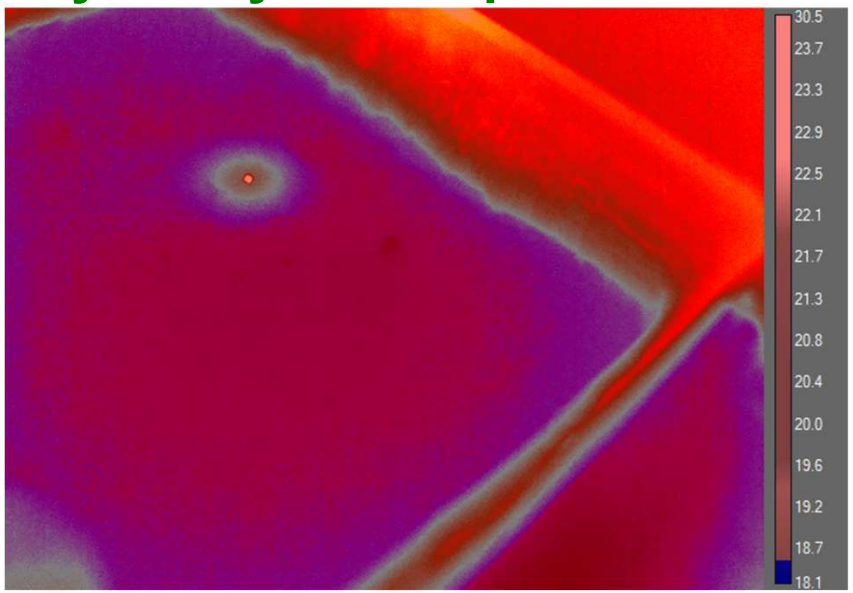
0.001^2 m^2 × 22/7 × 200 = 0.000629 m^2 ~

0.6 % of the area



Temperature increase limited to a very small area

Laser treatment at room temperature:
Only a very small spot is affected!



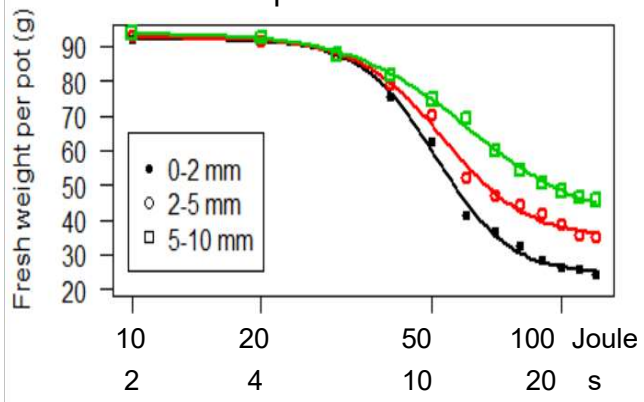
Blue: 18,5 °C

Soil surface temperature measurement with an infrared camera in a tray experiment

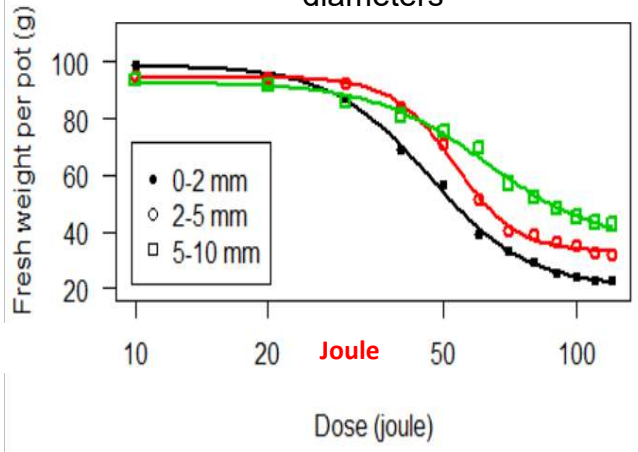
Beam diameter

Calculation of the energy = W x Second = Joule

Elymus repens exposed to **1 W** laser beams (435 nm) with different internal spot diameters

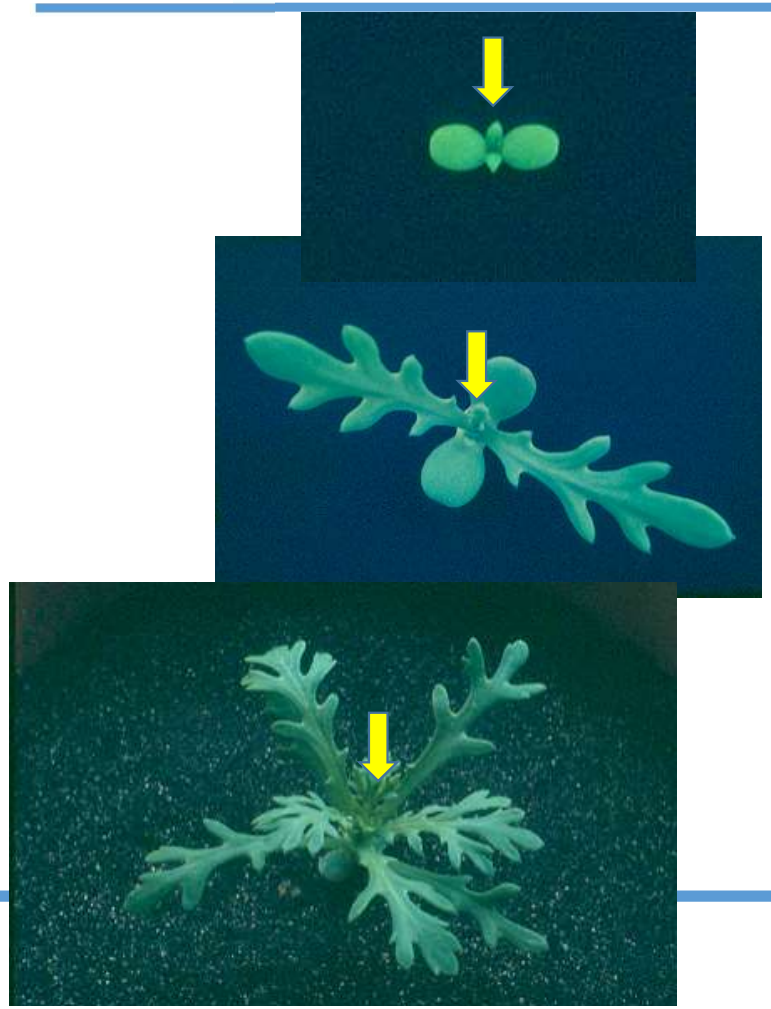


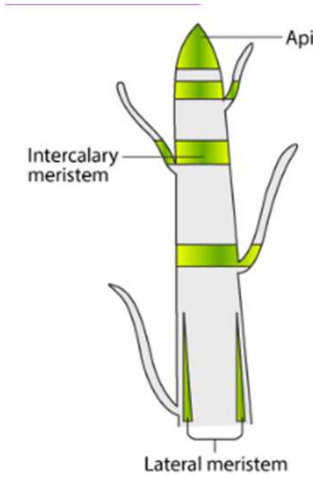
Elymus repens exposed to **5 W** laser beams (450 nm) with different internal spot diameters

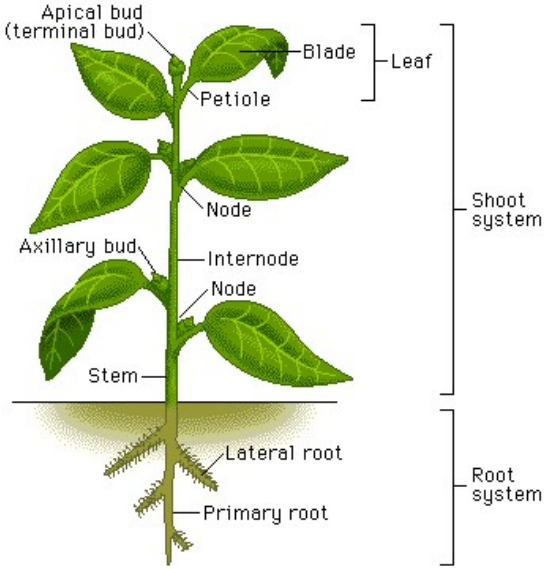


(From Rakhmatulin and Andreasen, *Agronomy* **2020**, *10*(10), 1616)

Chrysanthemum segetum

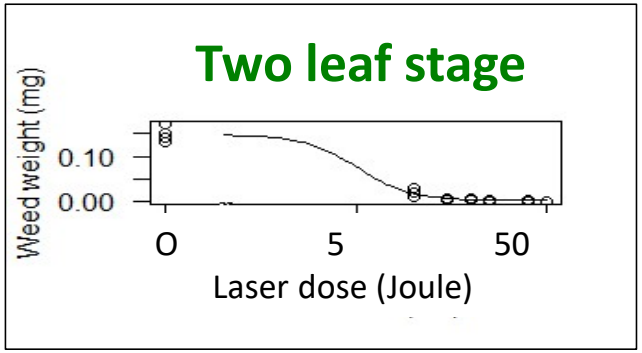


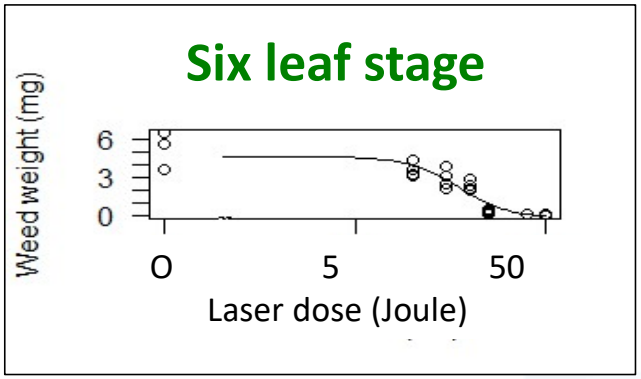




Dose-response - Annual weeds (50 W)

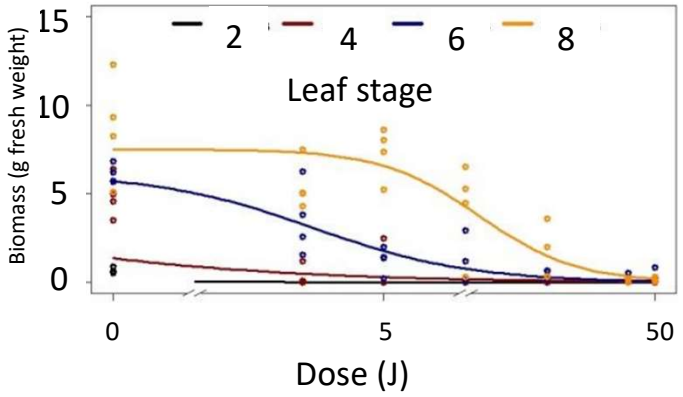
Dose-response experiment with the weed *Chenopodium album* (Fat Hen)



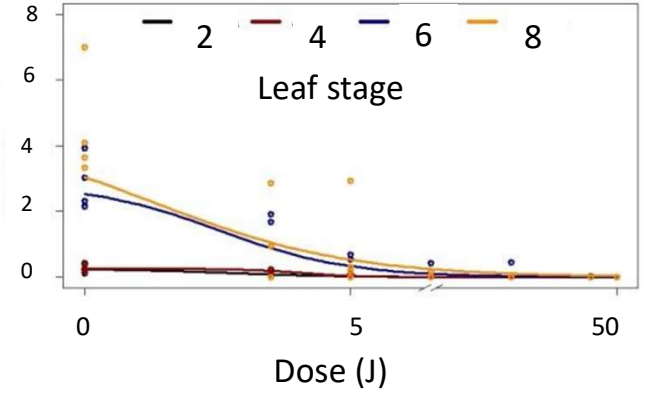


The effect on plants (50 W Laser)

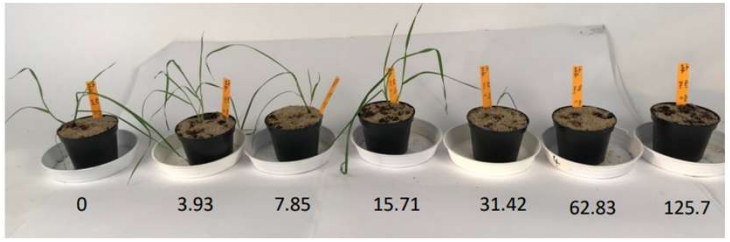
Centaurea cyanus



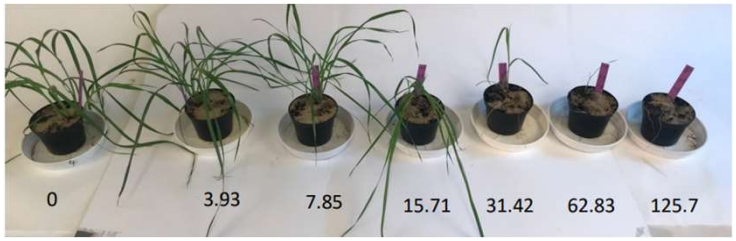
Capsella bursa-pastoris



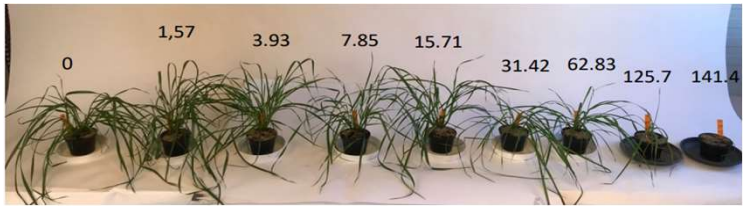
The effect on *Lolium multiflorum* (50 W Laser)



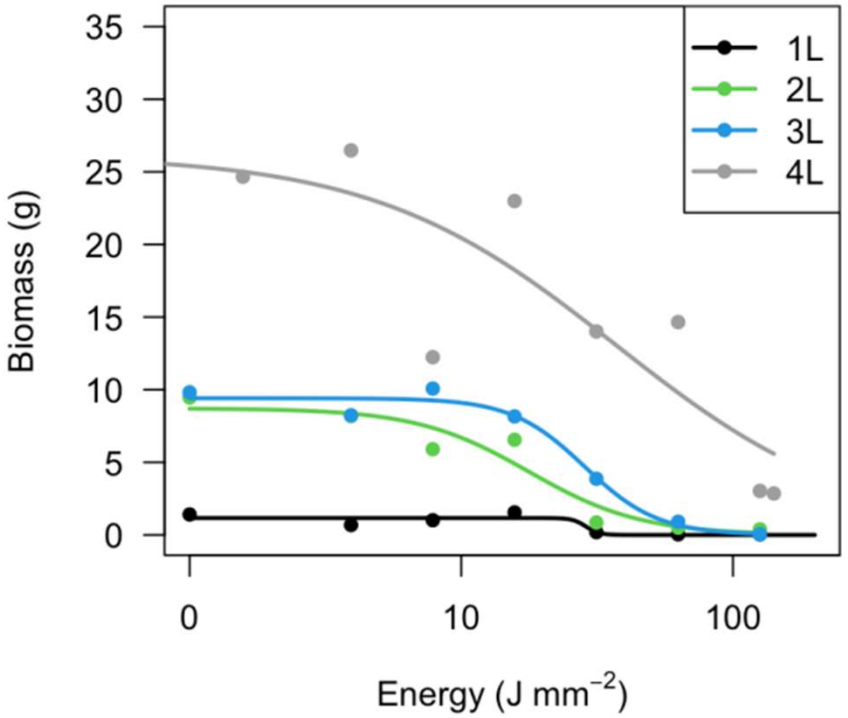
L. multiflorum one leaf stage 21 days after laser treatment.



L. multiflorum two leaf stage 21 days after laser treatment.



L. multiflorum four leaf stage 21 days after laser treatment. The doses are expressed in J mm^{-2}.



Perennial weeds: *Cirsium arvense*

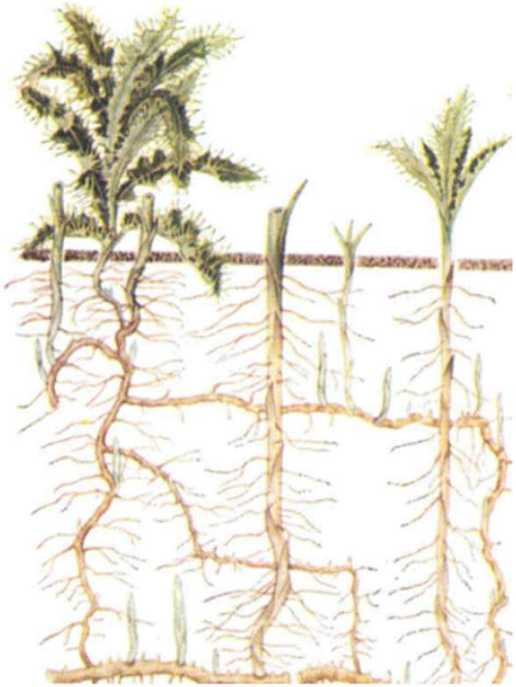


Figure 1. The extensive roots of Canada thistle make it difficult to control.

Perennial weeds: *Cirsium arvense*

WeLASER Summer School

Experiments with Canada thistle (*Cirsium arvense*)

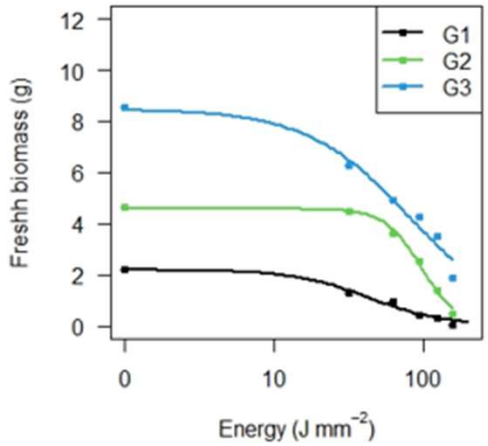
Plant from root

Growth stage 1 (G1)

Growth stage 2 (G2)

Growth stage (G3)

Weight of *Cirsium arvense* after three weeks



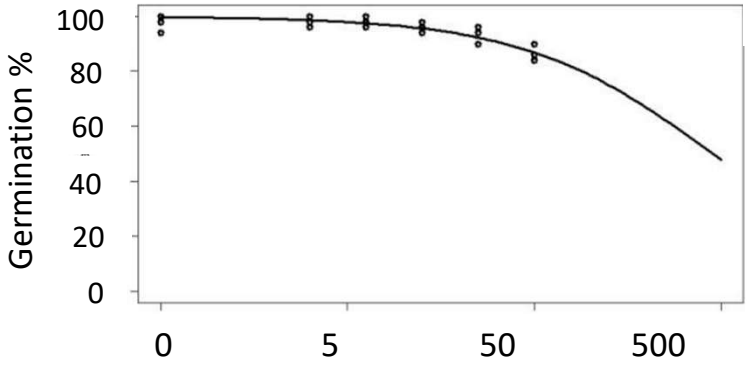
Dose-response experiments with seeds on the soil surface (50 W laser)

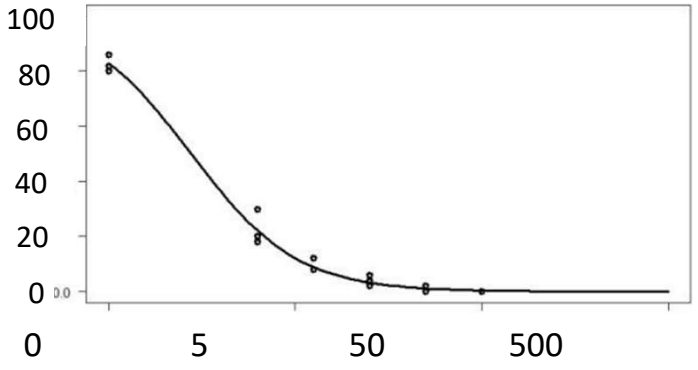
5 to 9 mm long

Wheat seeds

3.4 long

Centaurea cyanus seeds





From Zang (2022)

The effect on worms

Enchytraeus albidus and *Enchytraeus crypticus* are often used in ecotoxicological studies

Enchytraeus albidus and *Enchytraeus crypticus* living in different soil types

Enchytraeus

A colony

Scientific classification

Kingdom:	Animalia
Phylum:	Annelida
Class:	Clitellata
Order:	Tubificida
Family:	Enchytraeidae
Genus:	***Enchytraeus*** Henle, 1837

Species

NO EFECT OF LASER ON THE WORMS !

Life cycle of yellow mealworm (*Tenebrio molitor*)

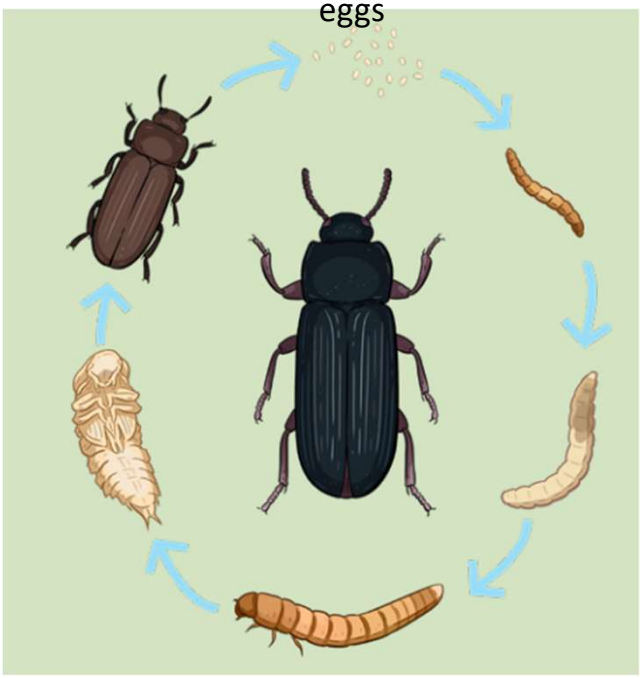
Model insect

1. 

2. 

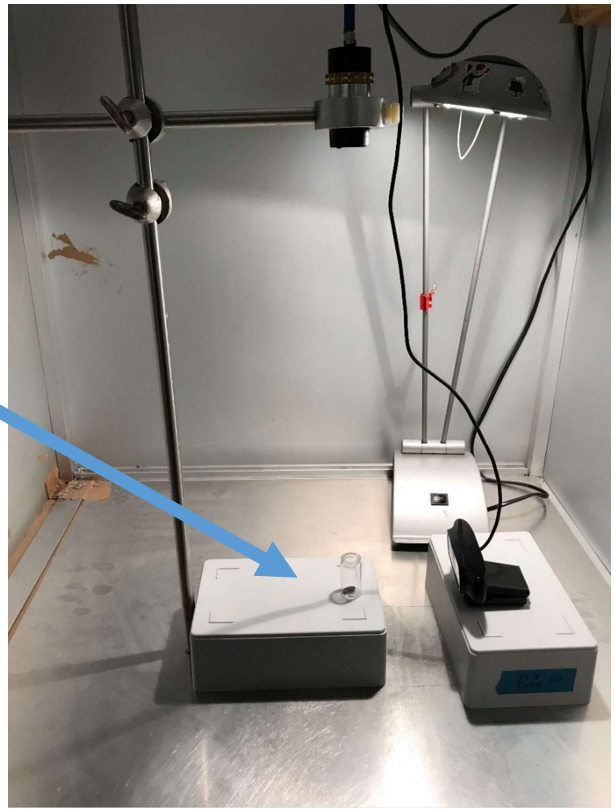
Pupa

3. 

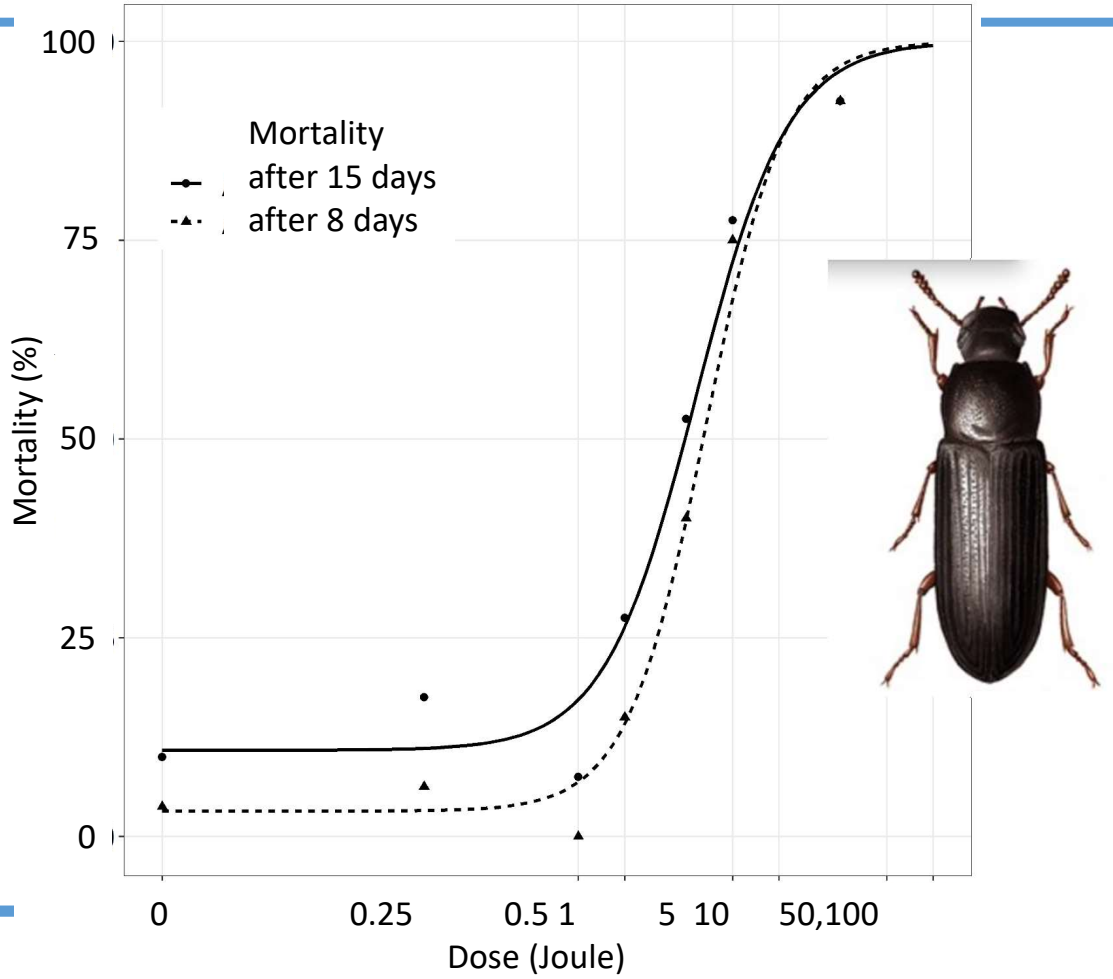


Dose-response experiments with *Tenebrio molitor* beetles

Beetle in glass tube



Dose – response experiment *with T. molitor pupae*



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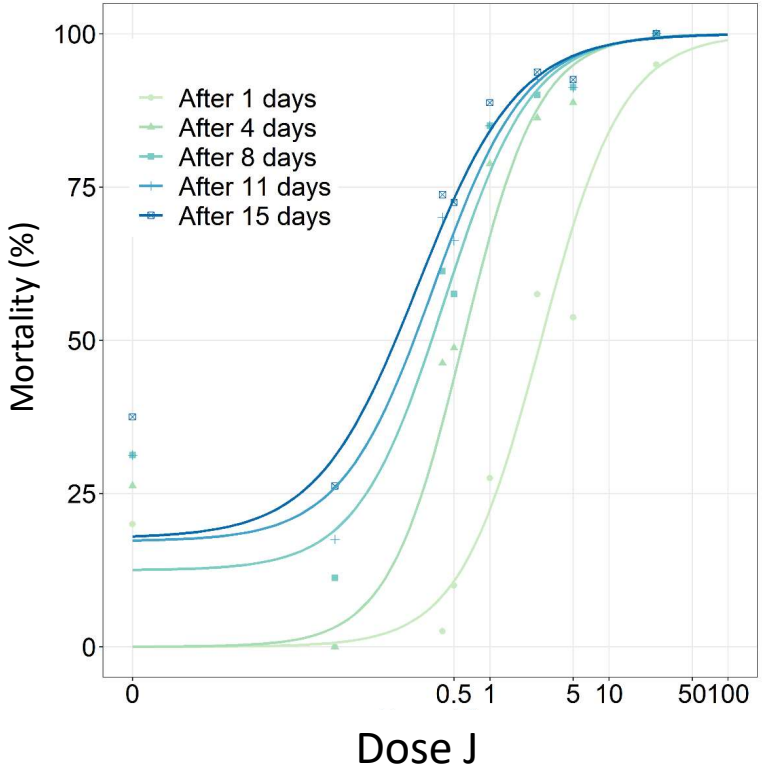
Dose-response experiments with ladybugs



frontiers

Frontiers in Agronomy, 02 November 2022.

ORIGINAL RESEARCH article

Front. Agron., 02 November 2023
Sec. Weed Management
Volume 5 - 2023 |
https://doi.org/10.3389/fagro.2023.1198840

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SHARE ON

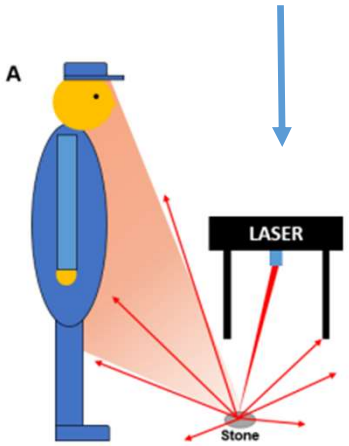
Side-effects of laser weeding: quantifying off-target risks to earthworms (Enchytraeids) and insects (*Tenebrio molitor* and *Adalia bipunctata*)


Christian Andreasen* Eleni Vlassi Kenneth S. Johannsen Signe M. Jensen

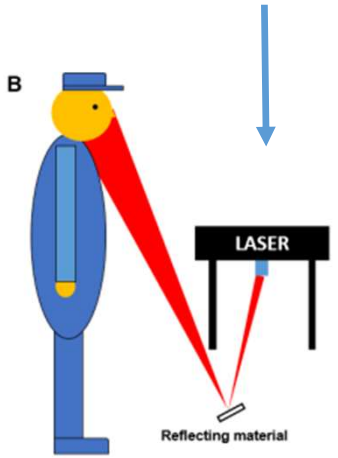
Humans and larger animals

If the applied laser radiation is divergent, i.e. expanded, the irradiance decreases with increasing distance from the laser beam focus.

Fiber laser for weed control with a wavelength of 2 µm (invisible)



A. If the laser beam hits a stone, it is reflected diffusely, and the laser energy is spread in all directions.



B. A reflected beam remains directed and expands as given by the laser optic. It may pose a serious risk for the person and the surroundings

Conclusionc

- Good effect on small annual plants
- Perennial weeds require several treatments
- No effect on soil worms in the soil
- Insects at all life stages are sensitive to laser irradiation, but as only a very little area is exposed, the risk of hitting the fauna is very small.
- Human and larger animal can be blinded and burnt by the laser beam.

Laser safe goggles

frontiers Frontiers in Agronomy, 07 March 2022.

Laser Weeding With Small Autonomous Vehicles: Friends or Foes?

Christian Andreasen[1*] Karsten Scholle[2] Mahin Saberi[1†]

Safety

Laser beams can be harmful to humans and animals. Infrared cameras and sensors must be mounted on the vehicle to warn and stop it when it approaches humans, animals or any other obstacles ensuring an appropriate safety distance. Depending on the laser wavelength, the laser can be more or less harmful to the eyes and skin and cause irreversible damages (e.g., blindness). Visible and near-infrared (400–1,400 nm) laser light pose a critical hazard on the retina. Since the tissue structures of the retina are unable to undergo any repair, lesions caused by the focusing of visible or near-infrared light on the retina may be permanent. The most critical area of the retina is the central portion, the macula, and the fovea.

Laser light in the ultraviolet or far-infrared spectrum can cause damage to the cornea or the lens. Far infrared (1,400 nm – 1 mm; CO_2 lasers, 10,600 nm) can cause thermal damage by the heating of the tears and tissue water of the cornea. Excessive exposure to infrared radiation results in a loss of transparency of the cornea or surface irregularities (Occupational, Safety and Health Administration, 2022).

Thank you for your attention!

Please find more information on
https://welaser-project.eu/

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