

Laser Light Beams for Open Field Weed Control in Horticulture

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Objectives

The application ranges of laser techniques are miscellaneous. Basic trials should investigate the applicability of lasers as a method of direct and selective plant treatment for growth depression (weed control).

Material and Methods

Tests with different energy doses were carried out concerning absorption spectra, growth habit, laser wave length, and obvious lethal doses.

- ▶ **Plants:**
 - *Nicotiana tabacum* (dicotyledonous) and *Echinochloa crus-galli* (monocotyledonous)
 - 3 growth stages (BBCH-Codes: 13, 12, 10), 4 replicates
- ▶ **Lasers:**
 - diode laser system ($\lambda = 940$ nm, continuous wave)
 - carbon dioxide laser system ($\lambda = 10600$ nm, quasi-continuous wave)
- ▶ **Treatment:**
 - focusing the apical meristem with a laser spot diameter of 6 mm
 - fresh mass measuring of treated and untreated plants one week after treatment

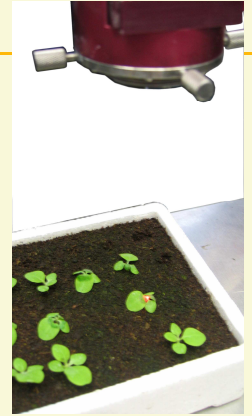


Fig.1: Treatment with CO₂ - laser

Results

In order to calculate necessary energy and lethal doses (LD₉₀), i.e. 90 % growth reduction compared with untreated plants, dose-response-curves were carried out (fig. 2 and tab. 1). Results for *E. crus-galli* are similar but on a higher energy level.

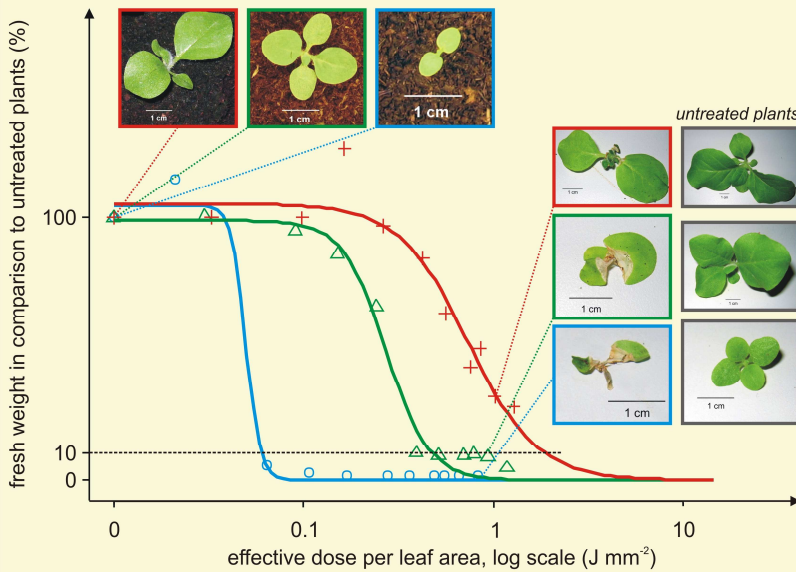


Fig. 2: Dose-response-curves on CO₂ laser treatment of *N. tabacum* plants (3 growth stages, see BBCH-code)

Plant specie	Laser type	Growth stage, BBCH		
		13	12	10
<i>N. tabacum</i>	CO ₂	1.85	0.48	0.06
	diode	12.9	2.67	1.21
<i>E. crus-galli</i>	CO ₂	2.85	1.71	0.75
	diode	3.16	2.92	1.21

Tab. 1: Calculated LD₉₀ values (J mm⁻²) of selective plant treatment with both laser systems (growth stages see fig. 2)

Conclusions

- Weed control by pointed laser light beams is effective and efficient.
- A maximal dose of 5 J mm⁻² is needed (CO₂-laser), which leads to 141 J of laser output energy per weed.
- Supposing a high weed density of 40 plants/m², laser weeding can reduce 70 % of the energy comparing to flaming.
- Diode laser wavelength is less absorbed than CO₂-laser wavelength → lethal doses are reciprocally higher.
- Future work on heat absorbance, automation and optical meristem localisation is necessary.