The Response Of Duckweed To CO_2 - Laser Radiation

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ABSTRACT

Duckweed (*Lemna minor* L.) was irradiated with a CO_2-N_2-He laser to evaluate this plant's response to 10.6 μ laser energy. Energy levels of 10 and 100 J/cm² reduced growth of duckweed after 3 and 7 weeks as compared to the control plants. Duckweed proved to be a desirable experimental organism.

INTRODUCTION

Waterhyachinth (*Eichhornia crassipes* [Mart.] Solms.) plants were used in work initiated in 1968 to test the effectiveness of laser radiation for controlling the growth of certain aquatic plants (1, 2). This plant was chosen because of its seriousness as a weed pest over the southeastern United States. However, the waterhyacinth plant was not the most desirable experimental organism for laboratory experiments. Waterhyacinth plants are relatively large and vary greatly in physiological age. Therefore, duckweed was chosen for this study because of its small size, classification as an angiosperm, relatively uniform growing habit, and ease of care and handling. This plant is particularly useful in laboratory experiments because good experimental designs involving randomness, ample replication, and unbiased sampling can be constructed.

METHODS AND MATERIALS

The laser used for this test was a CO_2-N_2-He laser built at Redstone Arsenal, Alabama. It was modular in form in that 18 sections, each 2.74 m long, were used to construct the whole laser. Each section had its own power supply. One vacuum pump served two sections. By adjusting the individual power supplies, the laser power could be controlled from several hundred watts to full power of approximately 2 kw. Gas composition and flow rate were also factors controlling the power output. The details of the design have been described by Roberts (3).

Figure 1 shows the general arrangement of the laser apparatus for irradiating plants. The laser beam, with a total power output of about 2 kw at 10.4-10.6 μ wavelength, was reflected from a flat mirror (gold-plated over a bismuth substrate on glass) and then was focused by a parabolic focusing mirror. A graphite stop mounted on a pneumatic piston was used to interrupt the beam. Solenoid-operated air valves actuated the pneumatic system to permit passage of the beam for controlled exposure times. Automatic electric timers controlled the solenoids. The beam intensity at the target area was measured with a 100-w, full scale Coherent Radiation Laboratories, Inc. radiometer equipped with fast-response thermocouples specifically designed for use in the 10 μ range of radiation. The total power was measured with a water-cooled cone calorimeter capable of measuring more than the expected highest continuous power of the laser. The radiometer signals were recorded on a direct-writing-pen recorder.

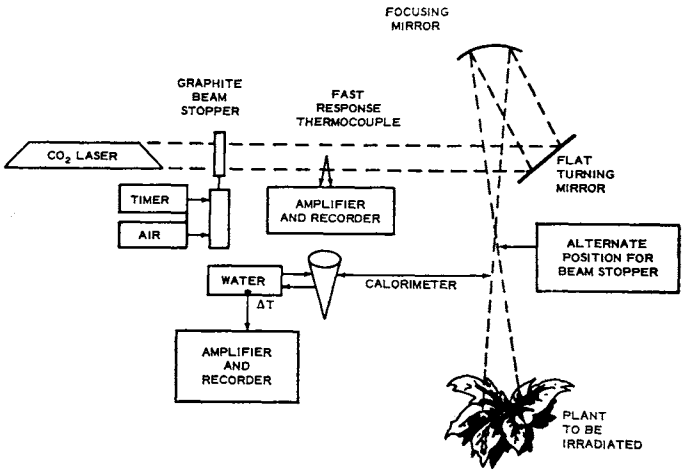

Figure 1. Experimental arrangement for plant irradiation.

On June 4, 1971, four replications of 100 duckweed plants in each treatment were subjected to 0, 1, 10, and 100 J/cm² of continuous CO_2-laser energy. During irradiation, the upper exposed leaf surface of the duckweed was dry. Being a small, thin-leaved plant, irradiation was uniformly received by all the plants. Following treatment, the plants were maintained outdoors in shaded, water-filled, 3.7-L plastic containers and fertilized at a rate of 112 kg/ha with 12-6-6 commercial fertilizer. Plant counts were taken on June 25 and July 23, 1971.

RESULTS AND DISCUSSION

Plants irradiated with 100 J/cm² laser energy died within three weeks (Table 1). The 10 J/cm² treatment reduced growth and no new plants were propagated within 7 weeks. The LSD test showed that 1 J/cm² did not reduce growth as compared to the control plants. No differences existed in the number of living plants in the 10 and 100 J/cm² treatments. Plants in the control group and plants in the 1 J/cm² treatment vegetatively propagated new

TABLE 1. RESPONSE OF DUCKWEED TO VARIOUS LEVELS OF CO_2-LASER RADIATION.

Energy Applied (J/cm^2)	Number of Living Plants[a]	
	After 3 Weeks	After 7 Weeks
0	75	90
1	68	81
10	19	17
100	0	0
LSD 5%	24	42
1%	34	59

[a]Each value is the mean of four replications.

plants with an increase in total number during the period from June 25 to July 23, 1971.

Duckweed, a flowering plant having similar morphology and physiology to other flowering plants, is small enough to make an ideal organism for future mode-of-action study dealing with the effects of laser radiation on plant growth.

ACKNOWLEDGMENTS

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