Response Of Eurasian Watermilfoil To Heat

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ABSTRACT

Fragments of Eurasian watermilfoil (*Myriophyllum spicatum* L.) drawn through cooling systems of large electricity generating stations would be exposed to temperatures from ambient up to 44 C for 2.5 to 10 min depending on the design and operation of the facility. Within this temperature:time exposure range, Eurasian watermilfoil was stimulated or partially inhibited but not completely killed. Fragments of this species were killed during a 5 min exposure, at 50 C. At 45 C a 10 min exposure severely inhibited subsequent growth.

INTRODUCTION

Eurasian watermilfoil is an exotic aquatic angiosperm that has been introduced into various American freshwater locations. This species reproduces almost entirely by vegetative fragments (10). Because of its rapid rates of growth, fragmentation, and establishment of new colonies, heavy infestations can develop quickly and threaten various desirable uses of water resources.

A large volume of water is drawn through steam-electric generating stations for cooling. If Eurasian watermilfoil is present in the source of this cooling water, fragments may be captured in the flow of water drawn in for cooling the steam condensers. If this cooling water is then discharged to a cooling lake, spray pond, or other impoundment, otherwise free of this weed, these fragments could establish a new infestation. In many cases, plant fragments would not only have to pass mechanical barriers (screens) but would also have to survive physical and thermal stresses. Within electricity generating stations operated by the Tennessee Valley Authority increase in water temperature in the condensers ranges from 5 to 15 C above ambient temperature. At the station with maximum expected condenser temperature, maximum annual ambient temperature is generally about 30 C, and temperature rise in the condenser is 14 C. The highest temperature of in-plant cooling water expected in the Tennessee Valley Authority system is 44 C. In the research reported here, the ability of small fragments of Eurasian watermilfoil to survive thermal stresses was tested by dropping them into heated tap water (8).

METHODS AND MATERIALS

Plants were grown in forest soil under greenhouse conditions as previously described (11). Apices were cut to 4 cm, transported to the laboratory, and heat-treated within a few hours. Initial dry weight of untreated controls was 19.4 ± 3.0 mg per fragment. The temperature of the water into which plants were dropped was measured with a mercury thermometer, three replicates per treatment. Combinations of temperatures from 35 to 50 C and times of exposure of 2, 5, 10, and 15 min were tested. Results of 5-min exposure to various temperatures and of 45 C exposure for various times are reported. Plants were returned to tap water at room temperature immediately after exposure then planted the same day in 200-ml flat-bottomed test tubes in forest soil. After incubation for 32 days at 20 C with about 2700 lux light, roots and shoots were harvested separately, dried overnight at 70 C, and weighed.

RESULTS AND DISCUSSION

Growth was inhibited proportionally to both temperature (Figure 1) and exposure time (Figure 2). All specimens exposed for 5 min at 50 C or 10 min at 45 C died. These dead plants lost weight during heat treatment and incubation. Exposure to inhibit weight increase 50 percent (I_{50}) was interpolated to be 8 min at 45 C. The lowest heat treatments stimulated subsequent growth. The threshold of heat damage (I_{10}) was about 5 min at 40 C or 2 min at 45 C for roots and about 5 min at 45 C for shoots.

Eurasian watermilfoil showed the response to interaction of temperature and time of exposure typical of other plants (2, 3, 6). Duration of cold exposure plays a minor role in causing damage due to cold stress but duration of heat exposure is of fundamental importance in damage due to heat stress (9). Eurasion watermilfoil, in general, falls into the same range of thermal tolerance as most plants (5). However, the metabolic processes of even non-thermophiles can be stimulated by exposure as high as 56 C (4), well above the lethal temperature for Eurasian watermilfoil which is stimulated by 35 C for 5-min exposure. Comparison indicates that the thermal resistance of this species is somewhat less than that of *Rhoeo discolor* (L'Her.) Hance (6) but almost identical to that of bean (*Phaseolus vulgaris* L.) (1) and waterweed (*Elodea canadensis* Michx.) (9).

The temperature-time exposure to which Eurasian watermilfoil would be exposed if drawn through electricity generating stations with cooling water is not sufficient to kill fragments of this species. Thus there is a possibility that downstream bodies of water could become infested by fragments transported in the cooling water. There are also physical barriers for the fragments at the water intake and physical stresses for the fragments to endure within the cooling coils. It is not certain that this pathway for infestation of downstream sites would be significant at a given location.

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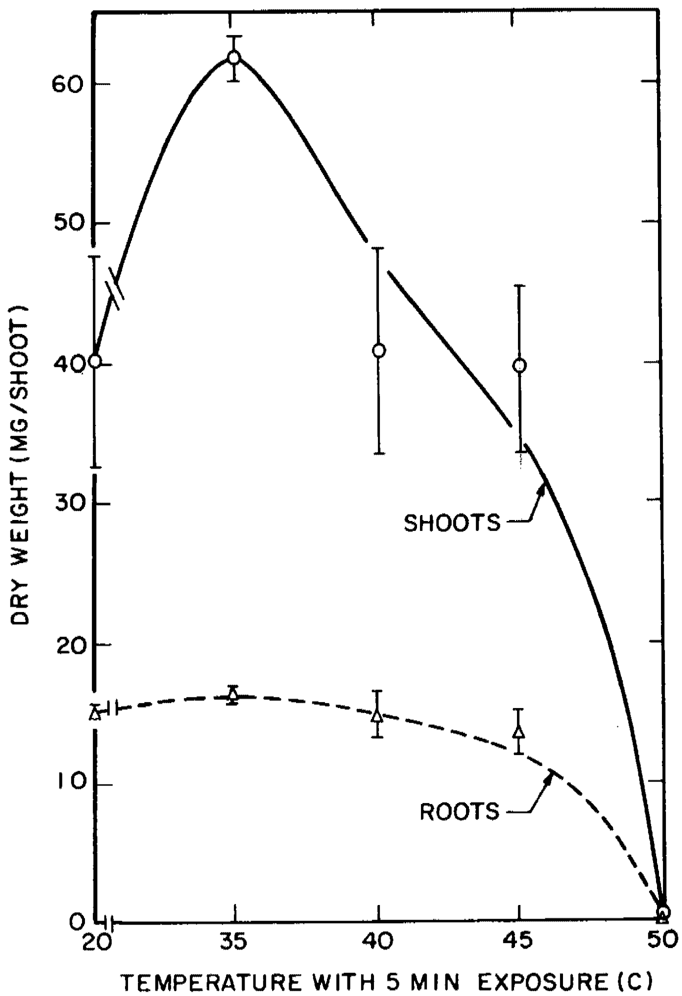

Figure 1. Final weight of apical fragments of Eurasian watermilfoil after heat treatment for 5 min at various temperatures and subsequent growth of heated apices at 20 C with 2700 lux light for 32 days. Initial shoot weight of fragments was 19.4 ± 3.0 mg/per fragment.

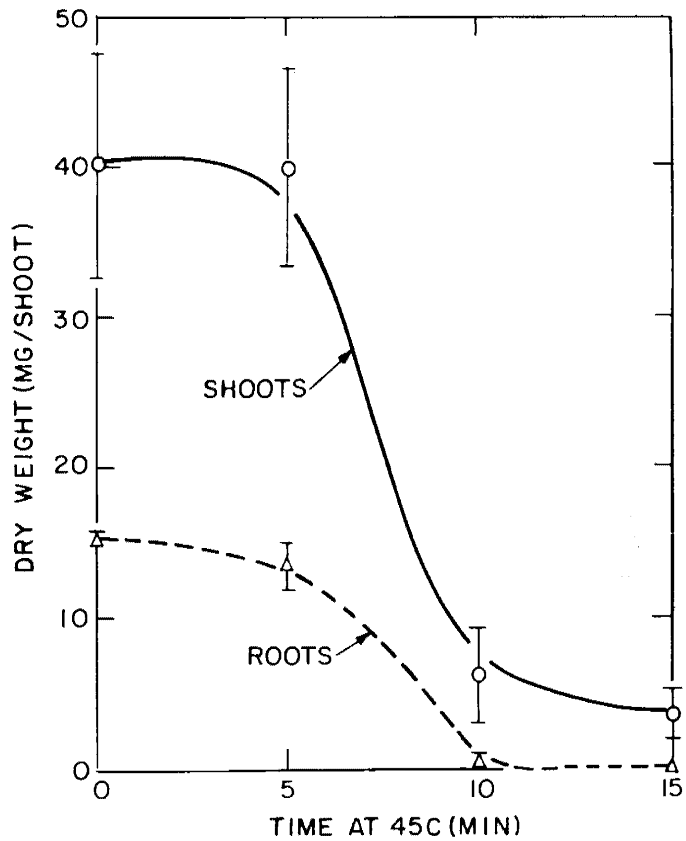

Figure 2. Final weight of apical fragments of Eurasian watermilfoil after heat treatment for various lengths of time at 45 C and subsequent growth of heated apices at 20 C with 2700 lux light for 32 days. Initial shoot weight of fragments was 19.4 ± 3.0 mg/per fragment.