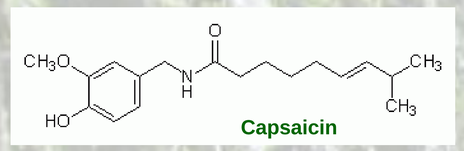
Seedling Uptake and Translocation of Soil-Applied Capsaicin



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Abstract

Seedling damage due to browsing from white-tailed deer and other mammalian species constitutes a major challenge to afforestation and reforestation efforts in the Central Hardwood Forest region of the USA. Many efforts have been made to deter herbivores by applying chemical repellents, physical barriers, and fencing, but the costs, implementation methods, and relative ineffectiveness of existing mitigation options often preclude operational implementation. An alternate means of potentially deterring wildlife browse is capsaicin, a hot pepper concentrate, which has been recently approved for this use by the EPA. Capsaicin has been reported to decrease herbivory of young tree seedlings and is available in a controlled-release form designed to act systemically following application to the soil and subsequent plant uptake. However, the degree to which seedlings are capable of absorbing capsaicin from the soil solution and the fate of absorbed capsaicin within the plant remain largely unexamined. Our experiment seeks to investigate the potential for seedling uptake and translocation of soil-applied capsaicin. An earlier experiment used HPLC to assess capsaicin content of foliar samples from seedlings in a field trial, and results suggested that capsaicin was not present in the leaves at the time of sampling. In order to more fully and accurately evaluate the effects of soil-applied capsaicin on seedlings throughout a broader range of plant parts and sampling times, we propose to study the effects of soil-applied capsaicin on post-transplant northern red oak (*Quercus rubra* L.) seedlings under controlled environmental conditions during the first season following transplant.

Introduction

- Repellex©, a company producing pest control products containing capsaicin, is promoting the application of capsaicin systematically to seedlings to eliminate animal browse (Figure 1)
- A previous field study was conducted last fall investigating the presence of capsaicin in leaves of out planted seedlings, but many variables were not controlled

Figure 1: Bottle label on systemic capsaicin tablets (picture obtained from website)

Research Objectives

- Determine the fate of applied capsaicin in *Q. rubra* seedlings by testing and quantifying the amount of capsaicin in a controlled environment in:
  1. the leaves, stems, and roots
  2. the immediate atmosphere around the seedlings

Study 1

Procedure

- Foliar samples were collected from chestnut seedlings planted with 0.85g capsaicin per seedling at SEPAC (Southeastern Purdue Agricultural Center)
- Samples were dried at 70°C for 4 days and analyzed using HPLC-UV detection (Collins 1995)

Results

- A standard curve was run to determine capsaicin retention time (Figure 2)
- The control treatment indicates other unknown compounds present in the leaves as shown by the series of UV detection peaks (Figure 3)
- Foliar samples containing capsaicin have peaks in the exact areas that the control treatment graph shows (Figure 4)

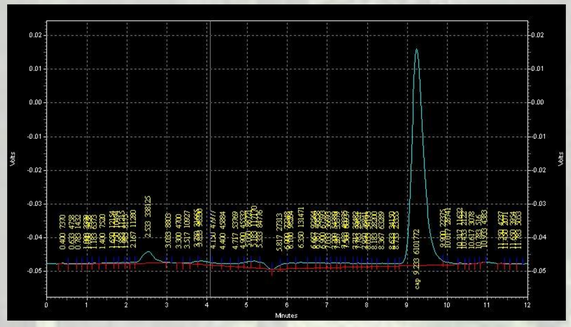

Figure 2: Capsaicin standard with a retention time of ~9.2 minutes

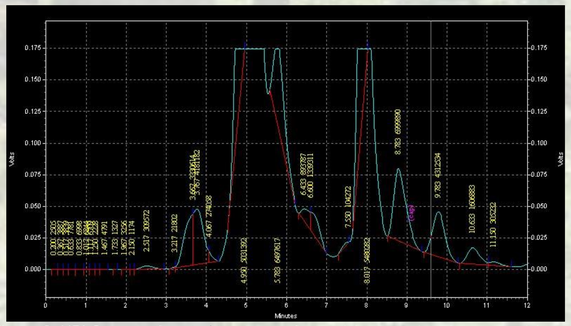

Figure 3: HPLC graph of control treatment of capsaicin; the point where capsaicin would be expected is highlighted in purple

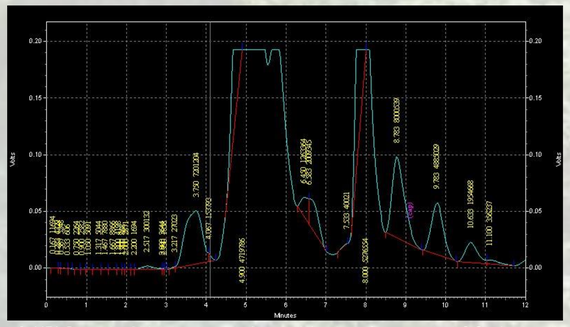

Figure 4: HPLC graph of high treatment of capsaicin; there is no peak at 9.2 minutes, the expected time of a peak

Study 2

Sampling

- 20, 1+0 *Q. rubra* seedlings will receive the recommended dosage of capsaicin according to Repellex©'s label in a mixture of sand and vermiculite and grown in a greenhouse
- Samples will be destructively harvested and separated by stems, leaves, and roots at time t = 0, 5, 10, and 20 days
- Prior to harvesting, glass enclosures will be placed over seedlings to capture volatilized capsaicin (Figure 5)

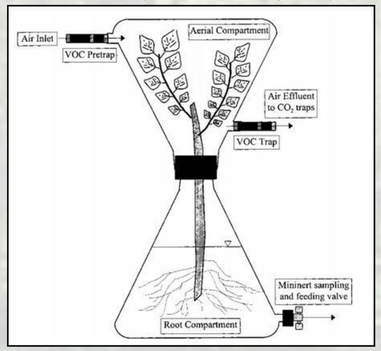

Figure 5: Schematic of how volatile compounds will be captured; samples will not be grown in a hydroponic solution (figure adapted from Burken et al.1998)

Equipment

- Plant tissues will be analyzed using a HPLC-mass spectrometry triple quadrupole to target capsaicin and potential metabolites/capsaicinoids (Figure 6)
- Volatilized material will be analyzed using gas chromatography-mass spectrometry

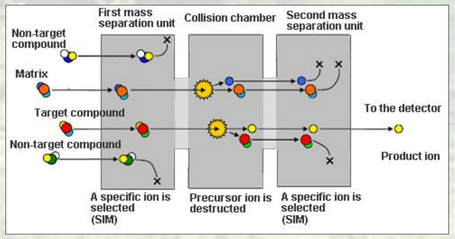

Figure 6: Diagram of how HPLC-MS triple quadrupole targets a specific compound/metabolite based on mass (figure adapted from Shimadzu Scientific Instruments)

Data Analysis

- All tissues will be frozen with liquid nitrogen immediately after harvest, ground using a Wiley Mill, and prepared in acetonitrile for HPLC analysis (Figure 7)
- Volatilized material will be dissolved in acetonitrile and prepared for GC-MS analysis

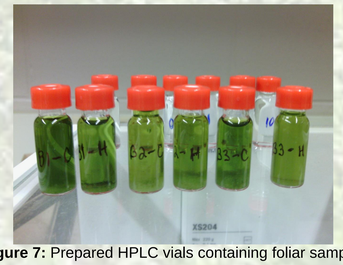

Figure 7: Prepared HPLC vials containing foliar samples

References:

Burken, J. G., Schnoor, J. L. 1998. *Predictive relationships for uptake of organic contaminants by hybrid poplar trees.* Environmental Science & Technology 32.21:3379-3385.
Collins, M. D., Wasmund, L. M., Bosland, P. W. 1995. Improved Method for Quantifying Capsaicinoids in Capsicum Using High Performance Liquid Chromatography. HortScience 30(1):137–139.