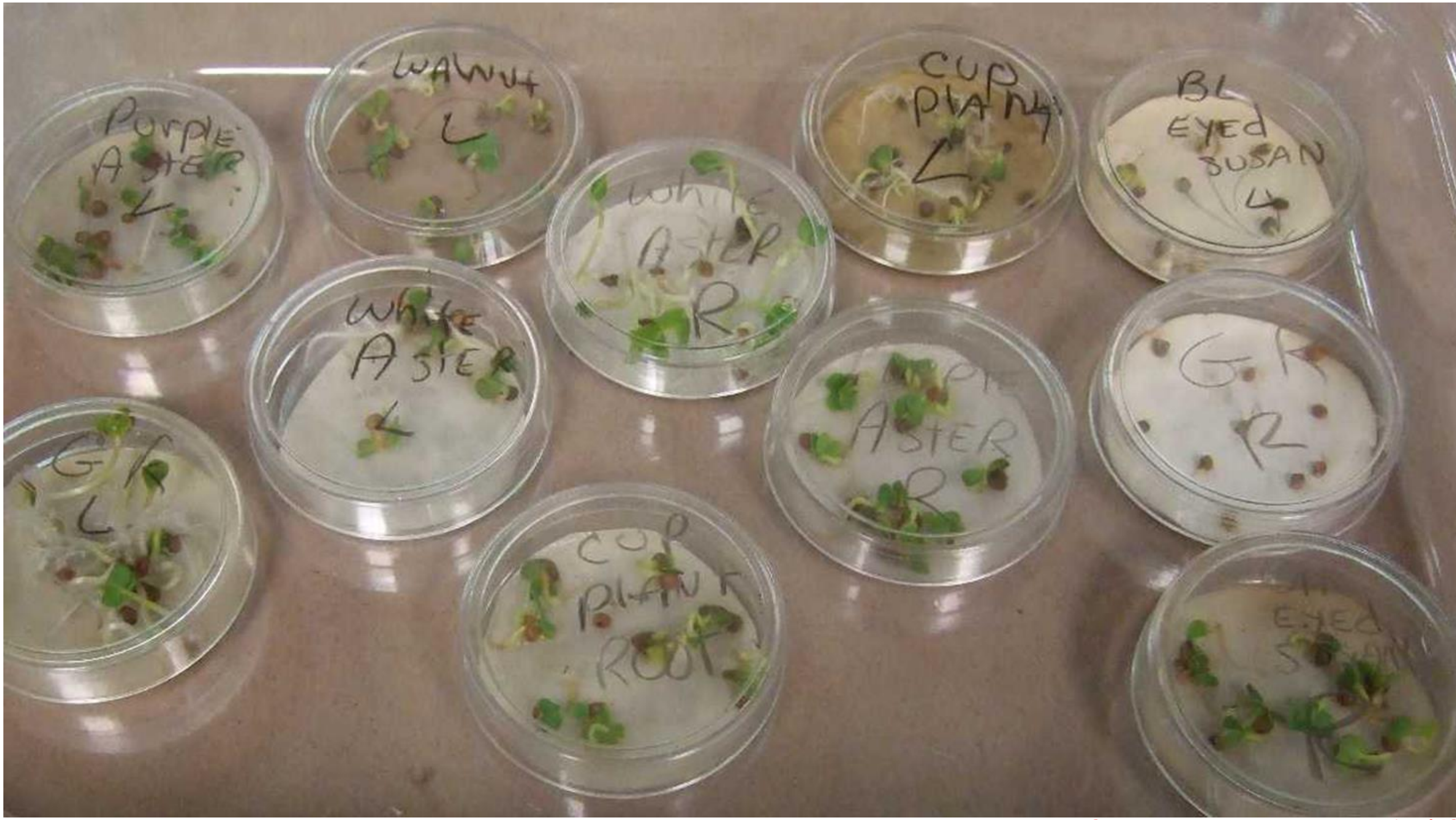
ALELOPATIA /LCB 2017- 2017



Prof. Sergius Gandolfi

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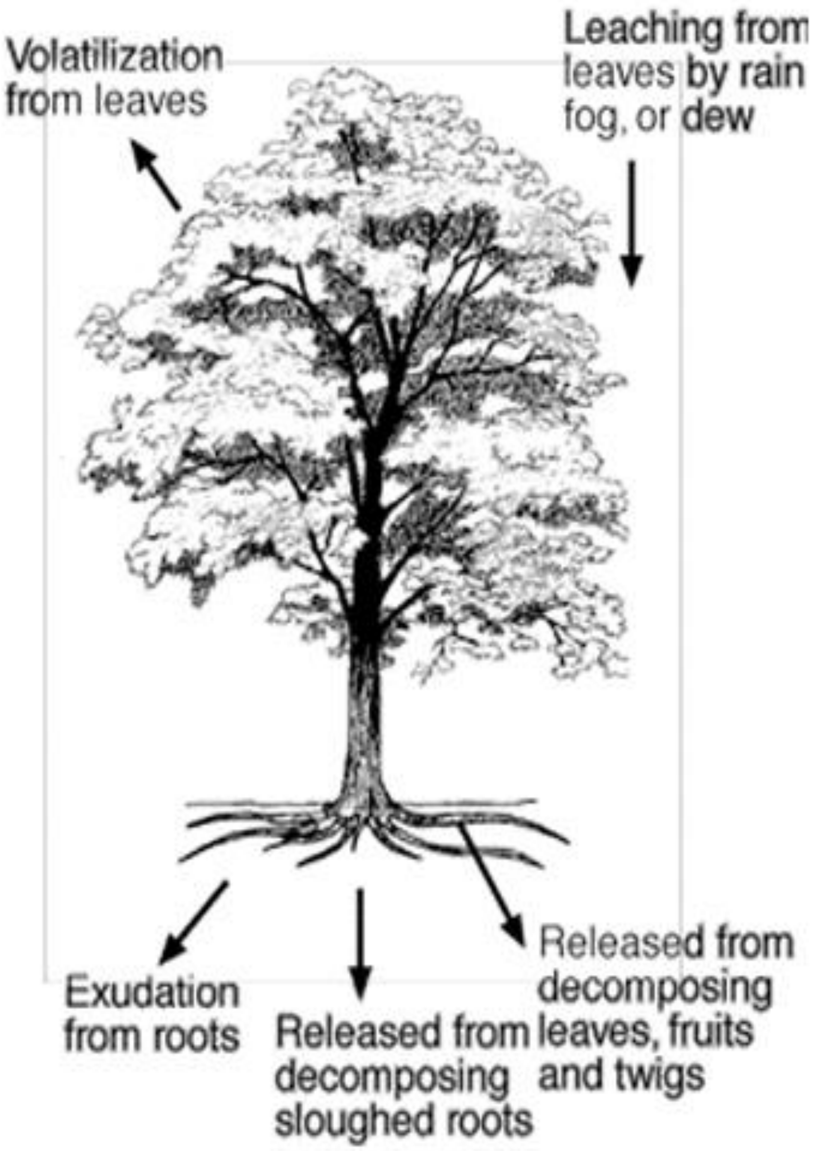
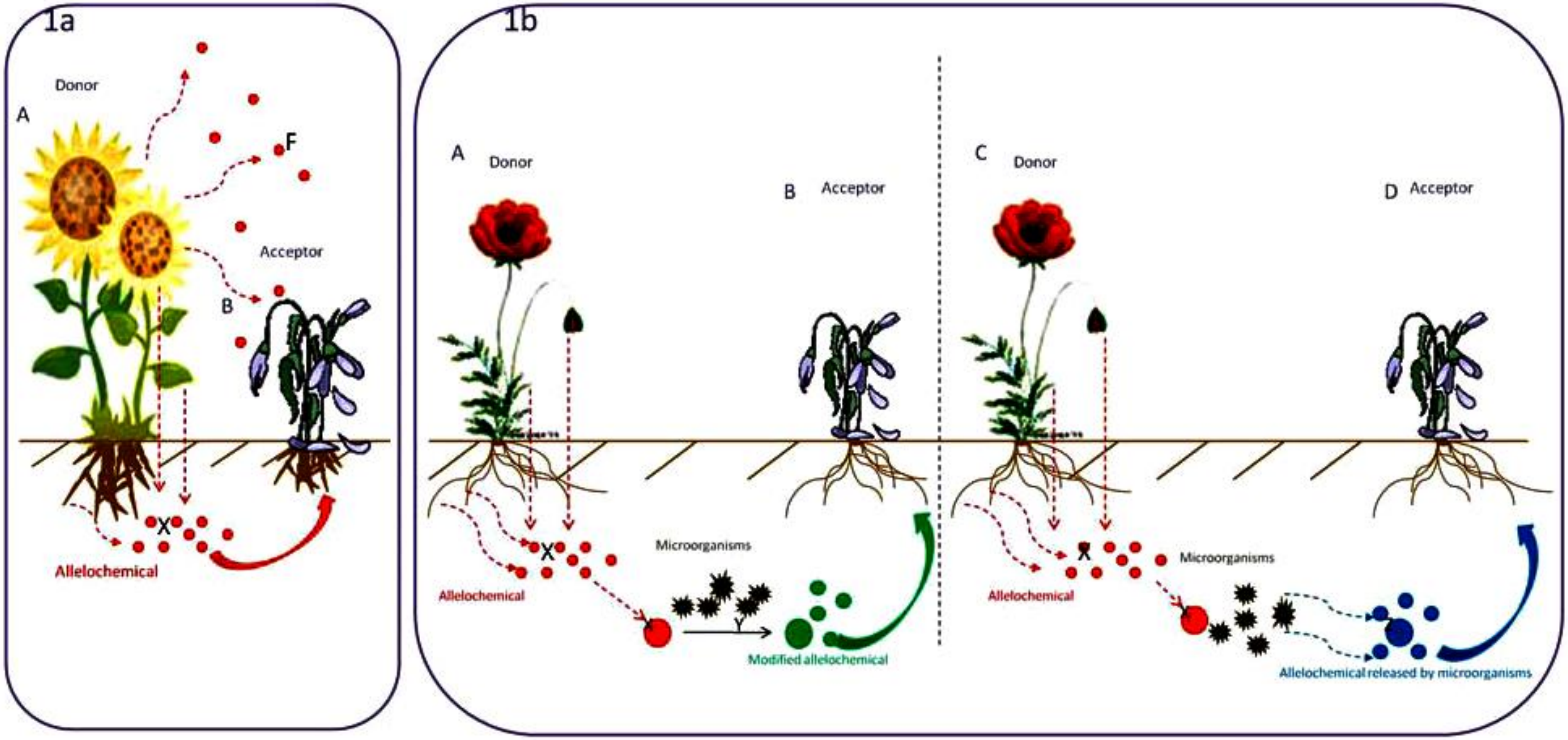
Departamento de Ciências Biológicas ESALQ/USP

Modos de liberação de compostos alelopáticos



ACACIA PRUINOCARPA PRODUCES COMPOUNDS THAT ARE ALLELOPATHIC (ELIMINATE THE GROWTH OF COMPETING PLANTS IN THE DIRECT AREA) AND CYTOGENIC IN NATURE. NOTE THAT THERE ARE NO OTHER PLANT SPECIES GROWING BELOW THIS ONE.



1a
Donor
A
F
Acceptor
B
X
Allelochemical
1b
A
Donor
B
Acceptor
X
Microorganisms
Allelochemical
Y
Modified allelochemical
C
Donor
D
Acceptor
Microorganisms
Allelochemical
Allelochemical released by microorganisms

Sub-bosque de uma floresta mostrando indivíduos de várias espécies num local sem MARICÁ, uma árvore alelopática.

Sub-bosque da mesma floresta anterior num local com MARICÁ, mostrando um forte efeito alelopático que inibe as a presença de plantas no sub-bosque

Forte efeito alelopático do Bambu

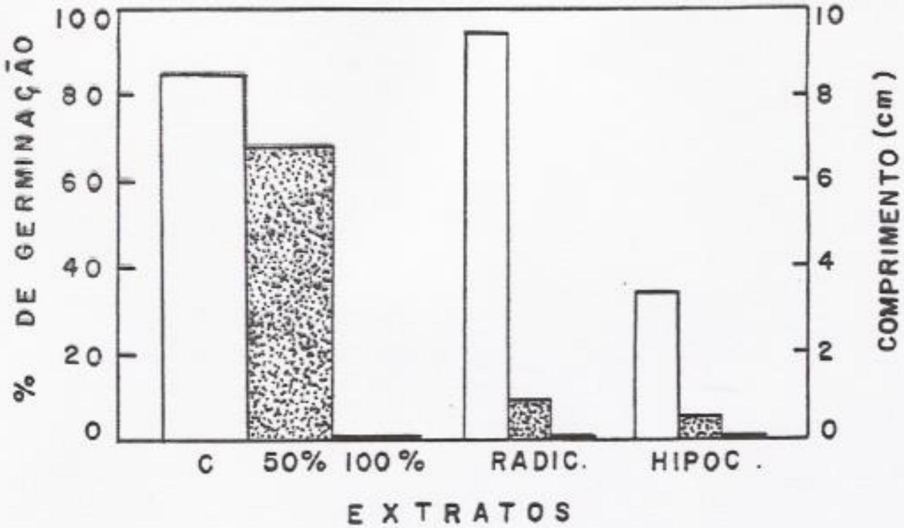


Figura 1 — Histograma representativo dos valores relativos a porcentagem de germinação e comprimento da radícula e hipocótilo do tomateiro, determinados 7 dias após a semeadura, em placas de Petri umidecidas com 0, 50% e 100% do extrato de tubérculos de *Cyperus rotundus*.

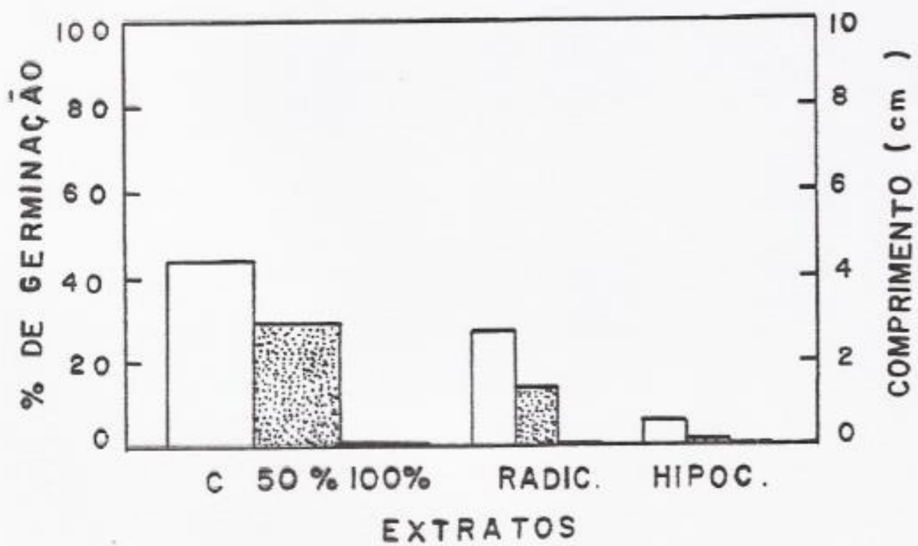


Figura 2 — Histograma representativo dos valores relativos a porcentagem de germinação e comprimento da radícula e hipocótilo do tomateiro, determinados 7 dias após a semeadura, em placas de Petri umidecidas com 0, 50% e 100% do extrato de rizomas de *Sorghum halepense*.

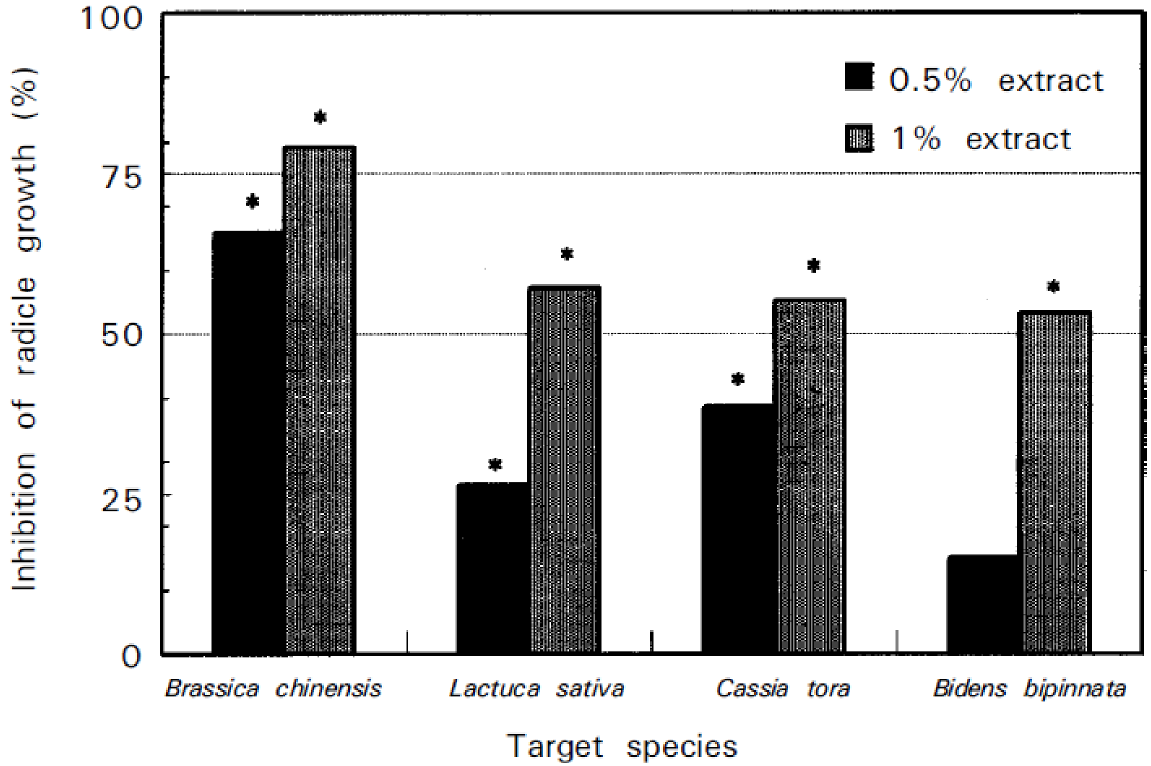


Fig. 5. Percent inhibition of radicle growth of four local herbaceous plants caused by 0.5% and 1.0% leaf extracts of *Stachytarpheta urticaefolia*. Asterisks denote significant difference from the controls ($p <= 0.05$)

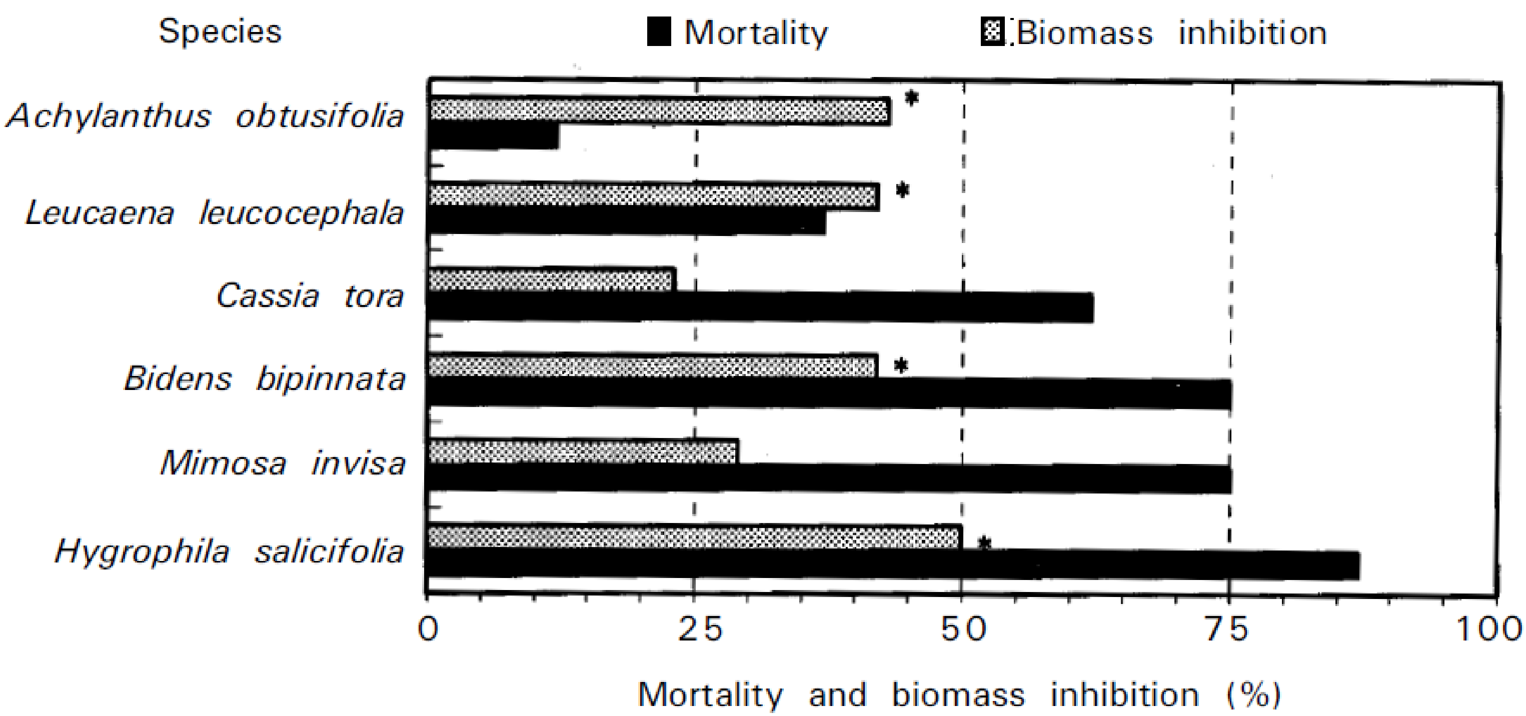


Fig. 6. Mortality and percent biomass inhibition of six test species affected by a mulch of powdered leaves of *Stachytarpheta urticaefolia*. An asterisk denotes a significant difference from the control ($p <= 0.05$)

LEUCENA x MILHO

TABELA 2 – Freqüência das diferentes fases da mitose em células meristemáticas de raízes de plântulas de milho desenvolvidas sob diferentes concentrações do extrato de leucena.

Concentração do extrato de leucena (%)	Número de células em mitose	% de células nas fases			
		Prófase	Metáfase	Anáfase	Telófase
0	127 a	55,96 ab	1,80 ab	1,38 a	2,02 a
0,4	106 ab	62,46 a	2,41 a	1,47 a	2,17 a
0,8	62 bc	43,06 bc	0,75 ab	0,87 a	0,66 ab
1,6	54 c	50,51 ab	0,85 ab	0,19 a	0,00 b
3,2	50 c	32,26 cd	0,42 b	0,61 a	0,00 b
6,4	24 c	21,67 d	0,00 b	0,45 a	0,00 b

Médias seguidas de mesma letra não diferem entre si pelo teste Duncan a 5 % de probabilidade.

Andira humilis (arbusto do Campo- Cerrado) - Alface

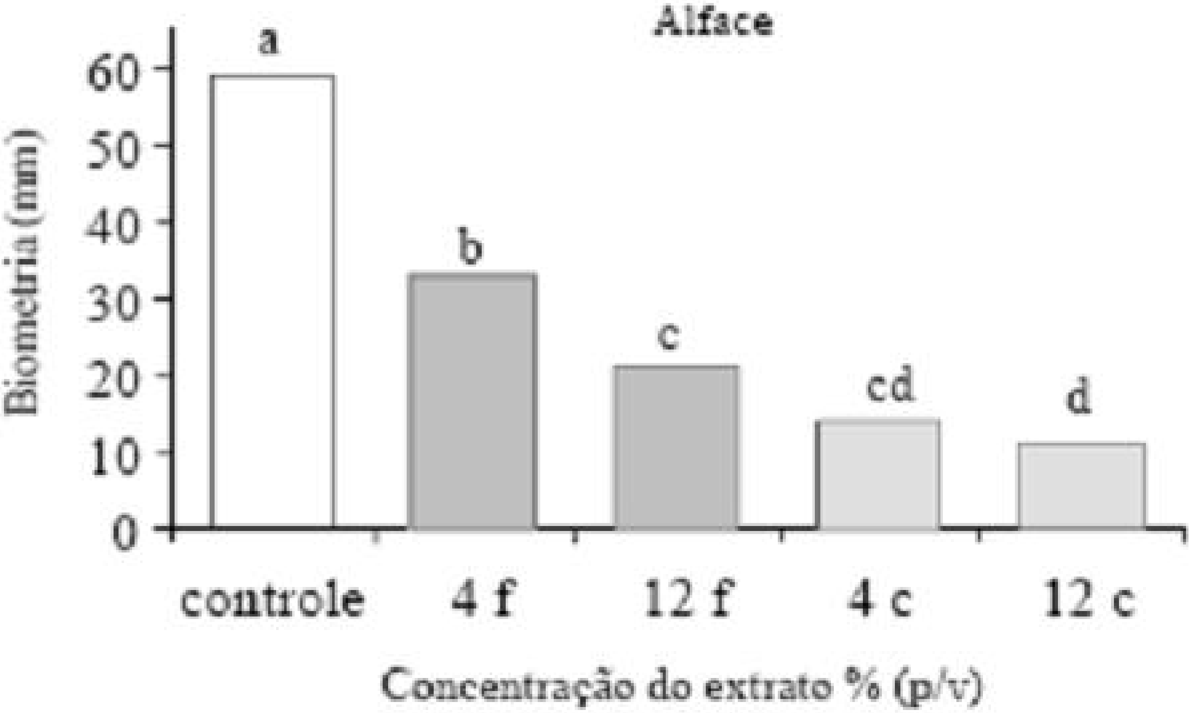
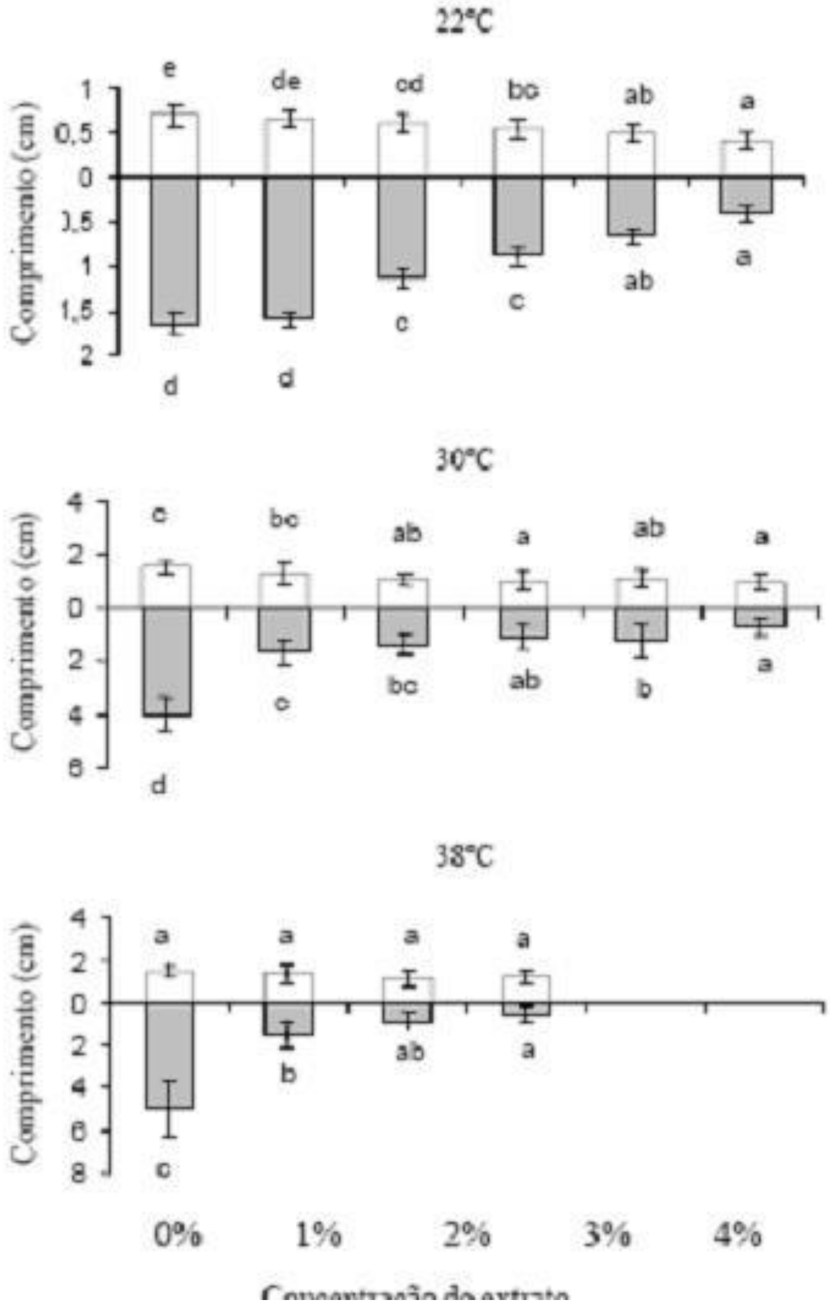


Figura 5. Comprimento das plântulas de *Lactuca sativa* L. sob o efeito de diferentes concentrações dos extratos aquosos de caules (c) e folhas (f) de *Andira humilis* Mart. ex Benth. Letras iguais indicam que os valores não diferem significativamente entre si a 5% de probabilidade, pelo teste de Tukey.



Lobeira x Gergilim

Figura 1. Tamanho médio (cm) da parte aérea (☐) e radicular (■) de plântulas de *Sesamum indicum* L. incubadas por cinco dias em diferentes concentrações de extrato aquoso de folhas de *Solanum lycocarpum* A. St.-Hil. Barras verticais representam o desvio padrão. Colunas com a mesma letra não diferem estatisticamente pelo teste de Tukey a 5%. As comparações entre as concentrações foram feitas separadamente para parte aérea e radicular (30 plântulas/tratamento).

A SEGUIR ALGUNS EXEMPLOS DE ESTUDOS SOBRE ALELOPATIA

Trends in Ecology and Evolution, December 2011, Vol. 26, No. 12

The ecosystem and evolutionary contexts of allelopathy

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Plants can release chemicals into the environment that suppress the growth and establishment of other plants in their vicinity: a process known as 'allelopathy'. However, chemicals with allelopathic functions have other ecological roles, such as plant defense, nutrient chelation, and regulation of soil biota in ways that affect decomposition and soil fertility. These ecosystem-scale roles of allelopathic chemicals can augment, attenuate or modify their community-scale functions. In this review we explore allelopathy in the context of ecosystem properties, and through its role in exotic invasions consider how evolution might affect the intensity and importance of allelopathic interactions.

Allelochemical interactions in the context of communities and ecosystems

How populations are organized into higher units, or 'communities', is a central issue in ecology [1]. The Russian ecologist T.A. Rabotnov [2] hypothesized that adaptation of plant species to the chemistry of other species was crucial to this organization. Rabotnov focused on allelopathic interactions, which involve biochemically based suppression of the establishment and growth of one plant by another. However, plant-released secondary chemicals also have powerful effects on decomposition [3], herbivory [4], trophic interactions [5] and nitrogen (N) cycling [6,7] (Figure 1). Allelopathy has been studied a great deal over the past 50 years but only a few studies have attempted to understand allelochemical interactions among plants in the context of these broader effects [8–14]. Consideration of allelopathy in this integrated community and ecosystem context requires the recognition of the large number of different processes that can be affected by the same chemical or its derivatives, and the potential for the direct allelochemical effects of plants on each other to be augmented, attenuated, modified or offset [11]. These other interactors can enhance or reduce allelochemical production, change the persistence or effectiveness of allelochemicals in soil, and select for higher or lower allelochemical concentrations over evolutionary time. Understanding allelopathy in the context of communities and ecosystems can be further developed by comparing the potential allelopathic effects of invasive species between their native and introduced ranges [15–18]. Such biogeographic comparisons suggest that evolutionary relationships among plants, and between plants and soil biota, may affect the role of allelopathy in community organization [16].

Mere production of chemicals by a plant is not sufficient to ensure their allelopathic potential. Abiotic and biotic environmental conditions determine the allelopathic potential of chemicals in soil [10]. Recent studies have advanced our understanding of allelopathy by examining it in environmental [12,19–21], biogeographic [15,16,22] and evolutionary [23,24] contexts. Our goal is to discuss how biotic and abiotic environmental conditions, and evolutionary history, affect the production, fate and effectiveness of allelopathic compounds in soils (Figure 1). Specifically, we consider how habitat or site-specific characteristics, non-native ecosystems, and environmental variables all influence the release, accumulation and function of chemicals, and thus affect the organization of natural systems.

Consumer, competitor and soil microbe effects on allelochemical production and activity

The production, storage and release of allelochemicals are key mechanisms of plant behavior which affect almost all aspects of a plant's ecology [9]. These processes are affected by the abiotic and biotic properties of the ecosystems in which plants grow [25], and chemicals produced by plants in turn have strong effects on ecosystem properties. We propose that by explicitly recognizing and integrating these ecosystem-level effects, we will better understand the various allelopathic, defensive, foraging and signaling roles of chemicals in the organization of natural communities (Figure 1).

Under natural conditions, allelopathic effects can result from interactive effects among multiple compounds [26–29]. One of the best understood allelopathic systems

Glossary

Allelopathy: suppression of the growth and/or establishment of neighboring plants by chemicals released from a plant or plant parts.
Allelochemicals: secondary compounds of plant origin that interact with their environment and possess allelopathic activities.
Novel weapons hypothesis (NWH): the idea that some invasive plant species produce secondary metabolites that are novel in their non-native ranges and that this novelty provides advantages to the invasive species as it interacts with native plants, microbes or generalist herbivores.

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Introduction to the special issue on allelopathy

Scott J. Meiners · Chui-Hua Kong

Published online: 11 December 2012

The last decade has seen a dramatic increase in ecological research on allelopathy, largely within the context of non-native species invasions. The vast majority of these studies focus on determining whether a species is allelopathic and in determining the mode of action for the interaction. The case study approach is a useful first step, but it should not preclude the integration of allelopathy into a broader ecological context. In preparing this special issue of *Plant Ecology* on allelopathy, we have specifically focused on studies that place allelopathy into the context of environmental variation, species interactions, soil microbial communities, restoration, and other ecological processes. We have attempted to span the breadth of allelopathy research—incorporating a broad range of plant communities/ecosystems, geographic locations, and taxonomic groups.

We have adopted a broad view of allelopathy and its consequences. While the incorporation of the Greek *pathos* (suffering) into the term suggests chemical interactions that are in some way inhibitory, we have adopted the broader definition of "any chemically mediated interactions among plants" (Rice 1974). That being said, most of the interactions described here are inhibitory. An interesting and related question is, how much chemical mediation is necessary before an interaction is considered to be allelopathic? The alteration of local soil pH is a common impact of many plant species that is not considered allelopathic, but would certainly involve the release of chemicals from plant tissues. Allelochemicals may have direct effects on other plants or they may be mediated through the action of soil microbes. Ultimately, the effects of allelopathic interactions may be expressed by changes in growth, competitive outcomes, and soil resource dynamics, among others. Of course, any allelopathic effects are only part of the potential suite of interactions between species, with the overall interaction reflecting the net effects of direct competition, facilitation, and allelopathy. It is the overall direction and strength of the interaction that will determine community dynamics and structure.

We have pulled together two very different research areas and their approaches to allelopathy in this special issue. Allelopathic research within agricultural systems has a long and largely continuous history, whereas interest in allelopathy in ecological systems has ebbed and flowed over the years. By including studies of agro-ecosystems into this issue, we have tried to form connections between the two research groups. We pose that agricultural systems may be considered as useful model systems for understanding

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Allelopathic Interactions and Allelochemicals: New Possibilities for Sustainable Weed Management

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ABSTRACT: Weeds are known to cause enormous losses due to their interference in agroecosystems. Because of environmental and human health concerns, worldwide efforts are being made to reduce the heavy reliance on synthetic herbicides that are used to control weeds. In this regard the phenomenon of allelopathy, which is expressed through the release of chemicals by a plant, has been suggested to be one of the possible alternatives for achieving sustainable weed management. The use of allelopathy for controlling weeds could be either through directly utilizing natural allelopathic interactions, particularly of crop plants, or by using allelochemicals as natural herbicides. In the former case, a number of crop plants with allelopathic potential can be used as cover, smother, and green manure crops for managing weeds by making desired manipulations in the cultural practices and cropping patterns. These can be suitably rotated or intercropped with main crops to manage the target weeds (including parasitic ones) selectively. Even the crop mulch/residues can also give desirable benefits. Not only the terrestrial weeds, even allelopathy can be suitably manipulated for the management of aquatic weeds. The allelochemicals present in the higher plants as well as in the microbes can be directly used for weed management on the pattern of herbicides. Their bioefficacy can be enhanced by structural changes or the synthesis of chemical analogues based on them. Further, in order to enhance the potential of allelopathic crops, several improvements can be made with the use of biotechnology or genomics and proteomics. In this context either the production of allelochemicals can be enhanced or the transgenics with foreign genes encoding for a particular weed-suppressing allelochemical could be produced. In the former, both conventional breeding and molecular genetical techniques are useful. However, with conventional breeding being slow and difficult, more emphasis is laid on the use of modern techniques such as molecular markers and the selection aided by them. Although the progress in this regard is slow, nevertheless some promising results are coming and more are expected in future. This review attempts to discuss all these aspects of allelopathy for the sustainable management of weeds.

Chapter 20

Allelochemicals as Bioherbicides — Present and Perspectives

Dorota Soltys, Urszula Krasuska,
Renata Bogatek and Agnieszka Gniazdowska

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/56185

7. Conclusions - The phenomena of allelopathy and phytotoxic interactions between plants are strongly expanding branches of biological science. Allelochemicals, as a group of substances also called biocommunicators, seem to be a fruitful challenge for combining traditional agricultural practices and new approaches in pest management strategies. Allelochemicals have already been used to defend crops against pathogens, insects or nematodes, parallel to some attempts to use them for weed control. Crop rotation, cover crops, dead and living mulches are being employed in agriculture. Both in natural and agricultural ecosystems allelopathic interactions are involved in practically every aspect of plant growth, as they can play the role of stimulants and suppressants. Complex plant-plant and plant-microbe interactions in ecosystems and currently developing studies on molecular, cytological and physiological levels bring us to a better understanding of processes occurring around us. The ancient knowledge of well-known toxic properties of water extracts of a variety of allelopathic plants give us a basis that could be used in the creation of a novel approach in weed control. Some allelochemicals, mainly these that are mentioned in the text above, may act as a starting point for production of new bioherbicides with novel target sites, not previously exploited, as the understanding of their mode of action is still growing. Creation of bioherbicides based on allelochemicals generates the opportunity to exploit natural compounds in plant protection and shows the possibility to cope with evolved weed resistance to herbicides. Despite the fact that we have extensive knowledge about thechemical nature of natural compounds, we can synthesize its analogues, and we have basically explored its phytotoxic potential, we still have insufficient data. Until recently, most studies on phytotoxicity have been conducted under laboratory conditions due tothe ability to eliminate other environmental factors such us temperature, soil texture and its chemical and physical properties. Such approach allows the recognition of only direct effects of allelochemical action. There is still a great need to transfer laboratory data into field conditions. Such experiments are not willing to be taken on due to troublesome field experiments dependent on environmental conditions and a few year repetitions. New tools of molecular genetics, proteomics and metabolomics profiling as well as modern and sophisticated methods of chemistry and biochemistry will lead to the creation of substances, maybe based on the structure of particular compounds occurring in nature, which could be used without any risks as selective and eco-friendly herbicides.

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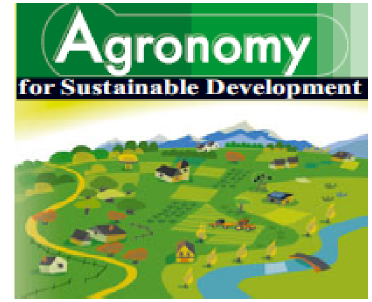

Review article

Allelopathy in Compositae plants. A review

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Abstract – Allelopathy plays an major role in agricultural management such as weed control, crop protection, and crop re-establishment. Compositae plants have potent allelopathic activity, and the activity is confirmed through (a) bioassays with aqueous or various solvent extracts and residues, (b) fractionation, identification, and quantification of causative allelochemicals, and (c) mechanism studies on the allelochemicals. Most assessments of allelopathy involve bioassays of plant or soil extracts, leachates, fractions, and residues based on seed germination and seedling growth in laboratory and greenhouse experiments. Plant growth may be stimulated below the allelopathic threshold, but severe growth reductions may be observed above the threshold concentration depending upon the sensitivity of the receiving species. Generally germination is less sensitive than is seedling growth, especially root growth. Some approaches showed that field soil collected under donor plants significantly reduced or somewhat promoted growth of the test plants. Petri-dish bioassays with methanol extracts or fractions and causative phenolic allelochemicals showed significant phytotoxic activities in concentration-dependent manner. Delayed seed germination and slow root growth due to the extracts could be confounded with osmotic effects on rate of imbibition, delayed initiation of germination, and especially cell elongation; the main factor that affects root growth before and after the tip penetrates the seed coat. Light and electron microscopic approaches extract evaluation at the ultrastructural level have been precisely investigated. Many Compositae plants have allelopathic potentials, and the activities and types and amount of causative compounds differ depending on the plant species. The incorporation of allelopathic substances into agricultural management may reduce the use of pesticides and lessen environmental deterioration.

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ALLELOPATHIC EFFECTS OF VOLATILE MONOTERPENOIDS PRODUCED BY *Salvia leucophylla*: INHIBITION OF CELL PROLIFERATION AND DNA SYNTHESIS IN THE ROOT APICAL MERISTEM OF *Brassica campestris* SEEDLINGS

Abstract:

Salvia leucophylla, a shrub observed in coastal south California, produces several volatile monoterpenoids (camphor, 1,8-cineole, b-pinene, a-pinene, and camphene) that potentially act as allelochemicals. The effects of these were examined using *Brassica campestris* as the test plant. Camphor, 1,8-cineole, and b-pinene inhibited germination of *B. campestris* seeds at high concentrations, whereas a-pinene and camphene did not. Root growth was inhibited by all five monoterpenoids in a dose-dependent manner, but hypocotyl growth was largely unaffected. The monoterpenoids did not alter the sizes of matured cells in either hypocotyls or roots, indicating that cell expansion is relatively insensitive to these compounds. They did not decrease the mitotic index in the shoot apical region, but specifically lowered mitotic index in the root apical meristem. Moreover, morphological and biochemical analyses on the incorporation of 5-bromo-20-deoxyuridine into DNA demonstrated that the monoterpenoids inhibit both cell-nuclear and organelle DNA synthesis in the root apical meristem. These results suggest that the monoterpenoids produced by *S. leucophylla* could interfere with the growth of other plants in its vicinity through inhibition of cell proliferation in the root apical meristem.