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Allelopathic Evidence in Exotic Guava (*Psidium guajava* L.)

Tatiani Elisa Chapla[1] **and João Batista Campos**[2*]
[1]*Universidade Estadual de Maringá; Avenida Colombo, 5790; Zona 7; 87020-900; Maringá - PR - Brasil.* [2]*Instituto Ambiental do Paraná; Av. Bento Munhoz da Rocha Neto, 16; Zona 7; 87020-170; Maringá - PR - Brasil*

ABSTRACT

*The allelopathic activity of the leaf aqueous extract of guava (*Psidium guajava *L.) on seed germination and root growth in lettuce (*Lactuca sativa *L.) was studied in an experiment consisting of four replicates with 10 seeds each and extract concentrations of 5, 10, and 20%. Guava allelopathic activity occurred during the germination and growth of lettuce roots at 20% extract concentration, as shown by ANOVA. This result suggested the allelopathic potential of the species. Therefore, the success of* P. guajava *in invading environments could be partially due to allelopathy. Further studies using other plant parts and field experiments should be conducted.*

Key-words: Abandoned pastures, allelopathy, biological invasion, riparian vegetation, seeds

INTRODUCTION

In several countries, the number and proportion of flora and fauna exotic species are extremely high (Sandlund *et al*., 2001). Plant invasions are a threat to biodiversity and to the stability of native ecosystems, and can also affect ecosystem functioning and processes (Ehrenfeld, 2003; Mack *et al*., 2001).

Commonly known as guava tree, *Psidium guajava* L. is a Myrtaceae originally from Central America from Southern Mexico to Northern South America (Morton, 1987). The species has been registered as invasive in pasture (Somarriba, 1985) and as an important pioneer species in the process of forest recovery on abandoned pasture (Aide *et al*., 2000; Berens, 2008). The success of *P. guajava* in occupying pasture is often attributed to its re-growth ability and to the dispersion of its seeds by birds and cattle (Berens, 2008, Somarriba, 1985). The *P. guajava* has been registered as an invasive species of secondary forests on abandoned pasture in the Upper Paraná River Floodplain (Campos and Dickinson, 2005). Understories dominated by *P. guajava* are poorer in species and specimens than areas dominated by native species (Chapla *et al*., 2008).

Allelopathy, defined as "the release of phytotoxins by the plants" (Bais *et al.*, 2003), has been considered a mechanism for the success of invasive plants (Hierro and Callaway, 2003) due to the phytotoxin effect on the growth and biological processes of other species in the community (Ridenour and Callaway, 2001). Previous studies on guava allelopathic effects on other species were conducted only with guava roots and fruits (Bovey and Diaz-Colon, 1968; Brown *et al.*, 1983). Therefore, guava allelopathic potential can be an additional factor in determining its success as an invasive species.

Based on the need to understand the invasive species and the processes occurring during the invasion (Sandlund *et al.*, 2001), this study was designed to evaluate the allelopathic activity of different concentrations of the leaf aqueous extract of guava (*Psidium guajava* L.) on the germination

* Author for correspondence: redebio@wnet.com.br

and root growth in lettuce (*Lactuca sativa* L.) (a standard for allelopathic tests) (Ferreira and Aquila, 2000).

MATERIALS AND METHODS

Plant material - The green leaves of *P. guajava* were collected at Santa Rosa Island in the Paraná River, municipality of Porto Rico, State of Paraná, on April 3rd 2008 (22º46'23''S and 53º18'15''W). The plants were placed in transparent plastic bags and kept refrigerated. On the following day, the material was taken to the laboratory at Universidade Estadual de Maringá, where the experiment was conducted.

Plant extracts - The leaves were washed in running water. Next, 100 grams of whole leaves were blended with 500 mL distilled water. The leaf extract obtained was filtered through a cotton cloth and concentrated to 20, 10 and 5% extract (Scherer *et al.*, 2005).

Tests - A filter paper sheet placed on a Petri dish received 2 mL extract or distilled water (as control). Four replicates with 10 seeds (commercial seeds) of *L. sativa* were used for each treatment. The dishes were placed in a germination chamber at 25º C and 12-hour photoperiod (Usberti and Felipe, 1980). Germinated seeds were counted after 24, 48, and 72h, and all the rootlets greater than 2mm in length (Hadas, 1976) were measured with a calliper.

Data analysis - The two-way ANOVA was used to measure the extract effect on the germination and root growth (Zar, 1999), where the factors were number of hours and extract concentrations at 5% significance. The means for germinated seeds and for root length were compared by the Tukey test at 5% significance (Zar, 1999). The statistical tests were processed using STATISTICA for Windows (Stasoft, 2005).

RESULTS AND DISCUSSION

The mean for the germinated seeds was 8±1 (germinated seeds per dish ± standard error) for the control and the 5% and 10% concentrations, and 7±1 (germinated seeds per dish ± standard error) for the 20% concentration. ANOVA showed differences in the means (Table 1). According to the Tukey test, the allelopathic effect of the leaf aqueous extract of *P. guajava* on the germination of *L. sativa* occurred only at 20% concentration.

The mean root length of *L. sativa* decreased with the increase in extract concentration (Table 2). According to ANOVA and the Tukey test, root growth in *L. sativa* was also affected by the leaf aqueous extract of *P. guajava* only at 20 % concentration (Table 3).

These results pointed to a potential allelopathic effect of *P. guajava* leaves on the seed germination and root growth of other species. From an ecological viewpoint, the inhibition of plant development after germination is a selection strategy that ignores the descent (Jacobi and Ferreira, 1991). Therefore, if *P. guajava* is a successful exotic invasive species in riparian areas, it can lead to lower diversity, particularly in areas of forest recovery.

Table 1 - ANOVA results for effect of leaf aqueous extract of *P. guajava* at different concentrations (control, 5%, 10%, and 20%) on the germination of *L. sativa*. Effects of interaction among factors.

Factor	F	P
Treatment	3.184	**0.035**
Number of hours	20.640	**0.000**
Treatment X Number of hours	1.774	0.132

Table 2 - Mean root length (mm) of *L. sativa* ± standard error per treatment.

Treatment	24h	48h	72h
Control	$2.56^{\pm 0.3}$	$7.56^{\pm 0.56}$	$14^{\pm 1,12}$
5%	$2.02^{\pm 0.3}$	$7.67^{\pm 0.6}$	$13.88^{\pm 1.64}$
10%	$1.36^{\pm 0.28}$	$5.76^{\pm 0.67}$	$11.21^{\pm 2.51}$
20%	$0.9^{\pm 0.05}$	$4.58^{\pm 0.45}$	$8^{\pm 1}$

Table 3 - ANOVA results for effect of leaf aqueous extract of *P. guajava* at different concentrations (control, 5%, 10%, and 20%) on root growth in *L. sativa*. Effects of interaction among factors.

Factor	F	P
Treatment	13.129	**0.000**
Number of hours	172.010	**0.000**
Treatment X Number of hours	0.634	0.702

Previous studies on the chemical composition of guava leaves have identified chemical products belonging to the groups with allelopathic properties (Monteiro and Vieira, 2002), such as the terpenoids, flavonoids, coumarins, cyanogenic acids, among others (Begum *et al.*, 2002; Gutiérrez *et al.*, 2008). Some of these, such as the terpenoids can be lixiviated from the leaves by rain (Monteiro and Vieira, 2002). Some studies have already identified guava allelopathic effects on other species, the effect of guava fruit extracts on cucumber germination (*Cucumis sativus*) (Bovey and Diaz-Colon, 1968), as well as the effect of guava root exudates on lettuce (*L. sativa*) germination and root growth, and the root growth of bristly foxtail (*Setaria verticillata*) (Brown *et al.*, 1983). The antibacterial activities of guava leaves aqueous extract has also been reported (Sanches *et al.*, 2005), which may imply effects on soil microbiota and cause more widespread effects such as on the functioning of the ecosystem.

Therefore, the significant success of *P. guajava* in invading abandoned pastures could be partially caused by allelopathy, primarily due to its ability to decrease the diversity in the lower forest strata (Chapla *et al.*, 2008). Further study is needed on the allelopathic effect of guava on native species in riparian forests and on other plant parts such as fruit, rhytidome, root, and senescent leaves. Field experiments are also needed (Barbosa *et al.*, 2008) because under natural conditions, the variety of guava interactions with the physical environment and other organisms can either intensify or decrease its allelopathic effects (Inderjit and Callaway, 2003).

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RESUMO

Com a finalidade de avaliar a atividade alelopática do extrato aquoso de folha da goiabeira (*Psidium guajava* L.) sobre a germinação e crescimento de raiz de alface (*Lactuca sativa* L.) foi aplicado um experimento com concentrações de extrato à 5, 10 e 20%, com 4 repetições e 10 sementes cada uma. Por meio de uma ANOVA, foi verificado atividade alelopática da goiabeira sobre a germinação e crescimento da raiz de alface na concentração de 20%, indicando o potencial alelopático da espécie. Desta forma, o sucesso de *Psidium guajava* em invadir ambientes pode ser atribuído, em parte, à alelopatia. Recomendamos mais estudos com outras partes da planta e experimentos em campo.

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