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ALLELOPATHIC POTENTIAL OF *SECONDATIA FLORIBUNDA* A. DC. (APOCYNACEAE) ON SEEDS OF *LYCOPERSICUM ESCULENTUM* MILLER. (SOLANACEAE)

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Abstract

The aqueous extract of fresh leaves of *Secondatia floribunda* A. DC. (catuaba-de-cipo) was tested to evaluate the allelopathic potential in seeds of *Lycopersicum esculentum* Miller (tomato). Four concentrations (25, 50, 75, 100%) were tested with five repetitions each, where they were compared to the control. The extract not inhibited the germination of the tomato seeds. On the other hand, there was a significant allelopathic effect on the germination speed index (GSI) and on the lengths of the aerial and root parts, which were reduced its length with increasing extract concentration, causing abnormal seedlings.

Keywords: Allelopathy, Cerrado, Chapada do Araripe, *Secondatia floribunda*.

POTENCIAL ALELOPÁTICO DE *SECONDATIA FLORIBUNDA* A. DC. (APOCYNACEAE) EM SEMENTES DE *LYCOPERSICUM ESCULENTUM* MILLER. (SOLANACEAE)

Resumo

O extrato aquoso de folhas frescas de *Secondatia floribunda* A. DC. (catuaba-de-cipó) foi testado para avaliar o potencial alelopático em sementes de *Lycopersicum esculentum* Miller (tomate). Quatro concentrações (25, 50, 75, 100%) foram testadas com cinco repetições cada, onde foram comparados com o controle. O extrato não inibiu a germinação das sementes de tomate. Por outro lado, houve um efeito alelopático significativo sobre o índice de velocidade de germinação (IVG) e os comprimentos das partes aéreas e raiz, reduzindo seu comprimento com o aumento das concentrações, causando plântulas anormais.

Palavras-chave: Alelopatia, Cerrado, Chapada do Araripe, *Secondatia floribunda*.

Introduction

The indiscriminate use of agricultural defenses have had repercussions worldwide, through environmental consequences as well as the contamination of foods, where herbicides are one of the means most utilized in combating weeds (CARVALHO et al., 2002).

An alternative that has been extensively studied for the control of these plants is the utilization of plant species that develop defense mechanisms, that is, allelochemicals, which when released into the environment are capable of interfering in some step of the life cycle of another plant, referred to as allelopathy (GOMIDE, 1993).

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The term allelopathy comes from the Greek words *allelon,* which means “from one to another” (mutual), and *pathos,* meaning “to suffer” (harm), referring to influence, be it positive or negative, one individual by another (MOLISCH, 1937; FERREIRA; AQUILA, 2000).

Allelopathy represents any effect, direct or indirect, harmful or beneficial, which a plant, also fungi and microorganisms, exerts on another organism by the production of chemical compounds that are released into the environment. These compounds can be released into the ecosystem in different forms, such as volatilization, root exudation, lixiviation of parts of live and dead plants and decomposition of residues (PUTNAM, 1983; RICE, 1984).

Allelopathic effects are mediated by chemical substances produced by secondary metabolism, called allelochemicals, which are related to the defense mechanism of plants against attacks by microorganisms and insects (MEDEIROS, 1990), where they can be found in various parts of the plants, including leaves, flowers, roots, rhizomes, stems and seeds (PUTNAM; TANG, 1986). Distribution can occur in all the organs of the plant and nonuniformly, because a large portion is concentrated in the epidermis of leaves and in the roots (OLIVEIRA et al., 1968).

According to Rizvi et al. (1992), allelochemicals can other plants affect in various ways, such as in the following: cytological structures and ultrastructure; hormones; membranes and their permeability; absorption of minerals; movement of stomata; synthesis of pigments and photosynthesis; respiration; synthesis of proteins; enzyme activities; water transport relations; and genetic material and changes in DNA and RNA.

Currently, more than 10.000 chemical products with allelopathic activity are known, where they belong to the most diverse groups of substances. Such activity is rarely elicited by a single isolated factor but by a combination of several of these substances, and their synergistic action plus environmental conditions (ALMEIDA, 1988). Among these chemical products are the terpenoids, steroids, alkaloids, tannins, phenols, cumarins, flavanoids, glycosides, cyanogenics, benzoic acid derivates, fatty acids and complex quinones, where the most important are the phenols and terpenoids (PUTNAM; DUKE, 1978; MEDEIROS, 1990; RIZVI et al., 1992; INDERJIT, 1996).

Resistance or tolerance to secondary metabolites that function as allelochemicals is a species-specific characteristic, where some are more sensitive than others, such as *Lactuca sativa* L. (lettuce) and *Lycopersicum esculentum* Miller (tomato). These species show rapid and uniform germination and are very sensitive to allelochemicals and, therefore, indicated as test plants for allelopathic experiments (FERREIRA; AQUILA, 2000).

Secondatia floribunda A. DC. (catuba-de-cipo), belong to the family Apocynaceae, is a scandent species often found in cerrado areas in Chapada do Araripe, in the south of Ceara State, and probably possesses some allelopathic activity, since members of this family generally show such activity (SILVA, G. et al., 2006; HOFFMANN et al., 2007; BARROS, 2008).

Taking into consideration the above presumption, the aim of this study was to determine the allelopathic activity of substances present in the leaves of catuaba-de-cipo, with regard to effects on seed germination and initial seedling development of tomato.

Material and Methods

The bioassays were conducted in the Applied Botany Laboratory (LBA) of the Department of Biological Sciences of Universidade Regional do Cariri – URCA. The identification of the botanical material was carried out by the taxonomist Dr. Ângela Maria Miranda Freitas at the Herbário Sérgio Tavares (HST) of the Universidade Federal Rural do Pernambuco (UFRPE), Recife – PE. The exsiccate is deposited at the Herbário Caririense Dardano de Andrade-Lima (HCDAL) of the Universidade Regional do Cariri – URCA, Crato - CE, registered under archive nº. 5505.

The plant extract was obtained from fresh leaves of catuaba-de-cipo collected from cerrado areas in Chapada do Araripe, situated at 7º17’ S and 39º32’ W, with an altitude of 925 m. Leaves were selected and triturated at 200 $g.L^{-1}$ in an industrial liquifier according to Cruz et al. (2000). The mixture was then filtered through gauze, homogenized with a magnetic stirrer for 24 h and afterward centrifuged at 3000 rpm for 10 min. The crude aqueous extract was considered the concentrate (100%), from which dilutions were made to obtain three other concentrations (75, 50, 25%). The effect of these concentrations was compared to that with distilled water, considered the control (0%).

Seeds for the test plant, *Lycopersicum esculentum* (tomato), were obtained from a farm supply store in the municipality of Crato - CE.

We used a completely randomized experimental design with four treatments (25, 50, 75 and 100%) and a control (distilled water), involving five repetitions of 20 seeds each, totaling 100 seeds per treatment. The seeds were acclimated in sterile Petri dishes, covered with two sheets of germitest paper, moistened with 3 mL of extract at different concentrations or with distilled water (control). The dishes were incubated for seven days in a germination chamber (BOD) at a controlled temperature of 25ºC and 12/12 h light/dark photoperiod.

The germination rate was determined every 24h for seven days, making it possible to evaluate germination speed, according to the method adopted by Maguire (1962), where the seeds were considered germinated if they showed 2 mm of protruding root. The length of the shoots and roots were measured with a millimeter ruler on the seventh day after planting.

The parameters analyzed were: percentage of germination (G); germination speed index (GSI); and growth of shoot and root. The data were submitted to analysis of variance (ANOVA) and the means compared by Tukey's test at the 5% level of significance.

Results and Discussion

In the bioassays carried out, the crude aqueous extract of the fresh leaves of *S. floribunda* did not have an inhibitory effect on the germination of the tomato seeds at any the concentrations tested when compared to control. In the control, 70% of the seeds germinated, while in the treatments analyzed, the germination rate varied between 58 and 63%, showing no significant difference between the extract concentrations (Table 1).

TABLE 1: Mean percentage of germination and Germination Speed Index (GSI) of *Lycopersicon esculentum* Miller., with seeds exposed to different concentrations of crude aqueous extract de *Secondatia floribunda* A. DC.

Concentrations (%)	**Germination (%)^{ns}**	**Germination Speed Index (GSI)****
0	70a	0.248a
25	63a	0.236b
50	63a	0.222c
75	58a	0.216c
100	61a	0.212c
CV%	**17.06**	**2.57**

Means followed by the same letter do not differ according to Tukey's test at the 5% level of significance.
ns: not significant.
** significant at 1% level.
CV%: coefficient of variation as percentage.

The results are in agreement with Silva et al. (2006), who examined the allelopathic potential of 15 native tree species of the cerrado and found that the majority do not have an inhibitory effec on germination of lettuce seeds (*Lactuca sativa* var. *grand rapids*), including the species *Aspidosperma tomentosum* Mart. (peroba-do-campo). According to these authors, there is no evidence in cerrado areas of any phenomenon indicating the occurrence of allelopathy, but this does not mean that species of the cerrado are incapable of exhibiting chemical defenses.

With respect to germination rate for test seeds, extracts delayed germination at all concentrations tested when compared to the control, decreasing speed with increasing concentration (Table 1).

According to Labouriau (1983), Ferreira and Aquila (2000), the allelopathic effect is often not seen on germinability but rather on the speed of germination or other parameters, where germination tests are generally less sensitive to allelochemicals than those that involve the development of the seedling.

For Santana et al. (2006), although the final percentage of germination may not be significantly affected by the action of allelochemicals, the germination pattern can be modified, with differences in speed and timing of seed germination when exposed to plant extracts.

Similar results were obtained by Capobiango et al. (2009), who found that germination speed index (GSI) for tomato was increasingly affected by aqueous extracts of *Joannesia princeps* Vell. (cutia) and *Casearia sylvestris* Sw. (guacatonga) with increasing concentration starting at 30%.

Significant reductions in GSI of seeds of *Lactuca sativa* L. (lettuce) and *Bidens pilosa* L. (pition-preto) were shown by Hoffmann et al. (2007) with aqueous extracts of *Nerium oleander* L. (espirradeira) and *Dieffenbachia picta* Schott (comigo-ninguem-pode), where both plant extracts were found to decrease the GSI when applied at increasing concentrations, due to the reduction in the speed of the deployment and translocation of nutritive components to the root and hypocotyl.

In relation to the mean shoot lengths, it was observed that there was a decrease in stem growth, which was more substantial at concentrations more than 50% (Table 2). In the work of Felix et al. (2007), the allelopathic effect of *Amburana cearensis* (Fr. All.) AC Smith (cumaru) was shown to exert a greater effect on the development of the seedling than on germination itself; even at low concentrations at which the seeds germinated, the seedlings appeared abnormal, where they were unable to develop further.

TABLE 2: Mean seedling shoot length (cm) and seedling root (cm) of *Lycopersicon esculentum* Miller., with seeds exposed to different concentrations of crude aqueous extract of *Secondatia floribunda* A. DC.

Concentrations (%)	**Seedling Shoot Length (cm)****	**Seedling Root Length (cm)****
0	3.36a	10.28a
25	2.54a	5.76b
50	1.36b	2.90c
75	1.54b	2.78c
100	1.46b	2.78c
CV%	**24.41**	**17.82**

Means followed by the same letter do not differ according to Tukey's test at the 5% level of significance.
** significant at 1% level.
CV%: coefficient of variation as percentage.

Anese et al. (2007) pointed out that at all concentrations, extracts of either the stem or the leaves of *Ateleia glazioveana* Baill (timbo) affected shoot length in lettuce seedlings. The higher concentrations (20 and 30%) showed more toxic effects, with smaller size and darkening of the aerial part.

Analyzing mean root length in Table 2, it can be noted that there was decrease in root size with all extract concentrations when compared to control. According to Hoffmann et al. (2007), the elongation of the aerial part, as well as the roots, is dependent on cell division and the formation of the cambium and of the xylem vessels, which are dependent on the partition of nutrients by the seedling. Therefore, the aqueous extracts, by diminishing the root or stem system, can affect these structures, causing abnormalities in the seedlings, consequently leading to death.

Gorla and Perez (1997), in evaluating the action of the aqueous extract of leaves of *Miconia albicans* Triana on seed germination and initial seedling growth of tomato, observed a negative effect on root development starting at a low concentration (25%), where a toxic effect was more evident at higher concentrations.

In this context, studies say that it is difficult to characterize allelopathy and its real impact, unless microorganisms and soil factors are taken into account (WHITE et al., 1989). Therefore, one can not extrapolate the results obtained in the laboratory to the field (CORREA et al., 2000).

Based on the results obtained, we can conclude that the aqueous extract of fresh leaves of *S. floribunda* did not show an allelopathic effect on the germination of *L. esculentum* but did tend to cause a delay in the speed of germination and a decrease in shoot and root lengths. We believe that some allelochemical substance(s) present in the leaves was capable of interfering in some step in the development of the test plant. Therefore, new assays are needed to identify the chemical constituents responsible for the above activity.

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