

## Allelopathic effect of aqueous extract of *Cyperus rotundus* on *Lactuca sativa* and *Solanum lycopersicum*

### Efeito alelopático do extrato aquoso de *Cyperus rotundus* em plantas de *Lactuca sativa* e *Solanum lycopersicum*

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#### Abstract

The demand for vegetables was reinforced by the search for healthier foods, favoring increased sales of fresh products. Lettuce (*Lactuca sativa* L.) and tomato (*Solanum lycopersicum* L.) are the most cultivated vegetables in Brazil, thus being economically important. This study evaluates the allelopathic effect of aqueous extract of nutgrass (*Cyperus rotundus*) on lettuce (*Lactuca sativa*) and tomato (*Solanum lycopersicum*) plants, aiming to analyze its influence on species development. Two trials were conducted in the premises of the Taquaritinguense Institute of Higher Education (ITES) in Taquaritinga city, São Paulo State, under temperatures ranging from 14 °C to 28 °C, in a greenhouse. The variables analyzed were: fresh shoot and root weight (g), using a semianalytical scale; and root length (cm), using a ruler. *Cyperus rotundus* leaf extract at higher concentrations positively affected the early growth of vegetables. Studies on allelopathic effects between plants are extremely important because the use of this extract can contribute to seedling growth. The 200% concentration of *Cyperus rotundus* extract increased root and shoot development in tomato crop.

**Additional keywords:** growth; nutgrass; production; vegetables.

#### Resumo

A demanda por hortaliças foi reforçada pela busca de alimentos mais saudáveis, favorecendo também o crescimento da venda do produto fresco. A alface (*Lactuca sativa* L.) e o tomate (*Solanum lycopersicum* L.) são as hortaliças mais cultivadas no Brasil, que apresentam importância econômica. O objetivo do trabalho foi avaliar o efeito alelopático do extrato aquoso de tiririca (*Cyperus rotundus*) em plantas de alface (*Lactuca sativa*) e tomate (*Solanum lycopersicum*), visando avaliar a influência no desenvolvimento das espécies. Dois ensaios foram conduzidos, ambos nas dependências do Instituto Taquaritinguense de Ensino Superior (ITES) localizado no município de Taquaritinga, estado de São Paulo, sob temperaturas variando de 14 °C a 28 °C, em casa de vegetação. As variáveis analisadas foram: Massa fresca da parte aérea e das raízes das plantas (g), utilizando balança semianalítica e comprimento (cm) da raiz utilizando régua. O extrato da folha de *Cyperus rotundus* nas concentrações mais elevadas provocaram efeitos benéficos no crescimento inicial das hortaliças. Estudos sobre efeito alelopático entre plantas são de extrema importância, uma vez que a utilização desse extrato pode contribuir com o crescimento das mudas. A concentração de 200% do extrato de *Cyperus rotundus*, aumentou o desenvolvimento da raiz e parte aérea na cultura do tomateiro.

**Palavras-chave adicionais:** crescimento; hortaliças; produção; tiririca.

#### Introduction

Lettuce (*Lactuca sativa* L.) and tomato (*Solanum lycopersicum*) are the most cultivated vegetables in Brazil, thus being socioeconomically important. These crops provide employment, income, and currency for the country, playing a significant social role. The demand for these vegetables has been reinforced by the search for healthier foods, favoring

increased sales of fresh products (Carvalho & Pagliuca, 2007; Silva et al., 2017).

One of the stages that most influence vegetable production is seedling formation, directly affecting the performance and yield of the crop to be planted (Costa et al., 2011). In this sense, composting and vermicomposting are organic matter recycling tools that stand out in plant growth. These techniques aim to reduce contaminants found in residues, which are

converted into biofertilizers, enabling nutrient recycling in the soil (Dominguez et al., 2010).

The effect characterized as allelopathy corresponds to the interference of substances produced in the secondary metabolism of plants. When released into the environment, these substances may influence the development of other plant species (Carvalho et al., 2011; Monquero et al., 2009). Weed management is a current necessity because weeds are widely distributed in agricultural systems and there is a yield loss of 9.7% as a result of 1,800 different types of weeds in agricultural crops per year. Management to reduce these weed species can be performed in different ways (Li & Wang, 2010; Shah et al., 2016; Shah et al., 2017).

However, to obtain the allelopathic substances of a given plant material, it is important to observe ideal temperatures and specific solvents, which will allow the most efficient and complete extraction of substances with greater allelopathic effect (Leão et al., 2016).

According to the literature, treatment with high concentrations of aqueous extract of *Cyperus rotundus* leaves decreased the germination percentage of turnip, broccoli, cauliflower, and radish seeds. The authors also observed a reduction in the germination percent-

age of lettuce and tomato seeds, regardless of the extract concentration used, and a reduction in cabbage germination percentage, at 90 and 100% extract concentrations (Andrade et al., 2009).

Several studies demonstrate that *Cyperus rotundus* extract can regulate some substances in plant metabolism, influencing the rooting of some species in a manner similar to auxins (Souza et al., 2012).

This study evaluates the allelopathic effect of aqueous extract of nutgrass (*Cyperus rotundus*) on lettuce (*Lactuca sativa*) and tomato (*Solanum lycopersicum*) plants, aiming to analyze its influence on plant development.

## Materials and methods

Two trials were conducted with lettuce (*Lactuca sativa*) and tomato (*Solanum lycopersicum*) crops in the premises of the Taquaritinguense Institute of Higher Education (ITES) in Taquaritinga city, São Paulo State, under controlled temperatures ranging from 14 °C to 28 °C, in a greenhouse.

Doses were proposed according to Villa et al. (2016), using 1g of *Cyperus rotundus* leaves in 10 mL distilled water (Table 1).

**Table 1-** Treatments evaluated in the experiment.

Treatment	Lettuce	Tomato
T1 – 0%	0 g 10 mL <sup>-1</sup>	0 g 10 mL <sup>-1</sup>
T2 – 50%	0.5 g 10 mL <sup>-1</sup>	0.5 g 10 mL <sup>-1</sup>
T3 – 100%	1 g 10 mL <sup>-1</sup>	1 g 10 mL <sup>-1</sup>
T4 – 150%	1.5 g 10 mL <sup>-1</sup>	1.5 g 10 mL <sup>-1</sup>
T5 – 200%	2 g 10 mL <sup>-1</sup>	2 g 10 mL <sup>-1</sup>

The experimental design was completely randomized (CRD), consisting of five treatments (nutgrass extract concentrations) with five replicates, totaling 25 experimental units. Each experimental unit consisted of a pot containing one plant.

In the preparation of aqueous extract of *Cyperus rotundus* leaves, the material was randomly collected from the plants. *Cyperus rotundus* leaves were previously washed with running water and crushed in a processor, the material was then filtered and applied to lettuce and tomato crops.

Lettuce plants used in the experiment were curly and purple, with a cycle ranging from 35 to 40 days after transplanting. The tomato variety used was Rio Grande, which is a variety for industrial processing. It has undetermined growth and a cycle of 110 to 120 days after transplanting.

Twenty five 5-liter pots with 60% soil and 40% Carolina® commercial substrate were used in the initial growth tests of each species.

Seedlings were transplanted at 25 days after sowing in tomato crop and 20 days after sowing in lettuce crop.

Experiments were carried out for 47 days after seedling transplantation (DAT) in lettuce crop and for 37 days DAT in tomato crop. Extracts were applied weekly via foliar spray.

The variables analyzed were: fresh shoot and root weight (g), using a semianalytical scale; and root length (cm), using a ruler.

The obtained data were submitted to analysis of variance by the F test. Moreover, a polynomial regression study was performed, adopting the significant equation with the highest coefficient of determination. The AgroEstat Statistical Software was used in all analyses (Barbosa & Maldonado Júnior, 2010).

## Results and discussion

The concentrations of aqueous extract of *Cyperus rotundus* showed no significant difference for shoot fresh weight (SFW) of lettuce, with an overall average value of 104 g (Table 2). Substances produced by the secondary metabolism of plant species also have chemical characteristics that contribute to their identification. Solubility, for example, is related to the polarity of chemical bonds, i.e., nonpolar compounds are generally soluble in nonpolar solvents, while high polarity compounds are soluble in polar solvents, which agrees with the principle that 'the like dissolves the like' (Martins et al., 2013). *Pouteria ramiflora* ethanolic extract can reduce primary root and shoot length more significantly than aqueous extract,

suggesting that allelopathic substances are extracted more effectively when using organic solvent (Oliveira et al., 2014).

There was a significant difference regarding the doses of aqueous extract of *Cyperus rotundus* on

lettuce root fresh weight (RFW) and root length (RL) (Table 2). The maximum concentration of the extract (200%) provided higher performance in the analyzed variables for lettuce, with 131.4 g shoot fresh weight, 25.76 g root fresh weight, and 26.4 cm root length.

**Table 2** - Variance analysis for shoot fresh weight (SFW), root fresh weight (RFW), root length (RL) of lettuce as a function of *Cyperus rotundus* aqueous extract concentrations.

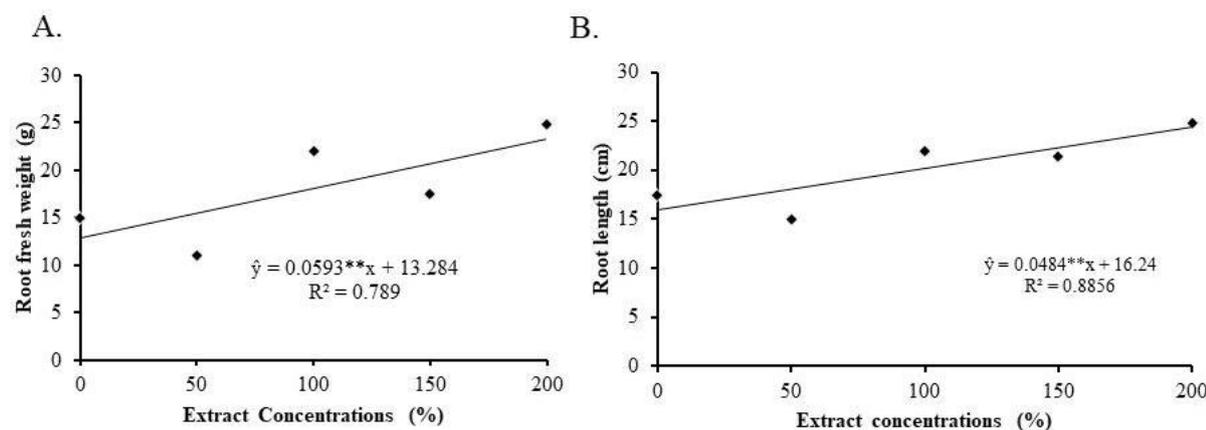
Extract concentration (%)	SFW (g)	RFW (g)	RL (cm)
0	116.44	14.14	17.40
50	104.40	13.62	16.60
100	116.40	22.52	22.20
150	127.40	20.04	22.80
200	131.20	25.76	26.40
F	0.63ns	6.03**	3.95**
CV (%)	24.99	23.70	21.49

ns, \*\*: not significant, and significant to 1% of probability F test, respectively.

There was a significant linear fit, significant to 1% of probability, to the averages as a function of extract doses, with 14.14 and 25.76 g root fresh weight for *Cyperus rotundus* extract concentrations of 0 and 200%, respectively, showing that root weight increases with increasing extract concentrations (Figure 1A). Câmara et al. (2016) report that *Cyperus rotundus*

extract positively influenced survival and sprouting percentages in acerola (*Malpighia glabra* L.) minicuttings.

Root length ranged from 16.40 to 26.40 g at *Cyperus rotundus* extract concentrations of 0 to 200%, respectively, with root growth as a function of increasing extract concentrations (Figure 1B).



**Figure 1** - Root fresh weight (A) and root length (B) of lettuce as function of *Cyperus rotundus* aqueous extract concentrations.

Souza et al. (2012) describe that *Cyperus rotundus* extract regulates some substances in plant metabolism, stimulating the rooting of some species in a similar manner to auxins. Lorenzi (2000) corroborates by stating that *Cyperus rotundus* has a high level of indolbutyric acid (IBA), that is a specific phyto regulator that induces root formation.

For tomato, concentrations of aqueous extract of *Cyperus rotundus* significantly affected shoot fresh weight (SFW), root fresh weight (RFW), and root length (RL) (Table 3). There was a significant linear adjustment in the averages as a function of the extract doses in the analyzed variables, being applied the regression test in RFW and RL, where both presented responses according to the concentrations of the aqueous extract of *Cyperus rotundus*. Which explains

the results found in the present study, taking into account the levels of indolbutyric acid that the extract presents, guaranteeing the reuse of materials produced by nature itself, aiming at the quality of life and plant growth (Cardoso et al., 2007).

Tomato shoot fresh weight ranged from 5.60 to 57.58 g at concentrations from 0 to 200%, respectively. *Cyperus rotundus* extract concentrations of 50 to 150% led to a lower shoot fresh weight compared to the control treatment. This caused epinasty during crop development, in which leaves show curvatures. The highest dose did not cause such a pronounced effect, and led to the highest values of SFW, thus showing a positive response of extract application. Villa et al. (2016) report that *Cyperus rotundus* extract concentrations of 0, 20%, 40%, 60%, 80%, and 100% did not

influence the germination of yellow passion fruit (*Passiflora edulis* F.) seeds. In contrast, high concentrations of *Cyperus rotundus* extract impaired the ger-

mination potential of turnip, broccoli, cauliflower and radish (Andrade et al., 2009).

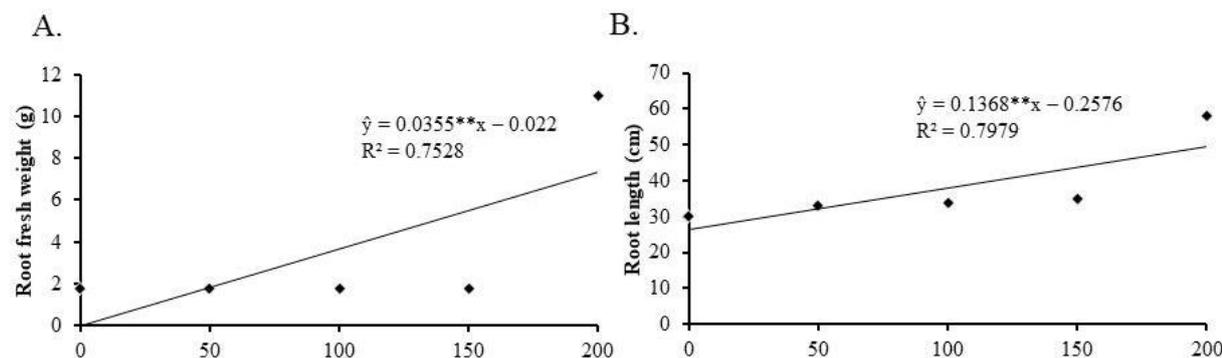
**Table 3** - Variance analysis for shoot fresh weight (SFW), root fresh weight (RFW), lettuce root length (RL) of tomato as a function of *Cyperus rotundus* aqueous extract concentrations.

Extract concentration (%)	SFW (g)	RFW (g)	RL (cm)
0	7.21	1.98	29.40
50	6.69	1.73	32.40
100	6.75	1.93	35.80
150	5.60	2.21	39.60
200	57.58	10.32	60.00
F	85.35**	15.74**	4.68**
CV (%)	32.94	37.95	31.72

\*\* Significant to 1% of probability by F test, respectively.

Tomato fresh weight (Figure 2A) and root length (Figure 2B) ranged from 1.98 to 10.32 g and 29.40 to 60.00 cm, respectively, at *Cyperus rotundus* extract concentrations of 0 to 200%. Thus, higher concentrations of the extract favored tomato root growth, consequently providing the ability to absorb and retain water, nitrogen, and other nutrients during initial growth. Silva et al. (2016) found a statistically signifi-

cant difference for *Cyperus rotundus* extract concentration of 50% compared to the concentrations of 25%, 100%, and the control treatment (0%). The authors assumed that the 50% concentration of the extract increased auxin content in the cuttings, favoring blackberry root growth.



**Figure 2** - Root fresh weight (A) and root length (B) of lettuce as function of *Cyperus rotundus* aqueous extract concentrations.

### Conclusions

- 1 - Higher concentrations of *Cyperus rotundus* leaf extract significantly affected the initial growth of lettuce plants;
- 2 - Studies on allelopathic effects between plants are extremely important because the use of this extract can contribute to seedling growth;
- 3 - The *Cyperus rotundus* extract concentration of 200% increased root and shoot growth in tomato crop;
- 4 - The application of increasing doses of *Cyperus rotundus* leaf extract on lettuce and tomato affected the growth and development parameters of these crops.

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