ALLELOPATHIC EFFECT OF *Senna obtusifolia* ON SEED GERMINATION OF VEGETABLES *Lactuca sativa* AND *Beta vulgaris*

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ABSTRACT

Allelopathy refers to the effects that one organism can cause on another directly or indirectly, and can favor or suppress everything from seed germination to seedling development. The allelopathic action is specific, that is, each plant, both living and decomposing, exerts inhibition only on certain species. These compounds, produced in various parts of plants, such as leaves and roots, can be released by exudation, volatilization, leaching or decomposition of waste. Its effects are varied, including inhibition of germination, impaired growth, and, in extreme cases, death of recipient plants. Although allelopathy can have positive or negative effects, its impact is specific depending on the plants involved.

In horticulture, recent studies demonstrate the potential allelopathic effects on crops such as lettuce and sugar beets. For example, extracts of Nicotiana tabacum and Eucalyptus grandis have shown inhibitory effects on the germination of lettuce and broccoli seeds. Species such as Senna obtusifolia, a weed common in several agricultural areas, stand out for their potential to inhibit crop development due to the release of allelochemicals. Studies such as the impact of Senna obtusifolia on vegetables are essential to better understand these mechanisms and develop more sustainable agricultural practices, promoting greater productivity and cost reduction in agroecosystems.

Keywords: Senna obtusifolia, Allelopathy, Lettuce, Beetroot.

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INTRODUCTION

Allelopathy refers to the effects that one organism can cause on another directly or indirectly, as a result of chemical substances that are released into the environment (MOLISH, 1937; PEIXOTO, 1999). These allelopathic substances, known as allelochemicals, are implicated in a wide variety of effects on plants. These effects include delay or complete inhibition of seed germination, paralyzed growth, injury to the root system, chlorosis, wilting and even death of plants (CORREIA, 2002).

The allelopathic action is specific, that is, each plant, both living and decomposing, exerts inhibition only on certain species of weeds or cultivated plants (LORENZI, 1984). In allelopathy, the plants that produce the allelochemicals and that cause the allelopathic effect, whether positive or negative, are called donors, while the plants to which the allelochemicals are directed and that, therefore, suffer the allelopathic effects are called receptors.

In horticulture, the effect of allelopathy has gained notoriety in recent years. Goetze and Thomé (2004) studying allelopathy of extracts of *Nicotiana tabacum* and *Eucalyptus grandis* proved that extracts made from fresh and dried leaves of these species showed a strong inhibitory effect on the germination of lettuce, broccoli and cabbage seeds.

Senna obtusifolia is a weed popularly known as mata-pasto, this species has assumed great relevance as a weed, as it is present from intensive cultivation soils, to pastures, orchards and vegetable gardens (SILVA & SANTOS, 2010) and because they compete for water, light and nutrients, affecting the growth, development and productivity of crops.

The identification of allelopathic species and the knowledge of the mechanisms by which they exert their effects on the environment can offer new and important alternatives from the economic and productive point of view, as they will enable the reduction of the consumption of agricultural inputs, such as herbicides, in addition to being able to increase crop productivity due to less competition with weed species. as well as optimize its management.

Considering the incipience of studies on this theme, this work aims to evaluate the allelopathic activity of *Senna obtusifolia* on the germination of lettuce (*Lactuca sativa*) and beet (*Beta vulgaris*) seeds.

ALELOPATHY

The etymology of the word allelopathy arises from two Greek words allelon, which has the meaning of "from one to the other" and pathós which means "to suffer"

(FERREIRA; AQUILA, 2000). In the agricultural sciences, the best definition of the term allelopathy was given by Molisch (1937), he defined it as the influence of one individual on another, either harming or favoring. The same author suggests that the effect is carried out by biomolecules (called allelochemicals).

The location of allelochemicals covers different parts of the plant, such as leaves, branches, roots, and their release is done by leaching, volatilization, root exudation, decomposition of residues, among others (FERGUSON; RATHINASABAPATHI; CHASE, 2013). For Rodrigues et al., (1993) the main ways in which allelopathic substances are released into the environment is through the decomposition of waste, volatilization, leaching and exudation produced by a plant and released into the environment. For Rizvi et al., (1992) this influence can be either in the aqueous phase of the soil or in the substrate, or by gaseous substances volatilized in the air that surrounds terrestrial plants.

Other authors also gave their concepts to allelopathy, for Rice (1984) the term refers to "any direct or indirect harmful or beneficial effect that one plant (including microorganisms) exerts on another by the production of chemical compounds released into the environment". In fact, this is a good definition. For Soares and Vieira (2000), allelopathy is a process by which products of the secondary metabolism of a given plant are released, preventing the germination and development of other relatively close plants. So we can conceptualize in a general way that allelopathy is the mechanism in which plant species interfere or influence the development of others, whether this influence is positive or negative.

Allelochemicals are a subset of secondary metabolites, not necessary for the growth and development of the producing organism. These play an important role in shaping interactions between communities, such as in agroecosystems, where they have a determinative effect on crop growth and next season's crops. In addition to these effects, allelochemicals can also contribute to disease and pest resistance and subsequently confer competitive advantage (LI et al., 2010).

For Waller (1999) it is in the secondary metabolism that most of the allelochemicals are produced, as they represent some protection for plants against microorganisms or even some benefit in their development. Allelochemicals can undergo modifications depending on the cover to be incorporated or maintained on the soil surface (FERREIRA; AQUILA, 2000). In other words, as for the allelopathic effect on a crop, we must think that the plant remains, whether mulch or straw from a predecessor crop, because of the chemicals they expelled into the environment can influence a successor crop, and can influence in a way that favors growth, or prevents it. This mechanism can be seen in horticulture, grain cultivation or forest species.

In several branches of agricultural sciences, the effects of allelopathy in horticulture, fruit and vegetable cultivation have been studied. In horticulture, for example, Goetze & Thomé (2004), studying the allelopathic effect of extracts of *Nicotiana tabacum* and *Eucalyptus grandis*, proved that extracts made from fresh and dried leaves of these species showed a strong inhibitory effect on the germination of lettuce, broccoli and cabbage seeds. Bendin et al., (2006), studying the allelopathic effect of *Eucalyptus citriodora* extract on tomato seed germination, observed that the extracts did not present inhibitory effects on germination at the concentrations tested, but realized that the extracts with 3% concentration presented negative effects on germination speed.

Lucchesi and Oliveira (1988), still in the 80's, studying the possible allelopathic properties of cabbage (*Brassica oleracea* L.) demonstrated the inhibitory effect on the germination of tomato seeds, in the highest concentrations of the extract obtained from cabbage leaves. In fruit growing, studies on allelopathy have also stood out in the Brazilian scenario, especially in the control of weeds, such as Neto Filho & Carvalho (2011) who, verifying allelopathy as an alternative for weed control in citrus, detected that among the covers evaluated, *Brachiaria decumbens* and *Canavalia ensiformis* were the most efficient with weed control rates higher than 75%.

Evaluating different vegetation covers in the development of peach, Rufato et al., (2007) found that the covers, with the exception of forage turnip, increased the development of peach plants. In olericulture, Mauli et al., (2009), studying the allelopathic effect of leucaena on soybean and invasive plants, identified the negative interference of the extracts in the root length of viola chord, in the percentage of germination and in the root length of guanxuma and picão-preto. But they did not find negative interferences in the parameters analyzed for soybean seeds.

DONOR PLANTS AND RECIPIENTS

In allelopathy, the plants that produce the allelochemicals and that cause the allelopathic effect, whether positive or negative, are called donors, while the plants to which the allelochemicals are directed and that, therefore, suffer the effects of allelopathy are called receptors. There are some studies in Brazil pointing out which plants have the greatest allelopathic potential in agricultural systems.

In their study, Cremonez et al., (2013) consider that the species with the greatest allelopathic potential in Brazil are nutsedge (*Cyperus rotundus*), lemongrass (*Cymbopogon *citratus*), eucalyptus (*Eucalyptus* sp.), *Coleus barbatus*, *Jatropha curcas*, *Bidens pilosa*, castor bean (*Ricinus communis*), Pinus (*Pinus Taeda* and *Pinus elliottii*), Papaya (*Carica papaya*) and Safflower (*Carthamus tinctorius*). Donor plants are not necessarily competitors, as they involve the reduction or removal of some environmental factor necessary for another plant in the same ecosystem, such as water, light and nutrients (REZENDE et al., 2003).

Many researches have been developed to verify the vulnerability of weeds under the allelopathic effect of some species. Among them, vegetables are generally fundamental for the maintenance of family farming, providing a balanced diet for the family and a regular source of income (MAYER, 2009). In Brazil, according to the first Agricultural Census of family farming (IBGE, 2006), there are 23,089 agricultural establishments that produce carrots and 21,937 agricultural establishments that produce beets.

CULTURE FROM ALFACE

Lettuce (*Lactuca sativa* L.) is a leafy vegetable that is most consumed in Brazil (TRANI et al., 2005). Its center of origin is the Asian region. In mid-4,500 BC it was already known in ancient Egypt and arrived in Brazil in the sixteenth century, through the Portuguese. It has a fleshy stem in which the leaves attach themselves in the shape of a rosette. They can be smooth or curly, presenting a wide variety of leaves, colors, sizes and textures, according to the cultivar (FILGUEIRA, 2008).

It is an annual plant, originally from a temperate climate, belonging to the Asteracea family. Practically all lettuce cultivars develop well in mild climates, especially in the vegetative growth period. The occurrence of higher temperatures accelerates the crop cycle and, depending on the genotype, can result in smaller plants because tasseling occurs earlier (HENZ & SUINAGA, 2009).

The cultivation of this vegetable is of great importance in the economic and social spheres, given that they have high productivity and the high added value allows the generation of income in small areas, contributing to the social inclusion of needy families (FILGUEIRA, 2008). According to Resende et al., (2007) in Brazil, lettuce is grown from north to south because it is the main salad consumed by the population in Brazil, both for its flavor and nutritional quality and for the reduced price for the consumer.

Lettuce cultivation is carried out intensively and is generally practiced by family farmers, usually generating five direct jobs for each hectare cultivated (COSTA & SALA, 2005). Although lettuce is cultivated throughout Brazil, in the northeast region, production is low, compared to other regions with a mild climate, not meeting domestic demand, given the growing consumption of the vegetable and its low production (QUEIROGA et al. 2001).

The main factors that contribute to the low production in the Northeast, when compared to the rest of the country, is the lack of research on cultivars adapted to the region, the lack of technical information on the development of the vegetable, to favor management under these conditions (GRANGEIRO et al., 2006).

Bom Jesus in Piauí is a hub city in grain production and has stood out on the national scene in soybean agribusiness, but when it comes to olericulture and horticulture, the city does not show the same results. Only a small part of vegetables is sold by merchants who produce or buy from productions in the vicinity of the municipality of Bom Jesus itself, in small areas of cultivation or even in backyards, that is, from family farming units.

This situation contrasts with the extensive areas of land with good soils for horticultural cultivation, in addition to the rich concentration of groundwater in the southern region of the state of Piauí, where the municipality of Bom Jesus is located.

CULTURE OF BETERRABA

The beet crop (*Beta vulgaris* L.) is a tuberous, annual and herbaceous vegetable, originally from North Africa and southern Europe, belonging to the Amaranthaceae family (formerly Chenopodiaceae), as well as chard and true spinach (EMBRAPA, 2016). There are three types of beets: the sugar beetroot used for the production of sugar, the forage used for animal feed and the one whose roots are consumed as a vegetable, being the best known in Brazil, this one stands out for having a high iron content, both in the roots and in the leaves (SOUZA; LORENZI, 2008).

It is a vegetable with a sweet taste and a strong red color (VASCONCELOS, 2009). Such coloration is due to a pigment, also occurring in the leaves, veins and petioles. The tuberous part has a globular shape, developing almost at the surface of the soil. The so-called "seeds" are actually clusters of tiny cork fruits, the aglomeruli. Each fruit has an ovule, which originates a botanical seed. The root system is of the pivoting type, and the main root reaches a depth of 60 cm, with few lateral branches. Beets are not tuberous roots like carrots, which makes transplanting seedlings to the bed optional (FILGUEIRA, 2007).

The plant is typically biennial, requiring a period of intense cold to pass the reproductive stage of the biological cycle, when the emission of the floral tassel occurs, with seed production. In the vegetative stage, there is the development of elongated leaves around a tiny stem and the tuberous part is usable. Heat is a limiting factor for most cultivars (FILGUEIRA, 2007). According to Tivelli et al. (2011), as there are no well-adapted national varieties of beets, when grown under high temperature and rainfall, poor internal coloration may occur, with the formation of lighter colored rings, reducing the concentration of pigments in the roots, favoring the occurrence of the 'leaf spot' disease (*Cercospora beticola*), which can cause a reduction in the production of this vegetable.

There are few cultivars planted in Brazil, and the seeds are imported from the United States or Europe. The traditional Early Wonder cultivar, of which there are some differentiated selections marketed by seed producing companies, has become a quality standard. It is precocious, with globular roots and purplish color, internally and externally. The leaves are erect, elongated, of uniform size and dark green in color, which lend themselves to the preparation of bunches in some selections. These leaves are also edible, being richer in nutrients than the beet itself. It is an appropriate cultivar for the autumn-winter crop, not adapting well to the spring-summer crop (FILGUEIRA, 2007).

In Brazil, the largest producers of the vegetable are found in the states of São Paulo, Minas Gerais and Rio Grande do Sul. In the Northeast, its cultivation is lower, since high temperatures tend to decrease pigmentation and subsequently its quality (GRANGEIRO et al, 2007).

WEEDS AS A MECHANISM OF ALLELOPATHIC PLANTS

The term weed does not refer to any known biological function. Plants that currently cause damage to human activities, human health and the environment, when occurring outside their geographical distribution area or in population sizes above the carrying capacity of the environment, have several designations compatible with their biological function, such as: parasitic plant, invasive exotic plant, pioneer plant, climbing plant, among others (PITELI, 2015).

All these plants have a common character: their undesirability in the place, time and form in which they occur (PITELLI, 2015). They are considered undesirable due to the problems they cause to agricultural production, production costs, the maintenance of the integrity of environmental reserves, the increased risks of accidents on highways, railways and waterways, the integrity of aquatic environments and the generation of electricity, among other important interferences.

These species are characterized by having rapid development, being able to reach their maturity in a short time. Seed production is high, however, this is not the only means of reproduction of these invasive plants; some species also have reproductive capacity through bulbs, tubers, rhizomes and rooting (KARAM, 2008) which makes it difficult to control them.

Weeds need the same factors required by the crop for their development, that is, water, light, nutrient and space, establishing a competitive process when crop and weeds develop in the same place (VASCONCELLOS, 2012). It is of great importance in agricultural production due to its direct effects on crops, such as the high degree of interference (joint action of competition and allelopathy) and indirect effects such as increased production costs, difficulty in harvesting, depreciation of product quality, in addition to hosting pests and disease agents.

Currently, this mechanism of allelopathic plants has been used to replace the use of insecticides, nematicides and especially herbicides. Many research studies have been developed in Brazil and around the world to verify the effect of allelochemicals of some plants on others.

In a study carried out in Rio Grande do Sul, Ferreira & Áquilla (2000) noted that there are some species that form almost pure groups, keeping the other species apart. The same authors suggest tips for developing work in this segment, such as: collecting soil, litter, plant debris, proceeding to more controlled experiments, in beds and/or greenhouse.

In the literature, there are reports of the allelopathic effect of weeds in cultivated species such as: Allelopathic effect of *Senna obtusifolia* and *Commelina benghalensis* on the twinning and morphological characteristics of root and stem of tomato seedlings (Alencar et al., 2022), the allelopathic effect of Tirirca (*Cyperus haspan*) (DEOMEDESSE et al., 2019) and Assa-peixe (*Vernonia polysphaera*) in lettuce (NISHIMUTA et al., 2019), Assapê grass on corn (SANTOS et al., 2019). Allelopathic effect of aqueous extracts of *Solanum paniculatum* on the germination and initial growth of lettuce (ROCHA et al., 2018).

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