# GREEN COMPOST'S ALLELOPATHY ON THE INITIAL DEVELOPMENT OF LETTUCE (*Lactuca sativa* L.)

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*SUMMARY: The objective of this study was to evaluate the allelopathic effects of metabolites of green compost on the germination of lettuce seeds. Using parts of 5g of crushed green compost plants in 100 mL of distilled water, aqueous extracts were obtained. Bioassays were conducted in a germination chamber, using the following treatments in relation to percentage of the aqueous extract: T1 (control: distilled water), T2 oats 10%, T3 oats 20%, T4 turnip root 10%, T5 turnip root 20%, T6 turnip root 30%, T7 flower lupine 3.5%; T8 flower lupine 7.0%, T9 flower lupine 10.5%. Lettuce seeds were placed in Petri dishes containing germitest paper moistened with 5 mL of each treatment. The variables analyzed were: the germination percentage, the percentage of normal seedlings, shoot and radicle lengths. When submitted to higher concentrations of aqueous extract there was a greater commitment in the initial development of lettuce, limiting the development of root and shoot. Among the extracts of green compost used, oats was the one that showed the highest allelopathic effect in the smallest percentage used. The turnip root extract did not limit the germination, but affected the seedling development, while lupine flower extract influenced negatively the germination and seedling development.*

*KEYWORDS: germination, dormancy, horticulture.*

# ALELOPATIA DE ADUBOS VERDES NO DESENVOLVIMENTO INCIAL DE ALFACE (*Lactuca sativa* L.)

*RESUMO: O objetivo deste estudo foi avaliar os efeitos alelopáticos de metabólicos de adubo verde sobre a germinação de sementes de alface. Utilizando 5g de plantas esmagadas das plantas de adubos verdes em 100 mL de água destilada, os extratos aquosos foram obtidos. Os bioensaios foram realizados numa câmara de germinação, utilizando os seguintes tratamentos em relação à percentagem do extrato aquoso: T1 (controle: água destilada), T2 - 10% de aveia, T3- 20% de aveia, T4 – 10 % da raiz de nabo, T5 – 20 da raiz de nabo, T6 - 30% da raiz de nabo, T7 – 3,5% da flor de tremoço; T8 - 7,0% da flor do tremoço, T9 – 10,5% da flor de tremoço. As sementes de alface foram colocadas em placas de Petri contendo papel germitest umedecido com 5 mL de cada tratamento. As variáveis analisadas foram: porcentagem de germinação, porcentagem de plântulas normais, comprimento de parte aérea e radícula. Quando submetido a altas concentrações de extrato aquoso, houve um maior comprometimento no desenvolvimento inicial de alface, limitando o desenvolvimento de raízes e parte aérea. Entre os extratos de adubo verde utilizados, a aveia foi a que apresentou o maior efeito alelopático na menor porcentagem utilizada. O extrato de raiz de nabo não limitou a germinação, mas afetou o desenvolvimento das plântulas, enquanto o extrato da flor de tremoço influenciou negativamente a germinação e o desenvolvimento das plântulas.*

*PALAVRAS CHAVE: germinação, dormência, horticultura.*

## INTRODUCTION

The development, health and crop yields can be favored or prejudiced by microorganisms or substances present or introduced into the soil or rhizosphere (Cattelan & Santos, 2011).

Some plants release secondary products of their metabolism that can prevent or encourage the germination and / or development of other plants relatively close, featuring an allelopathic process. Studies conducted in the area of allelopathy may offer opportunities to solve practical problems of agriculture and to contribute to the knowledge of chemistry and biology of interspecific relationships of plants, bringing alternatives to synthetic pesticides (Peres et al., 2004) and aiming at more sustainable management and ecological agricultural production (Maraschin-Silva & Aquila, 2006). These substances belong to different classes of compounds such as phenols, terpenes, alkaloids, polyacetylenes, fatty acids and peptides (Periotto et al., 2004).

Green manure is also a corrective method as regards the supply of nutrients and in turn the practice of green manuring aims to sustainability, because through crop rotation to improve soil fertility and nitrogen fixation for legumes and coverage available formation of organic matter in soil, and characterization in the contribution of nutrients resulting from the practice of green manuring, the views of economic and environmental (Almeida et.al, 2007). Besides the use of total aerial parts and roots (Ducca & Zonetti, 2008), some studies demonstrated allelopathic effects of different organs of shoots tested separately as stems, leaves, flowers and fruits (Gatti et al., 2004).

In direct seeding residues forming the cover are important allelopathic to weeds (Nobrega & Tokura, 2006). The allelopathic potential of cover crops depends on the amount of plant residue and weeds present in the soil seed bank (Moraes et al., 2010).

Recent advances in chemistry of natural products, through modern methods of extraction, isolation, purification and identification, have contributed greatly to a better understanding of these secondary compounds, which can be grouped in different ways (Alves et al., 2004). Manipulation of factors related to the allelopathic action can be exploited for the improvement and increased production, environmental control of weeds, pests and diseases and for the synthesis of natural pesticides (Sartor et al., 2009).

The use of green composts in order to provide mulch on the soil tillage may damage the establishment of cultures sensitive to it (Faria et al., 2009). The deleterious effects may be related to allelopathic phenomena from the release of organic substances, called

allelochemicals, during decomposition process of residues (Correia & Durigan, 2006). It has been reported allelopathic effects of some of the green compost used as mulch, such millet on soybeans (Correia & Durigan, 2006).

Based on resistance or tolerance of certain species to the secondary metabolites with allelochemical function, some species were standardized as indicator plants or plant-test, as is the case of lettuce (*Lactuca sativa L.*). To be indicated as test plant, the species should present rapid and uniform germination, and a degree of sensitivity that allows expressing the results in low concentrations of allelopathic substances (Silva et al., 2009).

Fontanetti & Carvalho (2002) evaluated the allelopathic potential of bean-to-pig (*Canavalia ensiformes*) and velvet bean (*Stilozobium aterrimum*), found that these green manures showed significant allelopathic effects on germination of lettuce seeds.

The cover crops used as green manures generally form a physical barrier to invasive plants competing for light, water and nutrients and, when properly managed, can reduce the number of manual weeding and avoid the use of herbicides, adapting to the organic production standards.

Favero et al. (2001) studied jack bean-pork, bean-wild-do-Ceará (*Canavalia brasiliensis* Mart ex Benth), velvet bean, lab-lab (*Dolichos lablab* L.) and pigeon pea (*Cajanus cajan* (L.) Millsp) in weed control, found that velvet bean stressed from the others in their ability to cover the soil and smother weeds. The same authors also found that there was a change in the dynamics of succession of species in plots planted with these pulses, indicating a possible selection weeds imposed by climatic changes promoted by them.

Among these changes, we can mention the reduction of the amplitudes of the variation in thermal and hydric topsoil. This reduction has a significant impact on seed germination of weeds, especially the so-called ruderal, which occur in crops in (Pitelli & Durigan, 2003).

Besides the physical effects, some plants used as green manures have allelopathic effects that contribute to the management of invasive plants. Allelopathy is the production of certain compounds bodies which, when released into the environment, inhibiting or stimulating an impact on other organisms. Velvet bean, for example, exerts a strong and persistent inhibitory action on purple nutsedge (*Cyperus rotundus*) and beggarticks (*Bi-dens pilosa* L.), Carvalho et al. (2002).

However, some studies have shown that they see the use of green manure may hinder some agricultural practices, especially when these are intercropped with the main crop.

The objective of this study was to evaluate the allelopathic effects of metabolites of green composts on the germination of lettuce seeds.

## MATERIAL AND METHODS

The experiment was conducted at the Laboratory of seeds, and green composts, multiplied on the Farm of the Assis Gurgacz College- FAG, Cascavel - PR. To obtain the aqueous extract of oat (*Avena strigosa*) cultivar IAPAR 61 leaves were used; radish (*Raphanus sativus L.*) cultivar IPR 116 roots were used; and white lupine (*Lupinus albus L.*) cultivar IPR Forest, flowers were used. The plant parts were separated, weighed 5 g and added to 100mL of distilled water, where they were crushed in a blender for five minutes, with subsequent repose for 10 minutes more, and then filtered using filter paper placed in pyrex funnel.

Bioassays were conducted in a germination chamber BOD, temperature 25 ° C ± 2 ° C and a photoperiod of 12 hours of light. The following treatments were used in relation to the percentage of the aqueous extract: T1 (control: distilled water); T2 oats 10%; T3 oats 20%; T4 turnip root 10%; T5 turnip root 20%; T6 turnip root 30%; T7 flower lupine 3.5%; T8 flower lupine 7.0%; T9 flower lupine 10.5%. The experimental design adopted was completely randomized, with three repetitions and 25 seeds of lettuce per Petri dish containing germitest paper moistened with 5 mL from each treatment, and maintained for eight days. When necessary, the aqueous extracts were added to plates, to maintain the moisture degree of the paper.

After this period, biometric evaluations were performed by measuring the length (mm) of the rootlets and shoots, it means, the distance from the stem of each plant to the meristematic apex of the root and seedling (Gatti et al., 2004), with the help of a millimeter ruler. It was considered germinated that seed with approximately 0.1 mm of radicle protrusion, and the seedlings were considered normal or abnormal, according to the Rules for Seed Analysis (Brasil, 2009), considering sprouting the seeds that gave rise to normal seedlings, with all essential structures being perfect, thereby demonstrating its ability to produce normal plants under favorable conditions of field. After the evaluations, the data were submitted to analysis of variance and means were compared by Tukey test at 5% probability.

## RESULTS AND DISCUSSION

The percentages of germination, 99% and 100%, given by the control and by the concentrations of 10% and 20% of the leaf extract of oats, shows the influence of inhibition of germination (Table 1). Alves et al. (2004) studied the allelopathic effects of volatile extracts

of essential oils on the germination and root length of lettuce seedlings, and found that treatments in 0.001% and 0.01% of rosemary peppermint oil, the germination of lettuce seeds was 95% and under the concentrations of 0.1% and 1.0% germination was 0%, demonstrating an important decrease in the percentage of germination from 0.01%. Therefore, it can be inferred that low concentrations of allelopathic compounds may inhibit the germination of lettuce.

France et al. (2008) found that aqueous extracts, and exanólicos methanolic neem (Azadirachta indica A. Juss.) Reduce the percentage of germination of lettuce seedlings.
Also, Gatti et al. (2004) working with aqueous extracts of leaves of *Aristolochia esperanzae* Kuntze found that this species reduced the percentage of germination of lettuce and radish at all concentrations of the extracts used, ie 50 and 100%, when compared to control. However Ferreira et al. (2007) observed that extracts of *Pinus elliottii* showed no allelopathic effect on lettuce, but the ethanol extract of *Eucalyptus citriodora* significantly reduced the germination rate.

The same author adds that changes in the pattern of germination, may result from effects on membrane permeability, respiration, the conformation of enzymes and receptors, among others, or even the combination of these factors. According to Ferreira and Borghetti (2004), often the allelopathic effect may not be given on the germinability (final germination percentage), but on the germination rate or on other parameters of the process.
Mazzafera (2003) also noted that the aqueous extract of Syzygium aromaticum (L.) Merr. clove and India had strong inhibition on seed germination and germination rate of various seeds, including lettuce, also demonstrating the allelopathic potential of the species.

**Tabela 1**. Initial development of lettuce (*Lactuva sativa L.*) type flat on two concentrations of leaf extract of oat (*Avena strigosa*) cultivar IAPAR 61. Cascavel-PR, 2010.

| Treatments | Length (cm) | | Germination (%) |
|---|---|---|---|
| | Rootlets | Shoots | |
| Control | 5,0 a | 3,0 a | 99 a |
| 10% | 0,0 b | 0,0 b | 0 a |
| 20% | 0,0 b | 0,0 b | 0 a |
| CV % = 3,1 | | | |

1 letters followed by the same letter in the column do not differ by Tukey test at 5%.

The root extract of radish showed no significant difference between the control and the concentration groups (Table 2). The allelopathic effect often is not perceived on the germination percentage, which indicates the final percentage of germination in time, but may

differ on other parameters of the process (Ferreira, 2007), which can be seen in the development is the commitment of the root system. In this case, the radish extract directly affected the development of the rootlet, and the inhibitory effect occurred in the same proportion of increasing in concentration, with differences between dosages.

According Ferreira & Borguetti (2004), some allelopathic substances can induce the appearance of abnormal seedlings, thus affecting the radicle, and necrosis of the most common symptoms.

However, the shoot did not follow the same range of decrease in rootlet, and the commitment was on only 30% of extract, while lower doses were considered statistically similar and the percentage of germination was not affected by dosages.

Tokura & Nóbrega (2005) found that aqueous extracts of plants of wheat, oats, millet, radish and rape showed allelopathic effect on maize seedlings affecting rootlet growth, shoot and seedling dry weight.

**Table 2**. Initial development of lettuce (*Lactuca sativa L.)* type flat three concentrations of root extract of radish (*Raphanus sativus L.*) cultivar IPR 116. Cascavel-PR, 2010.

| Treatments | Length(cm) | | Germination(%) |
|---|---|---|---|
| | Rootlets | Shoots | |
| Control | 5,0a | 3,0a | 99a |
| 10% | 1,8b | 3,8a | 99a |
| 20% | 0,8c | 3,5a | 99a |
| 30% | 0,2c | 1,1b | 99a |
| CV% = 2,6 | | | |

1 letters followed by the same letter in column do not differ by Tukey test at 5%.

There was an inhibitory effect on germination of lettuce seeds caused by white lupine flower extract, and this inhibition was proportional to the increasing concentration presenting significant differences of the concentrations 7.0 and 10.5 compared to control (Table 3).

Similar to the effects caused by turnip root extract, the extract of the flower lupine influenced negatively the development of the rootlet, it means, as there was the increase in concentration was the response with the shortest length of rootlet, with a significant difference between all concentrations in relation to control. In the shoot, even with shorter length, the only concentration that significantly differed compared to control was the 10.5%.

Rabêlo et al. (2008) found similar results to those observed in the experiment, using aqueous extract of leaves of *B. pilosa*, checking reduced growth of aerial parts and root system in

species such as cabbage, turnips, lettuce and radish as well as reducing or inhibiting the germination percentage of all species tested.

**Table 3.** Initial development of lettuce (*Lactuca sativa L.*) flat type in three concentrations of flower extract white lupine (*Lupinus albus L.*) cultivar IPR Forest. Cascavel-PR,2010.

| Treatments | Length (cm) | | Germination(%) |
|---|---|---|---|
| | Rootlets | Shoots | |
| Control | 5,0 a | 3,0 a | 99 a |
| 3,5% | 1,6 b | 3,2 a | 99 a |
| 7,0% | 0,4 c | 2,9 a | 84 b |
| 10,5% | 0,1 c | 1,9 b | 69 c |
| CV% = 5,1 | | | |

1 letters followed by the same letter in column do not differ by Tukey test at 5%.

Favero et al, (2001), studying the inhibition of spontaneous plants, found that the use of legumes as green compost promotes changes in the dynamics of succession of wild species. Therefore, the fact of inhibiting the development of lettuce may be related to mechanisms that inhibit the spontaneous species, thus, green composts can be interesting for use as a suppressor of these species.

The germination is less sensitive to allelochemicals than seedling growth. However, the experimental quantification is much simpler, since for every seed phenomenon is discrete, or germinates does not germinate. In this context, allelopathic substances can induce the appearance of abnormal seedlings, and radicle necrosis one of the most common symptoms. Thus, evaluation of normal seedling is a valuable tool (Borela et al, 2009; Formagio, 2010).

## CONCLUSION

When submitted to higher concentrations of aqueous extract there was a greater commitment in the initial development of lettuce, limiting the development of root and shoot;

Among the extracts of green composts used, oats was the one that showed the highest allelopathic effect in the smallest percentage used;

The turnip root extract did not limit the germination, but affected seedling development, while lupine flower extract negatively affected the germination and seedling development.

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