Short communication

HERBICIDAL EFFECTS OF PYROLIGNEOUS ACID FOR CONTROL IN WEED SEED BANK

ABSTRACT

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Aims: Pyroligneous liquor, a by-product extracted from wood pyrolysis during charcoal production, is mainly discarded. Pyroligneous liquor has a phytotoxic effect and can be used environmentally as a herbicide of natural and sustainable origin for plant control. The objective of this research was to evaluate the effectiveness of pyroligneous liquor to control the plant seed bank.
Study design: Different concentrations of pyroligneous liquor (0, 1, 2, 3, 4, 5, 10, 15, 20, 25, 50, 75, 100% (v/v)) were tested in soil samples with 10 replications each. Statistical analysis of the data found was carried out using the Sisvar software, employing the single-factor Analysis of Variance (ANOVA) technique, followed by Regression Analysis.
Place and Duration of Study: The experiment was carried out in the Federal University of Tocantins, Gurupi – To, Brazil. Soil between Jan 2023 and December 2023.
Methodology: The soil was collected with the aid of a digger, with five subsamples within the useful area of the plot and constituted a composite sample. After collection, samples from the Seed Banks were separated to quantify the seeds present in the soil seed bank, the other half of the sample, the soil was divided into 10 gerbox boxes for each treatment and benches were placed with natural light and kept under irrigation. daily with 1 mm each, to stimulate germination. Throughout the experiment, temperature and relative humidity were monitored, remaining on average at 26.4°C and 73.5%, respectively.From the pyroligneous liquor obtained, dilutions were made with distilled water at liquor concentrations 0, 1, 2, 3, 4, 5, 10, 15, 20, 25, 50, 75, 100%v that were used in the treatments.

Results: Higher pyroligneous liquor concentrations inhibited seed germination, while lower concentrations had less impact.

Conclusion: These findings suggest that pyroligneous liquor can be used to control of weed seed bank.

Keywords: germination inhibition, natural herbicide, wood vinegar

1. INTRODUCTION

In cultivated soils, seed banks normally constitute a serious problem for agricultural activity, as they guarantee infestations of invasive plants for a long period of time, even when preventing the entry of new seeds into the area, resulting in a decrease in production. In increasing costs (Webber et al., 2018). Thus, pre-emergent herbicides with long residual action in the soil can interfere with the dynamics of entry and exit of seeds in the system, by controlling their germination, which influences in the medium and long term the number of species and individuals present in it (Amim et al ., 2016).

Through pre-emergence chemical management of weeds, herbicides with the greatest residual effect on the soil are chosen, classified as pre-emergence herbicides. (Sanchotene et al., 2017), which can cause major environmental impacts, such as leaching, contaminating groundwater. As the water approaches the surface, the possibility of contamination is greater (Santos, 2013).

Adverse effects on health and the environment are the focus of intense regulatory debate, for example Paraquat, with corrosive action, and classified as Extremely Toxic (Toxicological Classification 1), and dangerous to the environment (Class 3) (Martins, 2013) and has been prohibited for use in Brazil since 2017 by the National Health Surveillance Agency (Anvisa). Therefore, there is an urgent need to seek alternatives that are safe for the environment and human health and effective in controlling weeds.

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To promote the circular economy and the use of all co-products of the charcoal production process, the pyroligneous extract, contained in condensable gas, has been studied as a potential insecticide, fungicide, bactericide, among others, and also as a preservative agent for chemical products by authors such as Silva (2022), Zeferino et al. (2018 Neto et al. (2017) and Almeida (2012).

The controlled pyrolysis of wood waste is a useful solution to prevent the accumulation of these gases in the environment (Aguirre et al., 2020) and its by-products are extremely useful in various uses in agriculture such as controlling insects, nematodes, promoting growth and weed control. Pyroligneous liquor is obtained by retaining the gases that emanate from the burning of coal and by channeling these gases it is possible to condense the vapor and collect the liquid that is formed, thus giving rise to a coal by-product called pyroligneous liquor, also known as liquid, acid, pyroligneous extract or wood vinegar (Oliveira, 2019). This bioproduct contains a wide variety of oxygenated organic compounds, such as acids, alcohols, phenols, esters and sugars, with acetic acid as the primary compound (Porto et al., 2019; Martín et al., 2017; Mathew and Zakaria, 2015).

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Most countries that work with pyroligneous liquor already have policies implemented to promote production and use, as the commercialization of these products requires standardization and technical guidelines. In the United States, one way to encourage organic agriculture and the use of liquor in this activity was the creation of the National Organic Program founded by the Department of Agriculture, which also contributed to financing and technical assistance for small farmers. In fact, these are factors that provide the greatest stimulus for the pyroligneous liquor sales market to grow by 2025, by more than 5% (Chu et al., 2022). In Brazil, the Ministry of Agriculture, Livestock and Supply included pyroligneous liquor as an additive for use in mineral fertilizers, whose function is as an acidifying and stabilizing agent (Jesus, 2019)

The objective of this work was to identify whether pyroligneous liquor can act as a pre-emergent herbicide in the seed bank of weed plants, being a sustainable alternative with less environmental impact for weed control.

2. MATERIAL AND METHODS

The experiment was carried out in the Municipality of Gurupi – To, Brazil. Soil was collected in layers of 0.0–0.10m. The soil was collected with the aid of a digger, with five subsamples within the useful area of the plot and constituted a composite sample. After collection, the soil was taken to the Laboratory of Physiology and Forest Seeds, Gurupi Campus, of the Federal University of Tocantins where the experiment was carried out, to evaluate the soil seed bank, for 30 days.

2.1 Seed Bank Samples

To determine the quantity of seeds present in the soil seed bank, the methodology proposed by Silvaand Martins (2013) was followed. Constituting 150g of soil per sample sieved and added a solution containing 50g of K_2CO_3 prepared in 200mL of water. After manual homogenization for one minute and subsequently for 10 minutes, the sample was left to rest for decantation. The supernatants were then carefully removed and passed through a 50 mesh sieve to separate the seeds and other debris present in the solution. The supernatants were subjected to preliminary drying on filter paper, separated and counted to estimate the density of the seed bank present in the soil.

The other half of the sample, the soil was divided into 10 gerbox boxes for each treatment and benches were placed with natural light and maintained under daily irrigation with 1 mm each, to stimulate germination. Throughout the experiment, temperature and relative humidity were monitored, remaining on average at 26.4°C and 73.5%, respectively

2.2 Pyroligneous liquor

The firewood used in the carbonization for the extraction of Pyroligneous Liquor is made from *Eucalyptus urophylla x Eucalyptusgrandis* wood. The carbonization was carried out in a rectangular mini oven with a vertical smoke burner in Laboratory of Forest Tecnology, Federal University of Tocantins - Brazil and double-distilled in a stainless steel retort-type distiller, which aims to completely eliminate tar or other toxins that may still be present.

From the pyroligneous liquor obtained, dilutions were made with distilled water at liquor concentrations 0, 1, 2, 3, 4, 5, 10, 15, 20, 25, 50, 75, 100%v that were used in the treatments.

2.3 Experimental design and statistical analysis

The treatments were composed of doses of pyroligneous liquor at concentrations of 0, 1, 2, 3, 4, 5, 10, 15, 20, 25, 50, 75 and 100% of the pure extract. A completely randomized design was used, with ten replications and the liquor applied at the beginning of the experiment.

To evaluate the effect of pyroligneous liquor on inhibiting seed bank germination, we used a nonlinear regression model (Seber and Wild, 2003). The first-order exponential model was adjusted: where A is the increase to the asymptote (y0) that results in the intercept, t is the radius of curvature and x is percentage of germination. The model was adjusted by iteration using the Levenberg – Marquardt algorithm conducted in the OriginPro 2018 software (Mayand Stevenson, 2009).

3. RESULTS AND DISCUSSION

The seeds found in the soil sample had approximately 147 seeds/m².

In the control, seed germination was only 54% of the seed bank density, indicating that the bank was active, within the expected standards. After germination, 3 species of weeds were identified in the studied area: crabgrass (*Digitariaciliares*), forage peanut (*Arachispintoi*) and roundworm (*Spigeliaanthelmias*), which were also present at the collection site (Figure 1).

Figure 1. Weed species in the studied area and which germinated in the control: A - crabgrass (*Digitariahorizontalis*), B - forage peanut (*Arachispintoi*) and C - roundworm (*Spigeliaanthelmias*).

In treatments with concentrations below 3%, the pyroligneous liquor was not efficient in inhibiting germination, indicating that the occurrence of germination decreases as a result of the increase in the dosage of the pyroligneous liquor compared to the control group (Figure 2).

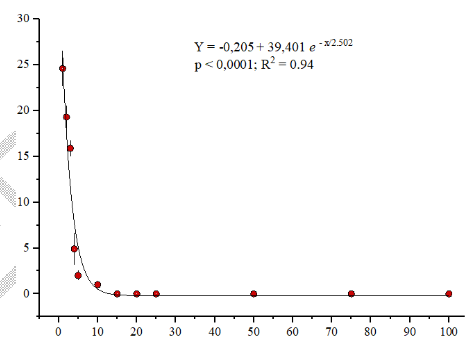

Figure 2: Percentage of seed bank germination as a function of liquor concentration.

The application of treatments with a concentration above 15% of pyroligneous liquor inhibited the germination of 100% of the seeds but resulted in excessive compaction of the soil, making water absorption difficult (Figure 11). These results corroborate Zeferinoet al. (2018) showing that the pyroligneous extract inhibited 100% of weed seed germination at high doses of 500 L/ha.

Weed control was efficient with 4% liquor applied only once at the beginning of the experiment. The pyroligneous liquor inhibited the germination of both broad-leaved species (forage peanut (*Arachispintoi*) - FABACEAE and roundworm (*Spigeliaanthelmias* - LOGANIACEAE) and also for narrow-leaved seeds (crabgrass (*Digitariahorizontalis*) - POACEAE).

These data highlight the importance of pyroligneous liquor as a possible factor inhibiting seed germination, and could be a low-cost sustainable substitute for non-selective pre-emergence control.

Previous research has focused on the use of pyroligneous liquor as a foliar herbicide to control flatweeds (Aguire, et al., 2020; Liu et al., 2021) Chu, et al. (2022) demonstrated that low concentrations of pyroligneous liquor substantially damaged newly germinated seeds. Lourenço et al, 2021, demonstrated that pyroligneous liquor applied in high doses can inhibit the germination power of *Bidenspilosa*, *Amaranthusviridis* and *Brachiariadecumbens* seeds.

However, only a few studies on its effect as a herbicide under natural conditions have been published, and most of these studies were on a single species (Chu, et al., 2022; Aguirre, et al., 2020) with no evaluation of the liquor. in weed seed banks.

Pyroligneous liquor not only inhibits seed germination, but also stands out for its remarkable environmental sustainability. By adopting pyroligneous liquor as a sustainable alternative for weed control, coal producers can increase profitability and reduce gas emissions from burning coal.

4. CONCLUSION

The pyroligneous extract of the *Eucalyptus urophylla* x *Eucalyptus grandis* hybrid with concentrations from 4% is effective in inhibiting the germination of weed seeds and concentrations above 15% make the soil unviable.

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