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The 3rd Joint Symposium on Plant Sciences and Products

JSPSP

November 16th- 17th, 2022
ITB Ganesha Campus, Bandung

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'Utilization of Biomass towards Strengthening Bioeconomy'

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B.5

The potential of *Praxelis clematidea* extract as a bioherbicide

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Abstract
Weed control is one of the important maintenance activities in plant cultivation to stabilize the quantity and quality of crop yields. Unfortunately, spraying synthetic herbicide is still the main choice to solve this risk. Improper use can increase environmental damage. Therefore, the development of bioproducts from plants by utilizing their toxic properties is considered to be able to act as an eco-friendly biocontrol. This study aims to determine the potential of *Praxelis clematidea* extract of different plant parts on the seed germination, seed mean germination time (MGT), and sprout morphology of *Asystasia gangetica* weed. The study was conducted by bioassay test using a completely randomized design (CRD) in germination room to explore the effect of *Praxelis* water extract from the aerial part (including stems; leaves; and flowers), non- aerial part (including basal stems and roots), and whole plant. Whole plant extract suppressed germination and MGT higher than extract derived from aerial and non-aerial parts. The result was also supported by results of color changes observation, which showed browning in the roots, cotyledons, and hypocotyls of *Asystasia* treated seedling. Thus, *Praxelis* extract using all parts of the plant is the optimal formula for bioherbicide against *Asystasia,* as weeds in Palm oil plantation.

Keywords: invasive alien plant, weed control, herbicide, extract source, efficacy

1. Introduction

Weeds are unwanted plant which grow in an agro-ecosystem. It has the potential to harm the environment and human interests because it grows rapidly covering the cultivated area, has high adaptability [1, 2] and compete with cultivated plants for resources such as water, nutrient, sun shine which can reduce the quantity and quality of crop yields [2, 3].

Chemical weed control management practices, such as by using inorganic synthetic herbicides, are dominantly chosen by farmers because they have been proven to be effective in suppressing weeds and reducing costs, so as to optimize crop productivity [4]. But recently, many environmental issues are connected to the use of synthetic herbicides, such as weed resistance to herbicides and pollution in water and soil [5].

Allelopathic activity in plants can be an alternative solution for chemical weed control by utilizing plant toxicity. Biological solutions aimed to weed management practices that minimize the harmful effects of synthetic herbicides [6]. *Praxelis clematidea* is an invasive plant that has a potency as a candidate for biocontrol. Several previous studies have proven the allelochemical performance of *Praxelis* on aerial parts separately and combined aerial parts in inhibiting the seed germination [8–10]. One of the factors that affect the efficacy of a plant extract, namely the allelochemistry contained [11, 12]. The development of new herbicides derived from various compounds is a good candidate because the extract has multitarget-site activity [12]. Therefore, this study aimed to determine the effect of *Praxelis clematidea* extract with different combinations of plant parts on the seed germination, seed MGT, and sprout morphology of *Asystasia gangetica* weed, so can optimize the efficacy of the product.

2. Materials And Methods

2.1 Materials

Praxelis clematidea plants and *Asystasia gangetica* seeds were obtained from oil plam plantations in Lampung Province, Indonesia. *Praxelis* plant parts were separated into two parts, namely the aerial and non-aerial. The aerial part included the stem, leaves, and flowers. The non-aerial part included the roots and basal stems with a cutting distance ±2 cm from the root base. The samples were washed and oven-dried at 80°C for 48 hours. The dried samples were ground using a grinder and stored in sealed containers [8, 9, 14]. Seeds were separated from the seed coat, dried in the sun for 1 hour, and stored in a sealed container.

2.2 Methods

2.2.1 Preparation of *Praxelis* Extracts

Each fine powder was macerated with distilled water at a ratio of 1:10 (g/mL) which was carried out 3 times in a row for 3 days (3 x 24 hours). Each extract solution was filtered using 2 pieces of cloth and the filtrate was evaporated with a vacuum rotary evaporator at 40°C until the weight of concentrated extract was constant. Each stock solution was made with a 100% concentration and dilution was carried out to obtain 50% concentration. The ratio of the whole plant extract was 1:3 (non-aerial and aerial parts) [8, 9, 15].

2.2.2 Preparation of Seeds

The seeds were soaked in 2.5% NaOCl for 1 minute and washed with water. After that, the seeds were soaked in warm water at 40°C until the water temperature turned cold, followed by drying the seeds with tissues [8, 16].

2.2.3 Bioassay Test

Each 9 cm diameter petri dish was covered with cotton and 20 seeds were placed. The extract solution was dripped as much as 2 mL in 20 mL distilled water and poured into each petri dish. The petri dishes were closed and stored in the germinator at 28°C under light conditions (12 hours photoperiod). Seeds are declared to germinate when radicles have appeared with a length of at least 2 mm [8, 9]. The control treatment was done in the same method and only given 20 mL distilled water. The study was conducted for 3 weeks of observation. Parameters observed were seed germination, seed MGT, and sprout morphology of *Asystasia gangetica* weed.

2.2.4 Statistical Analyses

The transformed bioassay data were analyzed by simple linear regression test and T-test on SPSS Statistics 26 program. Interpretation of correlation values refers to Elva *et al*. [16].

3. Results and Discussion

The *Praxelis* extracts showed different effect on seed germination, both between sources and control. The average value of the weed (*Asystasia*) seed germination from highest to lowest, namely the control (67,5%), non-aerial extract (20%), aerial extract (12,5%), and whole plant extract (0%), consecutively. Extract from whole plant can suppress seed germination better than the aerial and non-aerial parts which might be due to more complicated metabolites compositions or its concentrations (Figure 1).

Based on the simple linear regression analysis (Figure 2), it showed that there was a very strong correlation (R = 0,899) between *Praxelis* extract sources and *Asystasia* seed germination. The effect was 81% (R2 = 0,808). Then, the relationship between extract sources and germination was negative (Unstandardized Coefficients = -1,293), which means that the seed viability is lowest in whole plant treated extract. Extract sources had a significant effect on seed germination (0.002 < 0.05). Whole plant extract only had different effect with control (0.017 < 0.05). Meanwhile, the other formulas were not significantly different with control or between extract sources.

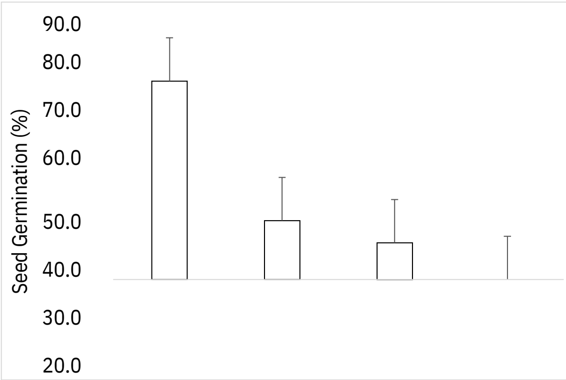

Figure 1. Effect of *Praxelis* extract source on *Asystasia* seed germination.

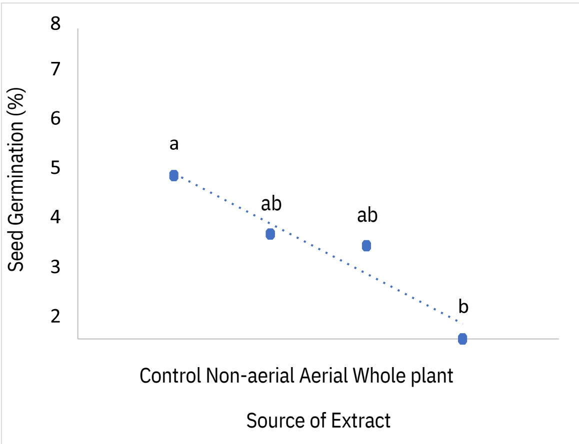

Figure 2. Correlation of *Praxelis* extract source on *Asystasia* seed germination.

All sources of *Praxelis* extract showed different effects on the MGT, both between sources and control. The average value of weed seed MGT from highest to lowest was aerial extract (18,8 days), non-aerial extract (10,6 days), control (7,6 days) and whole plant extract (0 days). All sources can inhibit the MGT. Extract derived from whole plant had the ability to delay seed germination longer than the aerial and non-aerial parts because germination did not occur for 3 weeks observation time (Figure 3).

Based on the simple linear regression analysis (Figure 4), it showed that there was a strong correlation (R = 0,713) between *Praxelis* extract sources and *Asystasia* seed MGT. The effect was 51% (R2 = 0,509). The relationship between extract sources and MGT was positive

(Unstandardized Coefficients = 0,310), which means that seed germination time will be longest in the whole plant extract treatment. Extract sources had a significant effect on seed germination (0,047 < 0,05). Extract formulas which had significantly different with control were the aerial and whole plant parts.

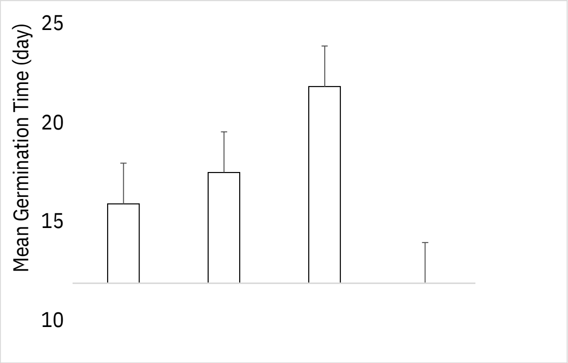

Figure 3. Effect of *Praxelis* extract source on *Asystasia* seed MGT.

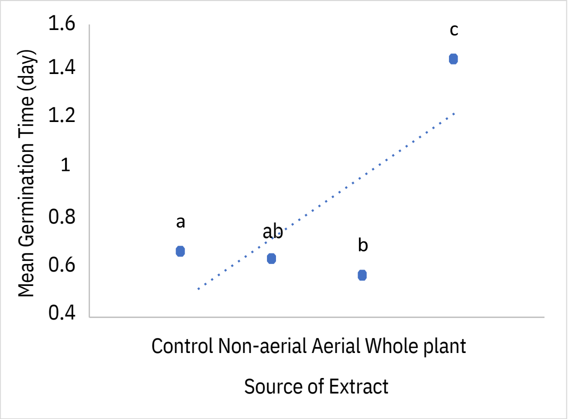

Figure 4. Correlation of *Praxelis* extract source on *Asystasia* seed MGT.

Based on morphological observations, treatment with the aerial and non-aerial extracts resulted in roots, cotyledons, and hypocotyls discoloration (Figure 5). All seeds turned black and failed to germinate on the weed treated with whole plant extract. Treatment with the aerial extract in the sprouts caused the roots, cotyledons, and hypocotyls that initially fresh become wilted, followed with a color change from white-green to yellow-brown. Meanwhile, the use of non-aerial extract on sprout made the roots, cotyledons, and hypocotyls that initially fresh become rotten with a color change from white-green to brownish.

Figure 5. Effect of *Praxelis* extract source on sprout morphology of *Asystasia*, [A] control; [B] non-aerial extract; [C] aerial extract; and [D] whole plant extract.

Praxelis extracts can inhibit germination and MGT, as well as inducing changes in sprout morphology due to allelopathic activity. Allelopathic activity depends on the allelochemicals contained in the extract. Allelochemicals can be found in every part of the plant with different levels and types of composition, resulting in different mechanisms of action and effectiveness [10]. Several previous studies showed that the aerial *Praxelis* extract was toxic to seed germination and caused discoloration of the root cap [8, 9]. However, research in a bioassay test study related to the use of non-aerial and whole plant extracts in *Praxelis* were not available.

Praxelis plants extracts can suppress, and delay seed germination as attributed by its allelochemical. Allelochemicals that have been studied in this plant and have been applied through a seed germination bioassay test are terpenoids such as monoterpene and sesquiterpene groups in a form of essential oils extract from aerial part [9]. One of them is *Caryophyllene* compound with a relatively high content (30.34%) through GC-MS analysis on *Praxelis* flowers [17]. Previous studies showed that *Caryophyllene* can inhibit and delay *Arabidopsis* seed germination which is thought to have the same mechanism of action as terpenoids in general, such as by inhibiting the works of germination enzymes (e.g a- and b-amylase) and affect hormones activity (e.g ABA) [18].

4. Conclusion

This study exemplified different effects of *Praxelis* extract on the seed germination and MGT, both between sources and control. All sources of *Praxelis* extract showed allelopathic activity against weed seeds. Extract formula produced by whole plant extract had a higher toxicity on the *Asystasia* weed, showed by inhibition activity and discoloration of the roots, cotyledons, and hypocotyls that were also observed. Therefore, utilization of whole *Praxelis* plant is recommended as an extract formulation for biocontrol because it obtains the best efficacy.

Acknowledgments

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