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# Study on the use of weed plants as bioherbicides: a review

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**Abstract** - Weeds are plants that are detrimental to cultivated plants if they live in the same area of life. The losses caused include reducing the production of cultivated plants. One effort to control weeds is the use of synthetic herbicides. However, excessive use of synthetic herbicides can cause problems, including reducing soil fertility, increasing weed resistance to herbicides and leaving residue. If herbicide residues are absorbed by plants and then the plants are eaten by humans, they can settle in the body and cause disease. This has triggered many researchers to look for other alternatives for weed control, namely environmentally friendly control. One of them is the use of bioherbicides. Weeds are one of the plants that have the potential to be used as bioherbicides. The ability of weed allelopathic compounds to inhibit growth has been used as a basis for developing bioherbicides. This article reviews weeds that have potential as bioherbicides, and the mechanisms of inhibition by allelochemical compounds.

**Keywords:** allelopathy, bioherbicides, study, weeds

## 1 Introduction

Weeds are organisms whose presence can cause problems for cultivated plants. The longer weeds are together with cultivated plants will result in inhibition of the growth of cultivated plants which will result in a decrease in the yield of cultivated plants [20]. According to Sharifa, et al. (2018) rice cultivation plants can experience a decrease in production of around 17% of rice fields and 40% of paddy fields due to the presence of weeds. Meanwhile, according to Madkar et al., (1986) in [16], the presence of weeds can reduce rice production by 20%-40%. This is due to competition between weeds and cultivated plants in terms of living space requirements, obtaining water and nutrients, and the absorption of allelopathic compounds produced by weeds which inhibit plant growth [22].

Therefore, efforts are needed to control weed growth, without affecting the growth of cultivated plants that live together with weeds [25]. One of the efforts made to control weeds is by administering herbicides. According to the origin of the word, herba means weed, and sida means to kill. So, herbicides are defined as substances that can kill weeds. Herbicides can be absorbed by plants through roots and stomata penetration [1].

Continuous use of synthetic herbicides can have a negative impact on the environment. Herbicides will reduce soil fertility, leaving residue in the soil because they are difficult to decompose. The residue left behind and absorbed by plants can harm the human body if the plants

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are eaten by humans [7], [25]. Apart from that, the residue left by herbicides on agricultural products can kill some natural enemies and providing these herbicides is expensive [27].

By paying attention to the impact of using synthetic herbicides, natural herbicides or bioherbicides can be used as an alternative because they are environmentally friendly. Weeds have the potential to be developed into bioherbicides because of their ability to inhibit the growth of surrounding plants by releasing allelochemical compounds [6]. This allelopathic mechanism is the basis for the use of weeds as bioherbicides [25]. In this article, we will discuss several weeds that have potential as bioherbicides and mechanisms for inhibiting allelochemical compounds.

## 2 Weeds that have potential as bioherbicides

Bioherbicides are herbicides that come from organic materials and are more environmentally friendly [24]. Bioherbicides utilize the ability of plants to produce chemical compounds (allelochemicals) [26]. Allelochemicals are secondary metabolism that can inhibit the germination, growth and development of a plant [21]. Weeds are one of the plants that have the potential to be used as bioherbicides.

### 2.1 Teki (*Cyperus rotundus* L.)

Teki (*Cyperus rotundus* L.) has potential as a bioherbicide because it contains the active compound phenol [8]. Phenol has the potential to be developed as a bioherbicide because of its ability to suppress the germination of other weeds [17]. The emphasis that occurs on the germination process is by reducing enzyme activity and growth hormone production which plays a role in the breakdown of food reserves as well as changes in cell membrane permeability which causes disruption of the imbibition process.

Based on the research results of Aldywaridha, et al. [3], sedge (*Cyperus rotundus* L.) can reduce the germination and growth of the weed *Asystasia gangetica* (L) T. Anderson. This is an allelopathic effect of enigma (*Cyperus rotundus* L.). Allelopathy also reduces seed germination and increases the time for germination and emergence of seeds on the soil surface compared to without allelopathy, because allelopathy results in inhibition of the activity of enzymes that degrade food reserves in seeds so that the resulting growth energy is very low and lasts longer, which in turn reduces germination potential [15]. Siregar, E.N., et al. [26] in their research concluded that nut root extract could reduce plant height, number of leaves, leaf area and dry weight of spinach weed (*Amaranthus spinosus* L). This proves that the nut root extract releases allelochemical compounds that can inhibit growth. Spinach spinach weed (*Amaranthus spinosus* L) is a weed in cultivated plants such as corn and beans. Nutella extract can also suppress weeds that grow on soybean plantations up to 2 weeks after planting (MST) [9]. This weed is a class of broad-leaved weeds, namely *Richardia brasiliensis*.

### 2.2 Reeds (*Imperata cylindrica* L.)

Alang-alang weed (Imperata cylindrica L.) is a grass weed that is often found in cultivated crop areas, especially oil palm [23]. Reeds contain allelochemical compounds that are toxic and can disrupt the process of photosynthesis or cell division. So that reeds have the potential to be used as a bioherbicide. The method used to make reeds as a bioherbicide is the maceration method, this method is done by soaking the powdered material in a filter solution. The research results of Sari, V.I., et al. [23] showed that alang-alang extract was more effective in controlling weeds from the grass and sedge groups compared to the broadleaf group. Meanwhile, the results of research by Lau, D.F., et al. [18] showed that alang-alang rhizome extract (*Imperata cylindrica* L.) can be used to control *Ageratum conyzoides* weeds, *Eleusine indica* weeds, and *Cyperus rotundus* L. The parameter observed was weed death.

Which is characterized by symptoms of crorosion. Chlorosis is an abnormal condition in leaves due to a lack of chlorophyll. As a result, the processes of respiration and photosynthesis are disrupted so that cells will die.

Alang-alang extract has been proven to suppress the germination of spiny spinach weed (*Amaranthus spinosus* L.) by up to 94.67% [14]. Purple maman weed (*Cleome rutidosperma* D.C.) which often grows in oil palm plantations can be controlled environmentally friendly, using reeds (*Imperata cylindrica* L.). The results of research by Apri, L., et al. [4] show that giving Alang-alang rhizome methanol extract can inhibit the germination percentage and sprout length of purple maman weed. Germination inhibition is caused by the presence of allelochemical compounds in the methanol extract of alang-alang rhizome.

### 2.3 Sembung creeping weed (*Mikania micrantha* H.B.K)

Sembung rambat weed (*Mikania micrantha* H.B.K) has allelochemical compounds in the form of phenols, terpenoids and flavonoids which can inhibit the growth of other plants, so they can be used as bioherbicides. Sembung rambat leaf extract can inhibit the germination percentage, sprout length, plant height, wet weight and dry weight of purple maman weed (*Cleome rutidosperma* D.C) and bahia grass (*Paspalum notatum* Flugge) [19]. Sembung rambat leaf extract can also inhibit the percentage of germination and growth of the putrimalu weed (*Mimosa pudica* L). Putri Malu weed can cause serious problems in corn, rubber, tea, field rice, green beans, oil palm and chili plantations [2].

Sembung rambat leaf extract also has the potential as a bioherbicide in controlling the weed weed (*Melastoma affine*) by inhibiting seed germination and growth. Sendua weed (*Melastoma affine*) is a woody and broad-leaved weed that can affect cultivated plants, such as tea (Camellia sinensis), rubber (*H. brasiliensis*) and oil palm (*E. guineensis*). Sembung rambat allelochemical compounds are thought to influence auxin activity for cell elongation, disruption of cell mitosis, and decreased membrane permeability [12].

### 2.4 Babandotan weed (*Ageratum conyzoides*)

Babandotan weed (*Ageratum conyzoides*) has the potential to be an environmentally friendly bioherbicide because of the active compounds such as saponins, flavonoids, tannins, essential oils and polyphenols it contains. Research Hikmah, A.U., et al. [11] showed that babandotan (*Ageratum conyzoides*) leaf extract could inhibit the growth of sedge grass (*Cyperus rotundus*) at a concentration of 50%. The inhibition of babandotan leaf extract on the growth of puzzles is due to the active compounds in the phenol group that it contains. Likewise, research by Isda, M.N., et al. [13] showed results that babandotan (*Ageratum conyzoides*) leaf extract reduced germination and growth and increased the percentage of damage to *Paspalum conjugatum* weed saplings. Symptoms of damage are characterized by the occurrence of chlorosis and necrosis in the P. conjugatum weed, apart from that, wilting also occurs. Withering occurs due to water in the weed tissue coming out. This is caused by damage to the root structure.

## 3 Forms of obstacles caused by allelopathic compounds

Allelopathic compounds are chemical compounds that plants (plant tissue) release into their environment and can inhibit or kill other plants [29]. In allelochemical interactions, one plant releases toxic compounds into the surrounding environment and can ultimately disrupt the growth and development of other plants in that environment [10].

### 3.1 Inhibits the synthesis of phytohormones

Phenol and flavonoids are allelochemical compounds whose presence can activate the *Indole Acetic Acid* (IAA) *oxidase* enzyme in destroying auxin which plays a role in cell elongation. If cell elongation does not occur as it should, it will result in stunted plant height. Reducing plant height causes the number of nodes where leaves grow to also decrease, which results in a decrease in plant wet weight. The reduction in the number of leaves also results in reduced photosynthetic activity which ultimately results in a decrease in plant dry weight ([4]; [12]).

Ardi (1999) in Hikmah, A.U., et al. [11] stated that the presence of phenol compounds will inhibit cytokinin activity. This obstacle causes cell division in the shoot meristem to be disrupted. Cytokinins function in root cell division and differentiation. Meanwhile, auxin is a compound that stimulates root elongation (Gardner et al. 1991. in [4]).

Yuliani (2000) in [16]; [25], allelopathic compounds inhibit the induction of growth hormones such as gibberellin acid (GA) and indolacetic acid (IAA). Inhibition of gibberellin synthesis means that the α-amylase enzyme will not be stimulated, so that the process of hydrolysis of starch into glucose in the endosperm or cotyledons is reduced, resulting in less glucose that can be sent to the growing points. The reduction in macromolecular components results in inhibition of protein synthesis which will also result in inhibition of protoplasmic synthesis. Barriers to the function of the enzymes A amylase and B amylase in carbohydrate degradation, protease enzymes in protein degradation, lipase enzymes in lipid degradation in seeds result in very little and slow energy produced during the germination process. This causes the process of cell division and elongation to be hampered, which in turn results in hampered germination and growth processes. Indications can be seen from a decrease in the percentage of germination and an increase in the length of time for germination [10].

### 3.2 Inhibits the process of cell mitosis

Phenol can disrupt cell mitosis by damaging the spindle fibers during metaphase. If the cell division process is hampered, cell enlargement is also hampered, resulting in decreased plant growth [5], [12]. Wattimena (1987) in Pebriani, et al. [19] stated that allelochemical compounds, especially phenol, damage the spindle threads during metaphase, as a result the number of cells does not increase.

### 3.3 Reduces cell membrane permeability

Phenol has the ability to damage the cell membrane structure, which causes cell building blocks and metabolites to exit the cell (Triyono, 2009. in [11]). Disruption of the transportation process resulting from the breakdown of food reserves from the endosperm to the growing point. This results in a decrease in germination speed [17]. According to Farooq et al. (2013) under normal conditions, cell membranes are selectively permeable, but as a result of allelochemistry the cell membrane will be disturbed so that it is no longer selectively permeable, resulting in cellular mechanisms not being able to work properly [16].

Sastroutomo (1990) in Pebriani, et al. [19] stated that phenolic compounds can reduce cell membrane permeability. Decreased cell permeability due to allelopathy makes cells inelastic, thereby inhibiting the traffic of water and dissolved nutrients through the cell membrane [15]. These obstacles occur during the process of nutrient absorption, namely the entry of water and dissolved nutrients into root cells as well as the transportation of nutrients and the results of photosynthesis between transport tissue cells in plants. This condition results in inhibited cell growth.

### 3.4 Chlorophyll destruction

May and Ash. (1990) in Sulandjari. [30] stated that phenolic compounds can damage the structure of chlorophyll [19]. Damage to the chlorophyll structure will inhibit the absorption of light needed in the photosynthesis process. Barriers to water absorption cause obstacles to the photosynthesis process, because they result in low water levels in plants resulting in stomata closing. Closing of stomata results in inhibition of $CO_2$ absorption which is needed for photosynthesis reactions. Kristanto [15] states that a decreased photosynthetic ability will be followed by a decrease in growth rate. Patterson (1981) in Hafsah, S., et al [10] stated that phenol compounds can reduce the chlorophyll content of leaves and can disrupt the conductivity of leaf stomata so that the photosynthesis process is hampered and ultimately the dry weight of the plant is disturbed.

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