

Allelopathic Effectiveness of Noni (*Morinda citrifolia* L.) Leaf and Fruit Extracts in Controlling The Growth of Cyperus Grass (*Cyperus rotundus* L.) Weed

Ananda Ismatul Alya Putri*, Yuliani

Study Program of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya

* Corresponding Author, e-mail: ananda.21052@mhs.unesa.ac.id

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Abstract

This study aims to identify the phytochemical content of *Morinda citrifolia* L. leaves and fruits and to analyze the effect of extract type and concentration on the growth of *Cyperus rotundus* L. tubers. Randomized Block Design (RBD) was used with two treatment factors. Observed parameters included plant height, number of leaves, growth rate, and phytotoxicity. Data were analyzed descriptively qualitatively and using two-way ANOVA, followed by Duncan's test for significant differences. The results showed that noni leaf and fruit extracts contain secondary metabolite compounds, including alkaloids, flavonoids, saponins, steroids, triterpenoids, phenolics, and tannins. However, fruit extracts had higher metabolite levels than leaf extracts, which showed no alkaloid presence in the Dragendorff test. Extract type and concentration significantly affected all growth parameters. The combined leaf-fruit extract and fruit extract showed an effect, but there was no significant difference. Similarly, 50% and 75% concentrations showed an effect but were not significantly different. The interaction between extract type and concentration affected the number of leaves and growth rate but did not affect the plant height or phytotoxicity.

Keywords: allelopathy; *Cyperus* grass tubers; noni plant; crop management.

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INTRODUCTION

Weeds are undesirable wild plant species due to them growing alongside and compete with cultivated plants. This competition occurs in the fight for water, nutrients, and habitat. Weeds can significantly affect production levels and inhibit crop growth. Therefore, monitoring the growth period of cultivated plants is very important, because weeds presence close to cultivated plants will be more difficult to control (Moenandir, 2010). One of the weed species often found on agricultural land is weed grass (*Cyperus rotundus* L.). *Cyperus* grass has good adaptability, can be found in both wetlands and dry land. This weed grows in underground rhizomes and can spread along with cultivated plants (Pranasari *et al.*, 2012). Increasing population of weeds hinders crop production in general (Talahatu and Papilaya, 2015). When weeds and cultivated plants grow in the same environment, the roots of both will intertwine and the top of the plant (crown) can touch each other. Under these conditions, plants with larger root systems and more leafy crowns tend to dominate plant growth (Padang *et al.*, 2017). According to Lawalata (2022), the level of competition will increase if the availability of the material being contested is insufficient.

Weeds grow quickly, causing them to suppress the growth of the main plants in the vicinity (Ringga *et al.*, 2014). Therefore, it is necessary to control weed growth so they do not become a problem for farmers in crop cultivation. Weed control can be done in various ways, for example by using herbicides. The use of herbicides in Indonesia has increased because the time used for weed control is relatively short, practical and also the cost of control is relatively cheap than control by other means (Fitria *et al.*, 2020). However, excessive use of herbicides can cause various side effects, such as killing non-target plants, causing poisoning in plants, and disrupting the physiological processes of animals that live around the cultivation area. It also has the potential to pollute the environment and can trigger the development of weed resistance to herbicides (Aditiya, 2021).

The alternative solution to these problems is to utilize the allelopathic process. Allelopathy acts as an substitute approach to weed management, which functions as a bioherbicide through active compounds called allelochemicals. Allelochemicals are secondary metabolites that serve as intermediaries in allelopathic interactions, involving relationships between plants or between plants

and microorganisms. Herbicides derived from plants or microorganisms provide significant sustainability (Darmanti, 2018). This is in line with agricultural principles that aim to minimize pest attacks, including weeds and diseases, through preventive measures and the application of safe and environmentally friendly treatments (Yuliani and Rahayu, 2018). The noni plant (*Morinda citrifolia* L.) is one of the effective plants for weed control. Noni plants are very famous because almost all parts have medicinal properties. Noni leaves contain various kinds of secondary metabolites, such as tannins, flavonoids, saponins, phenolics, and triterpenes, as described by Rambe *et al.*, (2021). Flavonoids are a class of compounds known for their toxic and allelopathic properties. Noni fruit contains a variety of compounds that are beneficial, for example terpenoids and various acids, including ascorbic acid, caproic acid, and capric acid, in addition to antibacterial compounds such as acubin, alizarin, and anthraquinone (Safitri and Ismawati, 2018).

Kusumaningsih (2021) found that 10-30% noni leaf extract effectively suppressed the growth of *Ageratum conyzoides* weeds. The results showed that the average time of initial weed death was 3 days after extract application. In this study, noni leaf extract was found to contain 0.056% tannins and 0.034% flavonoids. Tannins inhibit plant growth, disrupt respiration process in mitochondria, and disturb Ca^{+2} and PO_4^{3-} ion transport. Tannin compounds is also capable of inhibiting enzymes such as amylase, protease, lipase, and urease, in addition to reducing the function of gibberellin in stimulating cell division and elongation. Flavonoids inhibit growth by acting as IAA-oxidase inhibitors. Isda *et al.*, (2013) indicated that weed decline is caused by disturbances in the transport system or damage to the root structure, which causes an imbalance in evaporation and water transport. Research by Nonci *et al.*, (2015) showed that noni fruit extract was able to inhibit bacterial growth at 50% concentration and extend the shelf life of meat for three days. Ripe noni fruit has antibacterial properties due to various compounds such as flavonoids, terpenoids, anthraquinones, alizarin, and acubin, which collectively combat pathogenic bacteria. Noni fruit contains flavonoids that act as inhibitors of metabolic and nervous systems that work gradually (Gustia *et al.*, 2017).

Metabolite compounds content in noni leaves and fruits have potential to act as bioherbicides that are cheap and environmentally friendly to be applied in weed control. Based on various studies above, this study aims to identify chemical content of noni leaves and fruits (*Morinda citrifolia* L.) and determine the effectiveness of the extract of noni leaves and fruits (*Morinda citrifolia* L.) on controlling the growth of weed grass tubers (*Cyperus rotundus* L.).

MATERIALS AND METHODS

This research was conducted in two stages, descriptive qualitative by conducting phytochemical tests, and experiments conducted in the green house, Department of Biology, FMIPA, State University of Surabaya, from December 2024 to February 2025. This study was designed using Randomized Block Design (RBD) with two treatment factors; the type of noni extract and extract concentration. The first factor was the type of noni extract consisting of three types, including noni leaf extract, noni fruit extract, and a combination of both extract. The second factor was concentration, which consists of 0%, 10%, 25%, 50%, and 75%.

The research procedure consisted of two main stages, the first stage was phytochemical testing to identify active compounds contained in the leaves and fruits of noni (*Morinda citrifolia* L.). The secondary metabolite compounds tested including alkaloids, flavonoids, saponins, steroids, phenolics, tannins, and triterpenoids. The second stage includes the experimental stage, beginning with the preparation of tubers and planting media. The cyperus grass (*Cyperus rotundus* L.) tubers used were obtained from the Ararya House Plant online store as many as 45 tubers. One cyperus grass tubers was sown into each 10 x 15 cm polybag, which contained a mixture of regosol soil and manure in a 2:1 ratio. Watering was done twice a day, in the morning and evening (Anwar *et al.*, 2020).

Preparation of extracts begins with collecting noni leaves and fruits (*Morinda citrifolia* L.). The noni leaves taken were selected leaves (node 5 and above) with no holes, and no spots. The noni fruit used was fresh, not rotten or damaged, with a maturity level of half-ripe to ripe fruit. The collected noni leaves and fruits were washed thoroughly and then cut into small pieces and dried in an oven at a temperature of 40-50°C. After drying, the leaves and fruit were ground until smooth using a grinding machine to produce dry powder. Powdered noni leaves and fruits were weighed and then put into a jar to be macerated in 96% ethanol solution. Maceration was done three times within 24 hours with a ratio of 3:2:2. After maceration, the crude extract was filtered using a Buchner funnel lined with filter paper to separate the pulp. The results of the extraction underwent evaporation through a rotary evaporator, so as to obtain pure extracts of noni leaves and fruits (*Morinda citrifolia* L.) with a concentration of 100%. Extracts obtained from noni (*Morinda citrifolia* L.) leaves and fruits were stored in the refrigerator until ready to be tested. The application of noni leaf and fruit extracts was done by spraying at 7-day intervals;

day 7, 14, and 21 Days After Transplanting (DAT). The treatment using noni leaf and fruit extracts was applied with a volume of 5 ml per polybag.

This study analyzed parameters including weed height, number of leaves, growth rate, and phytotoxicity. Weed height was measured periodically at 7, 14, and 21 DAT using a ruler, from the base of the stem to the tip of the highest leaf. The number of leaves was assessed by carefully observing fully opened leaves at 7, 14, and 21 DAT. Growth rate was calculated from the difference in height between day 21 and day 7, thus obtaining the result of growth rate for 14 days. Phytotoxicity was carried out by observing symptoms of physiological stress, such as the appearance of chlorosis (leaf discoloration) and plant death at 21 DAT.

Data were analyzed descriptively qualitatively through observation of color changes obtained from phytochemical tests, and statistically through normality and homogeneity tests. If the data meet the assumption of normality, a two-way ANOVA test will be conducted to evaluate the effect of noni leaf extract, noni fruit extract, and their combination at concentrations of 0%, 10%, 25%, 50%, and 75% on the growth of cyperus tubers (*Cyperus rotundus* L.). If there are significant effects and differences, Duncan's test will be conducted at the 5% significance level to evaluate the differences between each treatment. Data analysis is then concluded with descriptive analysis to further describe the data.

RESULTS

This study was conducted to identify the results of phytochemical tests of noni leaves and fruits (*Morinda citrifolia* L.), to determine the effect of giving the type of noni extract, the concentration level of noni, and their interactions on the growth of teki grass tubers (*Cyperus rotundus* L.). The types of extracts given were noni leaf extract, noni fruit extract, and a combination of noni leaf and fruit extract (*Morinda citrifolia* L.) with concentration levels given as 0%, 10%, 25%, 50% and 75%. The parameters of this study were plant height, number of leaves, growth rate, and plant phytotoxicity (Table 1.)

Table 1. Results of phytochemical testing of the leaves and fruit extract of noni (*Morinda citrifolia* L.)

Phytochemical Test	Reagent	Result	Conclusion (+) / (-)	
			Leaf	Fruit
Alkaloids	Mayer	White Precipitate	++	+++
	Wagner	Brown Precipitate	+++	+++
	Dragendorf	Yellow/Orange Precipitate	-	+++
Flavonoids	Mg + HCl concentrated + ethanol	Blue/Green	++	+++
Saponins	-	Presence of Stable foam	++	++
Steroids	Liebermann-Burchard	Brownish Green	++	+++
Triterpenoids	Kloroform + H ₂ SO ₄ concentrated	Brownish	++	+++
Phenolics	NaCl 10% + Gelatin 1%	White Precipitate	++	+++
Tannins	FeCl ₃ 1%	Brownish Green	++	+++

Notes: (+) indicates an increasing level of secondary metabolite compound content.
(-) indicates the absence of secondary metabolite compounds.

Based on the results of the phytochemical test presented in Table 1, it can be seen that the extracts of noni leaves and fruits contain the same secondary metabolite compounds, including alkaloids, flavonoids, saponins, steroids, triterpenoids, phenolics, and tannins. However, there were differences in the level of content of these compounds. In the noni fruit extract, most of the compounds showed a high level of content (+++), while in the noni leaf extract the level of content was only moderate (++). In the saponin compound, both extracts showed the same level of content which was moderate (++). In addition, there are differences in the results of alkaloid testing, where the noni leaf extract with dragendorf reagent shows negative results. While the noni fruit extract showed positive results on all three reagents (Wagner, Mayer, and Dragendorf).

Duncan test results showed that the treatment of extract type and concentration affected weed height, but the interaction between the two had no significant effect (Table 2). The treatment of noni leaf extract was significantly different from the type of noni fruit extract and the combination of noni leaves and fruits. While between the treatment of noni fruit extract and the combination of leaves and noni fruit were not significantly different. In the treatment of noni fruit extract type produced an average plant height of 20.78 cm. While in the treatment of the type of extract of the combination of leaves and noni fruit produced an average plant height of 20.44 cm. Furthermore, the concentration treatments of 25%, 50%, and 75% have results that are not significantly different. The 25% concentration treatment produced an average plant height of 20.00 cm. The 50% concentration treatment produced an average plant height of 16.94 cm. Meanwhile, the 75% concentration treatment produced an average plant height of 15.67 cm.

Table 1. Weed Plant Height at 21 DAT with various types of extracts and concentrations

Concentration	Extract Type			Average (cm)
	Noni Leaf	Noni Fruit	Noni Leaf and Fruit	
0%	33.32 ± 9.57	35.63 ± 11.84	39.24 ± 11.64	36.06 ^c
10%	32.14 ± 9.27	22.52 ± 4.93	19.02 ± 2.26	24.56 ^b
25%	26.87 ± 7.96	15.54 ± 1.05	17.60 ± 0.43	20.00 ^{ab}
50%	21.42 ± 4.65	15.71 ± 0.03	13.70 ± 0.46	16.94 ^a
75%	19.85 ± 1.80	14.51 ± 1.77	12.67 ± 0.00	15.67 ^a
Average (cm)	26.72 ^b	20.78 ^a	20.44 ^a	22.64

Notes: 5% Duncan test is expressed through letter notation (a, b, c). the similarity of letters in the same column indicates that the treatments are not significantly different, while the difference in letters indicates that there is a significant difference.

The noni leaf extract treatment produced an average of 4.92 leaves, while the noni fruit extract treatment resulted in an average of 4.71 leaves in the weed. The combination of noni leaf and fruit extracts yielded the lowest average at 4.55 leaves. Regarding concentration levels, the 50% concentration treatment was significantly different from the 0%, 10%, and 25% treatments, but not significantly different from the 75% concentration. The 50% concentration treatment produced an average of 3.99 leaves, while the 75% concentration treatment resulted in an average of 3.79 leaves. The interaction between extract type and concentration level also significantly affected leaf number. Specifically, the combination of noni leaf and fruit extract at a 75% concentration yielded the lowest average number of leaves at 3.67 ± 0.00, indicating the highest effectiveness in inhibiting weed growth (Table 3).

Table 2. Number of leaves in cyperus weed at 21 DAT with various types of extracts and concentrations

Concentration	Extract Type			Average (Leaves)
	Noni Leaf	Noni Fruit	Noni Leaf and Fruit	
0%	5.70 ± 0.27 ^{gh}	6.24 ± 0.21 ^h	6.12 ± 0.75 ^h	6.02 ^c
10%	5.65 ± 0.25 ^{gh}	4.93 ± 0.07 ^{ef}	4.66 ± 0.33 ^{de}	5.08 ^b
25%	5.33 ± 0.33 ^{fg}	4.51 ± 0.17 ^{cde}	4.44 ± 0.19 ^{bcde}	4.76 ^b
50%	4.11 ± 0.69 ^{abcd}	3.98 ± 0.02 ^{abc}	3.88 ± 0.50 ^{abc}	3.99 ^a
75%	3.89 ± 0.16 ^{ab}	3.78 ± 0.19 ^{abc}	3.67 ± 0.00 ^a	3.79 ^a
Average (Leaves)	4.92 ^b	4.71 ^{ab}	4.55 ^a	4.72

Notes: 5% Duncan test is expressed through letter notation (a, b, c). the similarity of letters in the same column indicates that between treatments is not significantly different, while the difference in letters indicates that there is a real difference.

The results of the Duncan test showed that the treatment of extract type, concentration level, and the interaction of the two affected the growth rate (Table 4). Noni leaf extract produced an average growth rate of 14.92 cm, while fruit extract produced 12.41 cm. Meanwhile, the treatment of the combination of noni leaf and fruit extracts produced an growth rate of 9.54 cm. The interaction between the type of extract of the combination of noni leaves and fruits with a concentration of 50%, 75%, and the type of noni fruit extract with a concentration of 75% showed an effect that was not significantly different. Lowest weed growth rate was produced from 75% noni leaf and fruit combination extract, at 0.76 ± 0.25 cm.

Table 3. Weed growth rate for 14 days with various types of extracts and concentrations

Concentration	Extract Type			Average (cm)
	Noni Leaf	Noni Fruit	Noni Leaf and Fruit	
0%	26.70 ± 6.55 ^f	28.03 ± 9.66 ^f	32.86 ± 7.62 ^f	17.51 ^d
10%	19.06 ± 2.80 ^e	15.29 ± 1.69 ^{de}	9.23 ± 1.66 ^{bcd}	14.52 ^c
25%	13.52 ± 1.00 ^{cde}	10.51 ± 2.57 ^{bcd}	3.53 ± 0.90 ^{ab}	9.18 ^b
50%	9.59 ± 1.88 ^{bcd}	6.73 ± 0.80 ^{abc}	1.33 ± 0.70 ^a	5.88 ^{ab}
75%	5.76 ± 4.21 ^{ab}	1.53 ± 0.55 ^a	0.76 ± 0.25 ^a	2.68 ^a
Average (cm)	14.92 ^b	12.41 ^{ab}	9.54 ^a	9.95

Notes: 5% Duncan test is expressed through letter notation (a, b, c). the similarity of letters in the same column indicates that between treatments is not significantly different, while the difference in letters indicates that there is a real difference.

Results showed that the treatment of extract type and concentration affected phytotoxicity, but the interaction between the two had no significant effect. Combination of leaves and noni fruit extract produced an average phytotoxicity of 2.33%. The 75% concentration treatment was significantly different from the concentrations of 0%, 10%, 25%, and 50%. The 75% concentration treatment produced the best average phytotoxicity in weed at 3.66%.

Table 4. Phytotoxicity of noni extract for 21 days with various types of extracts and concentrations

Concentration	Extract Type			Average (%)
	Noni Leaf	Noni Fruit	Noni Leaf and Fruit	
0%	0.33 ± 0.57	0.33 ± 0.57	0.33 ± 0.57	0.33 ^a
10%	0.66 ± 0.57	1.00 ± 0.00	1.00 ± 0.00	0.88 ^a
25%	1.00 ± 0.00	2.00 ± 1.00	2.33 ± 0.57	1.77 ^b
50%	2.33 ± 0.57	3.00 ± 1.00	4.00 ± 0.00	3.11 ^c
75%	3.00 ± 1.00	4.00 ± 0.00	4.00 ± 0.00	3.66 ^d
Average (%)	1.46 ^a	2.06 ^b	2.33 ^b	1.97

Notes: 5% Duncan test is expressed through letter notation (a, b, c). the similarity of letters in the same column indicates that between treatments is not significantly different, while the difference in letters indicates that there is a real difference.

DISCUSSION

Based on the research conducted, the treatment of noni extract type and concentration level showed an influence on the growth of cyperus grass tubers based on parameters plant height, number of leaves, growth rate, and phytotoxicity. The results showed that the interaction between concentration and type of noni extract had a significant effect on the number of leaves and phytotoxicity, while the plant height and growth rate showed no significant effect.

Noni leaves and fruits contain useful secondary metabolite compounds. Some of the compounds found include flavonoids, saponins, alkaloids, triterpenoids, tannins, phenolics, and steroids. These compounds can function as antioxidants, antibacterials, and growth inhibitors. In this study, these compounds were tested against cyperus weed. These compounds had major role in the inhibition process. These compounds were found more in the fruit compared to in the leaves. Therefore, fruit extracts tended to be stronger in inhibiting weed growth.

Flavonoids able to function as antioxidants and also play a role in allelopathy. Allelopathy is the ability of certain compounds to inhibit the growth of other plants. Flavonoids in noni fruit were higher than in leaf, resulting in better effect in controlling weed growth. When the roots were inhibited, the plant could not absorb water and nutrients properly, resulting in disrupted plant growth. This was also seen in this study, where weed growth was disrupted after being given noni extract. Flavonoids have a role in the growth process, which acts as a strong inhibitor of IAA-oxidase (Kusumaningsih, 2021). Flavonoids work by damaging enzymes in weed plants, resulting in plants can not carry out normal physiological processes. As a result, the plant becomes weak and unable to develop properly (Damayanti *et al.*, 2023).

Steroids are one of the compounds contained in noni extract. This compound has a chemical structure that resembles the hormone auxin, which plays a role in plant growth (Suryelita *et al.*, 2017), resulting in disrupting of plant growth. Noni extract also contains phenolic compounds that cause disruption in the circulation of auxin and cytokinin. Auxin functions to spur root tip elongation, while cytokinin functions in root cell differentiation and cell division (Khairunnisa *et al.*, 2018).

In addition, tannin content also causes inoptimal respiration process in mitochondria and disrupt transporting Ca^{2+} and PO_4^{3-} ion transport. Tannins also have the ability to inhibit enzyme activity such as amylase, protease, lipase, and urease, and are able to reduce the function of the gibberellin in stimulating cell division and elongation (Kurniawan *et al.*, 2019). Meanwhile, alkaloids are known for its medicinal content and toxicity. Alkaloids work through various mechanisms, including interfering protein synthesis, inhibiting the activity of important enzymes in plant cell metabolism, lowering rate of seed germination and plant growth (Motmainna *et al.*, 2021).

According to Kostina-Bednarz *et al.*, (2023), saponins interact with the constituent elements of the cytoplasmic membrane, proteins, and lipids which will result in the death of the root system. Saponins can reduce the viability of target plant cells by destabilizing the plasma membrane, leading to leakage of cell contents and disruption of physiological functions. According to Zhao *et al.* (2024), triterpenoids work by interfering with the process of cellular respiration through interactions with mitochondrial enzymes, resulting in decreased ATP production and inhibited metabolism of target

plant. In addition, triterpenoids also trigger excessive accumulation of reactive oxygen species (ROS), causing oxidative stress that damages of plant cells.

From this study, it can be seen that the type of noni fruit extract can provide an equivalent effect to the type of extract of the combination of leaves and noni fruit. This shows that noni fruit is the largest contributor of secondary metabolites, so that noni fruit extract alone is enough to provide optimal effects without the need for additional noni leaf extract. Therefore, there is no difference in the combination of leaf and fruit extracts and fruit extracts alone. The fruit has more secondary metabolite compounds than the leaves because the fruit has seeds that must be protected from pathogen attacks. Based on the results of phytochemical tests carried out, there are differences in the results of alkaloid testing, where the noni leaf extract only shows positive results on Wagner and Mayer reagents, while the test with Dragendorff reagent shows negative results. This indicates that alkaloids in the leaves consist only of certain types. While the noni fruit extract showed positive results on all three reagents indicating that noni fruit has a wider diversity of alkaloid structures.

In addition to the type of extract, the level of concentration given also affects the growth of cyperus grass tubers. According to Faturrahman *et al.* (2022), the higher the concentration of the extract, the greater the inhibitory effect. At concentrations of 50% and 75%, the inhibition results look equally high. This is because there are more active compounds in high concentrations. Weeds become difficult to grow and show symptoms of stress faster. At low concentrations, the effect is still less strong. So, concentration is an important factor in the effectiveness of inhibition. So the results of this study show a direct relationship between concentration and inhibition strength.

Research conducted by Perveen *et al.*, (2021) proves that at the lowest concentration (2.5%) the application of moringa leaf extract has not had a good effect in inhibiting the growth of *Lepidium sativum* weeds. However, at a concentration of 10%, it can inhibit the growth of shoots and roots. This proves that higher concentrations of extracts can have a greater effect in inhibiting weed growth. Whereas in research by Talahatu and Papilaya (2015), it was explained that the type of clove leaf extract with a concentration of 50% was the highest concentration used in this study, as well as the most effective concentration in inhibiting the growth of weed grass. In this study, the same thing happened. Low concentrations have not given maximum results. Therefore, the minimum effective concentration must be considered. The higher the concentration, the inhibitory effect also increases. This supports the importance of dosage in the use of extracts.

Extracts used in high concentrations can cause phytotoxic effects. Signs of phytotoxicity such as leaf senescence, yellow-brown discoloration, and abnormal growth began to appear in treatments with extract concentrations of 10% and above. Pratama *et al.* (2024) recorded highest phytotoxicity score (4.0) after cyperus weed was exposed to 50% ketabang leaf extract, indicating that the cyperus weed suffered serious damage. These symptoms include physiological damage such as chlorosis, necrosis, wilting, and inhibition of root and leaf growth. Although this treatment was effective in suppressing weeds, the use of high doses can also have a negative impact if not controlled. Therefore, it is important to re-evaluate the ideal concentration that is effective but still safe, so that the results of weed control do not pose a risk to the main crop or the surrounding environment.

Weed plants treated with the extract grew shorter (Widiastuti *et al.*, 2020). Plant height and number of leaves decreased compared to control. This shows that the active compounds in the extract successfully interfered with growth hormones. Steroids and flavonoids affected auxin hormones and leaf meristems, leading to plants cannot form new leaves. Study conducted by Vyas and Sharma (2021) showed that the administration of 25 mg/ml moringa leaf extract caused inhibition of weed growth but had a toxic effect on the main plant. This is in accordance with the current study which showed that at high concentrations (saturation) had potential phytotoxicity.

The mechanism of weed inhibition occurs when phenolic compounds, which are generally allelochemicals or inhibitory compounds, interact with the weed. These compounds come from noni leaf and fruit extracts that function to inhibit weed growth. This interaction inhibits the synthesis and function of growth hormones such as Indole Acetic Acid (IAA) and Gibberellin (GA), which play an important role in initiating and accelerating the process of cell growth and stem elongation (Talahatu and Papilaya 2015). This causes the hormones IAA and GA to be inhibited and disrupts the synthesis of amylase, protease, and lipase enzymes. When amylase enzyme synthesis is inhibited, starch hydrolysis is reduced, thus reducing the amount of glucose available for the germination process. Inhibited protease enzyme resulting in lack of amino acids to form new enzymes and tissue structures, slowing root and shoot growth. Inhibited lipase enzyme leading to the energy reserves from fat cannot be optimally utilized, which will reduce the energy available for the growth process. These enzymes help to provide essential energy for early plant growth (Supriyatna *et al.*, 2015).

In this study, cyperus grass weeds treated with noni extract showed a significant reduction in growth. This can be seen from the plant height, number of leaves, reduced growth rate, and high level of phytotoxicity. Active compounds such as flavonoids and steroids work to interfere with the basic metabolic processes of plants in this study. As a result, the plants cannot absorb nutrients properly and experience physiological stress. In addition, the accumulation of ROS causes damage to plant cells (Chen *et al.*, 2020).

Based on the results of the study, it shows that noni fruit extract at 50% and 75% has similar effect as combined extract of noni leaves and fruits at 50% and 75% concentration. Therefore, as a bioherbicide it is economically recommended to use noni fruit extract at 50%, as it is sufficient to inhibit weed growth. The use of noni extract is also considered environmentally friendly because it does not contain synthetic chemicals. Thus, this extract can be used as an alternative solution to weed control. In addition, noni extract can be produced locally at low cost. This will greatly help farmers in reducing dependence on chemical pesticides.

CONCLUSION

Noni extract contained alkaloids, flavonoids, saponins, steroids, triterpenoids, phenolics, and tannins. Extract had significant effect on all growth parameters of weed grass (*Cyperus rotundus* L.). The interaction between the type of noni extract and the concentration level affected the number of leaves and phytotoxicity parameters. In the parameter of the number of leaves, the treatment of 75% combined noni leaf and fruit extract showed best results. In regard to phytotoxicity, 75% extract also showed the best result, but not significantly different.

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CONFLICT OF INTEREST

There is no conflict of interest.

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