Effects of the alang-alang (*Imperata cylindrica*) cutting practices to the gall growth

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Abstract. Alang-alang is an invasive weed species that can grow out of control and harm other plants. The weed control methods commonly applied are burning, cutting, and spraying with herbicides. There is an insect causing alang-alang gall found in Java, namely *Orseolia javanica* Kieffer & van Leeuwen-Reijnvaan (Diptera: Cecidomyiidae) or known as the alang–alang gall midge. This study was aimed at determining the effects of the alang–alang cutting practice on rice field bunds to the growth of alang–alang galls. The study was done in Cianjur District, West Java. There were several steps done in this study including the preparation of field sites, daily observation of the gall growth, and observation on the duration of the gall midge for emerging. The length of the alang-alang gall on the uncut alang-alang was significantly higher than on the cut alang-alang, while the diameter of the galls was not significantly different. The difference in the length of the galls is believed was due to the different of light exposures. The duration of the emerging time for the alang-alang gall midge was shorter on the cut than the uncut alang-alang which was might be caused by changes in micro climate such as the more sunlight exposures and higher temperature on the habitat. This study suggests that the alang-alang cutting practice can shorten the life cycle of the alang–alang gall midge and might have an impact on the biological control effectiveness.

1. Introduction

Alang-alang or cogongrass, *Imperata cylindrica* (L.) Beauv. (Poaceae) is a weed originating from Southeast Asia [1], grows in warm climates and is widespread throughout the continents except Antarctica. There are several varieties that are scattered, including *I. cylindrica* var. africana is distributed in West Africa and South Africa, whereas *I. cylindria* var. europe is widespread in North Africa, several European countries, and the Middle East region. Another variety is *I. cylindrica* var. major which is the most dominant variety based on the most extensive distribution areas in Southeast Asia and Australia [2]. Alang-alang spread in various regions is estimated more than 500 million ha throughout the world [3]. The alang-alang spreading area in Asia is estimated 35 million ha [4], while in Indonesia, its spreading area ranges from 20 to 64.5 million ha [5]. Alang-alang is one of the 10 weeds that can threaten crop cultivation in the world [6]. In Indonesia, alang-alang grows widely in open land, agricultural land, including lowland rice fields [7]. The weed grows quickly in areas that have 75-500 mm of rainfall [8].

One of the alang-alang control technique commonly practiced is grassland burning. This control technique is not safe because the presence of fire that is difficult to be controlled will threaten other plants. Chemical control of alang-alang is commonly done by herbicides with glyphosate active
ingredient [9]. Excessive use of herbicides has some negative impacts, including the death of non-targeted plants, growing of new invasive plant species that are more detrimental, and causing alang-alang resistant to herbicides. Mechanical control can be done by cutting or clearing alang-alang which can be done regularly. Cutting alang-alang is considered as a temporary control because this practice is only removing the parts of alang-alang above the ground surface, while the rhizomes of alang-alang remain in the soil that contains enough nutrients for the growth of young shoots [10].

Biological control can be done as an alternative means even though it has never been done extensively. One of the natural enemies of alang-alang is a gall midge, *Orseolia javanica* Kieffer and Van Leeuwen-Reijnvaan (Diptera: Cecidomyiidae) [11]. The alang-alang gall midge distribution has only been known in Java Island. The gall midge was reported found in Bogor and Cianjur Regencies (West Java) as well as in Magelang and Salatiga Regencies (Central Java) [4]. The alang-alang gall midge is monophagous insect and only infest specifically on alang-alang, therefore the gall midge is a potential to be a biological control agent for alang-alang [11]. Symptoms of the gall midge attacking alang-alang is abnormal growth of the shoot, forming a needle-shaped like structure with reddish color. In Java, the alang-alang gall symptom is called “ganjur alang-alang” as it is similar with those found in the rice caused by the rice gall midge *O. oryzae* called “ganjur padi”. The gall midge infestation can reduce the photosynthesis process and carbohydrate content, thereby inhibiting the growth and development of alang-alang [11]. The purpose of this study was to determine the effect of cutting alang-alang to the length and diameter of the alang-alang galls as well as to the length of time for the gall midges to emerge to be adults.

2. Methods

The study was conducted from February to September 2018. Observations were carried out in rice fields in Cibereum Village, Cugengan District, Cianjur Regency which were at the coordinates of 6°47’19.5” latitude and 107°3’58.7” longitude. Data analysis was carried out in the Insect Biosystematics Laboratory, Plant Protection Department, Faculty of Agriculture, IPB University. The tools used for the field works were scissors, small shovel, plastic tube, millimeter screw, camera, paint, and brush. The observations of the growth of alang-alang were done on the terraced rice field bunds which had a length of ± 20 m and a width of ± 1.5 m. Two rice field bunds that were dominated by alang-alang and showing symptoms of gall midge was selected as observation points. Alang-alang in selected rice field bunds were treated by cutting and without cutting of parts above the ground surface. On the cut treatment, alang-alang was cut to the ground and observed every day to record the growth of gall midge until the adult emerged (Fig. 1).

![Figure 1. Alang-alang in the rice field bun; (a) cut alang-alang; (b) uncut alang-alang.](image)

Observations were made by measuring the length and diameter of the galls which was done every day. The newly found alang-alang was marked using bamboo stakes painted in red at the top with the aim of making them easily visible. Observations was carried out every day at 8:00 to 12:00 until the gall midges emerged.
Observation of the length of time for the gall midges comes out from the galls (emerged) was done as well on the newly-discovered alang alang. Collected data was managed using Microsoft Excel for further analysis. Length and diameter of the galls were analyzed by using the independent t-test using Statistical Package for Social Science (SPSS) software version 22.

3. Results and discussion

The growth of alang-alang gall is usually started under the ground which is not seen without digging the soil around the rhizome [4]. The galls will appear to the surface of the ground beginning with the emergence of red shoots that are pointed at the tips (Fig. 2). This is consistent with Aviansyah's statement, young alang-alang that is attacked by gall midge larvae becomes reddish in color, forms a space like pipe, and pointed at the tips [3]. After the gall midge is ready to come out to emerge, a hole will be formed in the upper part of the gall and usually a part of exuvium was found in the edge of the hole. Alang-alang that are attacked can be infested by several individual midges, but only 1 individual will successfully be emerged [12]. The growth of the galls will be slowing after the gall midge emerged, then shrinkage in the middle, characterized by a reduction in the diameter of the gall, which is then followed by the wilting until it becomes dry and dies.

Figure 2. Alang-alang galls; (a) gall symptom (x: 1 cm); (b) a gall with emerged gall midge; (c) male adult of gall midge Orseolia javanica.

The growth of alang-alang galls in rice bunds which was not cut did not show any difference with those in cut treatment. During the observations, several pale alang-alang was found in the lower part of the grass. This is presumably because the parts of the alang-alang was not receiving enough sun light intensity.

There were three parasitoid families of the alang-alang gall midge, namely Platygasteridae, Eulopidae, and Peteromalidae [13]. The parasitoid of the Family Platygasteridae (Hymenoptera) especially the Platygasterinae subfamily are koinobionts, meaning that the female parasitoids lay eggs on the host eggs or early instar larvae but the parasitoid larvae allow the host to continue to develop and parasitoid adult arise from the host pupae [14]. In addition to being koinobionts, parasitoids which attack the gall midge are also polyembryony. The growth of galls containing gall midge parasitoids showed no different with those without parasitoids.

The results of measurements of the growth of the galls showed differences between the cut and uncut alang-alang. The length of galls in the cut alang-alang bunds was 44.68 ± 14.40 mm and whereas the length of galls in uncut alang-alang was 93.61 ± 25.59 mm (Table 1).
The results of the independent t-test showed that the gall length on cut alang-alang was significantly lower than that on uncut alang-alang. The differences on the length of galls was caused by less penetration of sunlight on the uncut alang-alang which induce the etiolation.

Table 1. The length and diameter of alang-alang galls measured after the gall midge emerged.

| Observation aspects | Cut (x̄ ± sd) | Uncut (x̄ ± sd) | P-value | n |
|---------------------|--------------|----------------|---------|---|
| Length (mm)         | 44.68 ±14.40 | 93.61 ± 25.59  | 0.0001  | 60|
| Diameter (mm)       | 2.37 ± 0.42  | 2.47 ± 0.41    | 0.1770  | 60|

*P value <0.05 indicates a significant difference based on independent t-test α = 5%.

The diameter of the galls in cut alang-alang was 2.37 ± 0.42 and those on uncut alang-alang was 2.47 ± 0.41 (Table 1). The results of the independent t-test showed that the diameter of the galls in the cut and uncut alang-alang was not significantly different.

The incremental growth of length of alang-alang with gall symptoms varies each day during observation period (Fig. 3). The highest incremental growth in bunds with the cut treatment occurred on the first day with an average value of 22.5 mm, while in the uncut treatment was 22.3 mm on the 3rd day of observation. The differences were caused by the different of microclimate and sunlight penetration on the bunds of alang-alang.

Figure 3. Box plots of the incremental length growth of alang-alang gall; (a) cut alang-alang; (b) uncut alang-alang.

Alang-alang gall midge larvae which cause mechanical injury by salivary secretion, causes an increase in the amount of growth hormone in the section of the galls [15]. Increased amount of growth hormone in the infested part causes hyperplasia or hypertrophy. The result is the formation of abnormal plant structures commonly called “ganjur” or alang-alang galls. Mangoendihardjo stated that larvae that successfully infested alang-alang can be found alive for 28-30 d depending on the sex of the insect and soil moisture [11].

The time needed for the gall midges to emerge in the cut alang-alang was observed in 60 samples. On the 1st d of observation no adult gall midge emerging. The average number of the gall midges that emerged on the 2nd d in the cut treatment was 31 individuals or 52%, this was the highest number during the observation period. The number of gall midge that emerged on the 3rd d of the observation was 24 individuals or 40%, while the lowest number of the gall midges emerged on the 4th d of
observation was only 5 individuals (8%) (Fig. 4). The time needed for the gall midges to emerge in the uncut treatment was observed in the 21 samples. On the 1st and 2nd d of observations, there was no gall midges emerged. The midges that emerged on the 3rd, 4th, 5th and 6th d after successive observations were 2 individuals (9.52%), 4 individuals (19.04%), 14 individuals (66.67%), 1 individual (4.76%) respectively. The number of the midge that came out on the 4th d was the highest number during the observation.

![Figure 4](image)

**Figure 4.** Percentage of the emerged gall midge *Orseolia javanica* from the cut and uncut alang-alang during 6 d observation.

There are differences of time needed for the gall midges to complete its life cycle on the cut and uncut alang-alang. On the cut alang-alang bunds, most of the gall midges emerged earlier, in the second day of the observation. While on the uncut alang-alang bunds most of the gall midges emerged in the fifth day of the observation, 3 d delayed from the cut alang-alang (Figure 4). This is presumably because the alang-alang in the bund with the cut treatment received more sunlight exposure than the uncut alang-alang. As a result, the temperature in the cut bund is warmer and that cause the gall midges growth faster.

4. Conclusion
The cutting practice affects the growth of alang-alang with gall symptoms. Additionally, cutting practice of alang-alang having an impact on shortening of the gall midge life cycle which might increase the effectiveness of the biological control of alang-alang.

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