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Control of white stem borer *Schirpophaga innotata* Walker and earhead bug *Leptocorisa oratorius* Fabricius by using formulated *Calotropis gigantea* linn extract in rice field.

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ABSTRACT

White stem borer (WSB) and earhead bug (EHB) play an important role in reduction of productivity and quality on rice. To overcome the problem by high application of synthetic fungicide for managing these pests, the use of *Calotropis gigantea* extract is one of alternatives as environmentally friendly agent in control technology. On rice field non treated in span time of 33 days until 97 days, the WSB population and their incidence was optimum respectively at 53 days and 57 days after transplanting, while the optimum of EHB population and their incidence was respectively at 83 days and 87 days after transplanting. Through comparing to the control, treatment with leaves extract of *C. gigantea* formulated in form of powder applied through spraying with concentration of 10g/l, 20g/l and 30g/l at these optimum days reduced WSB population by respectively 54.2%, 66.7%, and 75.0% and WSB incidence by respectively 34.0%, 42.8%, and 51.7%. With same concentration as mentioned above, formulated *C. gigantea* reduced also EHB population by respectively 38.4%, 45.2%, and 63.0% and EHB incidence by respectively 40.3%, 50.7%, and 58.7%. These data demonstrated the efficacy of formulated *C. gigantea* in controlling rice pests of WSB and EHB.

Keywords: rice pests, formulation, population, incidence, spraying.

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INTRODUCTION

Rice as a staple food of more than 60 per cent of the world's population suffers from number of devastating pests. Among the most important in Sulawesi, Indonesia are rice white stem borer (WSB), *Schirpophaga innotata* Walker (Lepidoptera: Cerambidae) and rice earhead bug (EHB), *Leptocoris oratorius Fabricius* (Hemiptera: Alydidae) (1,2). The first insect attack the rice in field at all stages of growth (3,4) causing stem injure, drying of the central whorl and discolored panicles with empty or partially filled grain. This insect have high fecundity (4) and its larvae can diapause up to 10-12 months and consequently is able to infest severely and survive climatically driven long fallows (5). The second insect is a sap sucking pest, both nymphs and adults suck the sap from grains during milking growth stage and therefore make these grains partial or completely chaffy. Under severe infestation, growing panicle is completely shattered and becomes white coloured (6).

The major measure to control these two insect pests depends upon application of chemical insecticides. However, insecticidal control frequently requires several applications of spray and it is considered costly and not environmentally safe. We have investigated using plant extract as a control alternative for management of WSB and EHB, this is based on advantage of its bioactive compound, largely non-phytotoxic and easily biodegradable in nature. Among natural products who meet above criteria is derived from *Calotropis gigantea*.

C. gigantea belongs to the family of Asclepiadaceae, widely spread all over the world, especially in the tropical and subtropical region and known as giant milk weed (7,8). The main bioactive substances in this plant species are alkaloids, carbohydrates, glycosides, phenolic compounds, proteins and amino acids, flavanoids, saponins, sterols, acid compounds, and resins (9,8). The methanol extract of root bark of *C. gigantea* and its chloroform and petroleum and its chloroform and petroleum ether soluble fractions ether display the insecticidal activity and repellent toxicity against larvae and adult of grain storage insect, *Tribolium castaneum* (9). The same study show also that its leave extract can delay the development and decrease adult emergence of grains storage of *Sitophilus zeamais* (10). However, very little is known about the use of *C. gigantea* against *S. innotata*, and *L. oratorius* while in Sulawesi, this plant is very abundant.

The primary objective of the research presented here was to evaluate the efficacy of product derived of *C. gigantea* in form of powder in decreasing the incidence and population of *S. innotata* and *L. oratorius* in the field. Its utilization, therefore, will be useful for the farmers as they can easily harvest and apply *C. gigantea* to control these insect pests in their rice field.

MATERIALS AND METHODS

Source and preparation of *Calotropis gigantea* for treatment

The experiment used leaves of *C. gigantea* as source of active ingredient for testing against rice pests in the field. These leaves were collected from Takalar regency, South Sulawesi, washed, air dried in room condition for three days, and cut into small pieces, around 2 cm diameter. These pieces of leaves was extracted with methanol at ratio of 2 : 8 (w/v) and the mixture was incubated until filtrate become appearently clear. The extract was then filtered through Whatman No.1 filter paper and its filtrate was concentrated with a rotary evaporator at 64°C to obtain crude methanol extract in form of pasta.

For more practical in field application, 50% of pasta (w) was mixed with 2.5% of Tween 80 (v), 2.5% of agristick (v), and adjusted to 100% (w) with addition of kaolin. To this mixture, it was added methanol, stired equally and then evaporated for eliminating methanol, therefore the final product was in forme of a powder.

Field assessment

To evaluate the efficacy of formulated *C. gigantea* against rice pests, *Schirpophaga innotata* (WSB) and *Leptocoris oratorius* (EHB), the product was suspended in water and then sprayed on rice plant surface with concentration of 10g/l, 20g/l, and 30g/l. The experiment was designed as randomized block design with three treatments of concentration mentioned above and control without any use of *C. Gigantea*. Each

treatment planted with rice in plot size of 3 m x 3 m and with three repetitions, the total including control was 36 plots where the distance between them was 2 m.

Spraying of formulated *C. Gigantea* (0,5 l/plot) was started on rice of 30 days old and repeated up to seven times with distance time of 10 days. Observation of WSB incidence and population was done before spraying, while observation of EHB population was started on rice of 33 days old and its incidence was started on rice of 67 day old.

To observe the population of WSB, six sub plots per treatment where each plot consist of four rice hills, so the total was 24 hills and these hills were observed definitively along this experiment with interval time of 10 days and started at 33 days after transplanting. With use a containment, the insect was taken by using vacuum pump and the imago and or nimph collected was calculated by using the formula $X = \frac{\sum Xi}{n}$ where X is average of population (insect/hill), Xi is number of insect and n is total number of insect collected.

The incidence by WSB and EHB was also observed on hill used for observation the population of WSB and EHB, started at 37 days after transplanting. WSB incidence was calculated using the formula $P = \frac{a}{a + b} \times 100\%$ where P is incidence by WSB, a is number of stem infested, b is number stem not infested. While, EHB incidence was calculated using the formula $I = \frac{c}{d}$ where I is the incidence by EHB, c is number of damage grains and d is total number of grains damage.

Analysis

The data of WSB and EHB population and also their damage were analyzed without any transformation. Duncan’s multiple range test (DMRT) was then used for evaluating significant differences between the treatment means.

RESULTS

White stem borer (WSB), *Schirpophaga innotata* was observed its presence in rice plot at 33 days until 93 days and its optimum at 53 days after transplanting. Their population at above times of 33 days ,53 days, and 93 days was respectively 0.15 adult/hill, 0.24 adult/hill, 0.06 adult/hill. Treatment by formulated *C. gigantea* with concentration of 10 g/l, decreased WSB population to become respectively 0.10 adult/hill, 0.11 adult/hill, and 0.03 adult/hill or by comparing to the control, the decrease of populasion was respectively 33.3%, 54.2%, and 50.0%. With concentration of 20 g/l, the population decreased to 0.07 adult/hill, 0.08 adult/hill, and 0.00 adult/hill respectively or this correspond to decrease by 53.3%, 66.7%, and 100.0% respectively. While, with concentration of 30 g/l, population decreased to 0.07 adult/hill, 0.06 adult/hill, and 0.00 adult/hill respectively and this correspond to decrease by 53.3%, 75.0%, and 100.0% respectively (Figure 1). Statistical analysis showed that the significant different ($P \leq 0.05$) between WSB population on control and treatment was just observed at optimum time, not at 33 days and at 93 days.

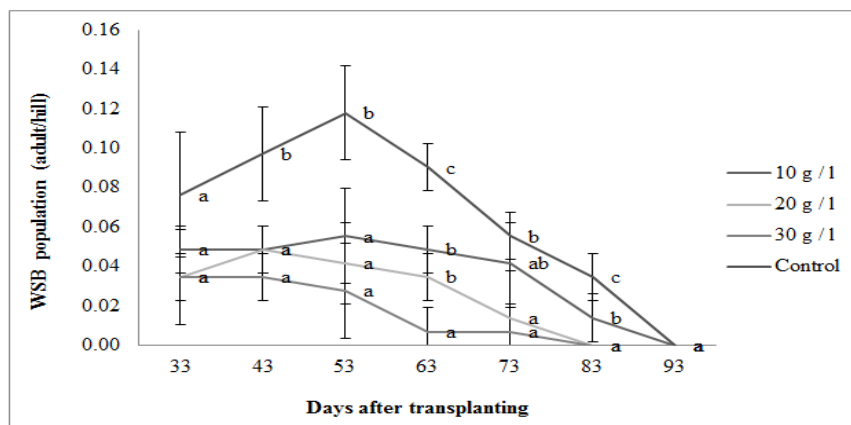


Figure 1. Population dinamic of rice white stem borer, *Scirpophaga innotata* on rice at span time of 33 days until 93 days after treatment by formulated *Calotropis gigantea* extract with concentration of 10 g/l, 20 g/l, and 30 g/l. Means in the same day followed by same letter are not significantly different according to 5% DMRT-test.

The incidence by WSB was observed first time on non treated rice at 37 days, its optimum at 57 days, and the last at 97 days with respectively 14.4%, 22.4% and 5.3%. Treatment by formulated *C. gigantea* with concentration of 10 g/l at above days, the incidence became 16.3%, 14.8%, and 1.8% and by comparing to control, the decrease of incidence was respectively -13.2%, 33.9%, and 55.6%. With concentration of 20 g/l, the incidence became respectively 13.9%, 12.8%, and 0.6% or the decrease of incidence was respectively 3.5%, 42.9%, and 66.0%. With concentration of 30 g/l, the incidence became respectively 14.9%, 10.8%, and 0.4% or the decrease of incidence was respectively -3.4%, 51.8%, and 92.5% (Figure 2). This incidence on control, except at 37 days, was significantly different ($P \leq 0.05$) with the treatments. While between treatments, treatment of 30 g/ at 57 days and 97 days was just significantly different with treatment of 10 g/l, not with treatment of 20 g/l.

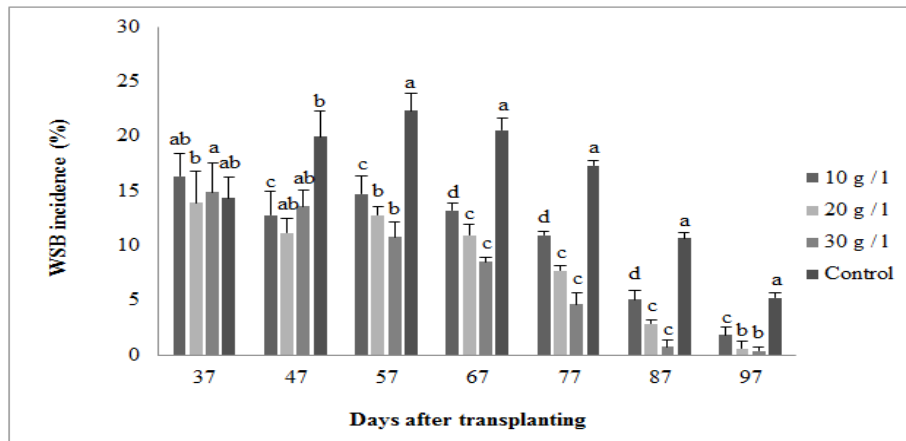


Figure 2. The incidence by white stem borer, *Scirpophaga innotata* (%) on rice at span time of 37 days until 97 days after treatment by formulated *Calotropis gigantea* extract in concentration of 10 g/l, 20 g/l, and 30 g/l. Means in the same day followed by same letter are not significantly different according to 5% DMRT

Rice earhead bug, *Leptocoris oratorius* existed in the rice field at span time of 33 days until 93 days and its optimum was at 83 days after transplanting. Its population at these times of 33, 83, and 93 days was respectively 0.01 adult/hill, 0.73 adult/hill, and 0.29 adult/hill. Treatment by formulated *C. gigantea* with concentration of 10 g/l, population at above day was 0.00 nymph and adult /hill, 0.45 nymph and adult /hill and 0.17 nymph and adult /hill respectively or the decrease by 100.0%, 38.4%, and 41.4 % respectively. With concentration of 20 g/l, the population was respectively 0.0 nymph and adult/hill, 0.40 nymph and adult/hill and 0.14 nymph and adult adult or the decrease by 100,0%, 45.2%, and 51.7%. With the concentration of 30 g/l, the population was respectively 0.0 nymph and adult /hill, 0.27 nymph and adult /hill, and 0.09 nymph and adult/hill or the decrease respectively by 100.0%, 63.0% and 69.0% (Figure 3). This EHB population on control was significantly different with all treatments at 83 days and 93 days and at same time its population on treatment of 30 g/l was also significant with on treatment of 10 g/l

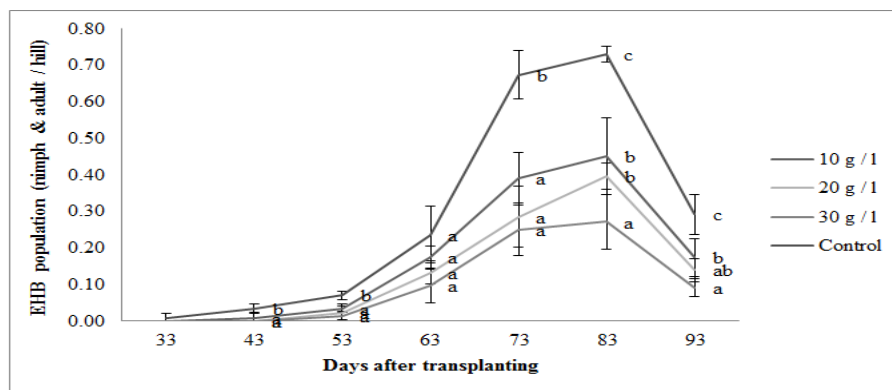


Figure 3. Population dynamic of rice earhead bug, *leptocoris oratorius* on rice at span time of 33 days until 93 days after treatment by formulated *Calotropis gigantea* extract in concentration of 10 g/l, 20 g/l, and 30 g/l. Means in the same day followed by same letter are not significantly different according to 5% DMRT-test.

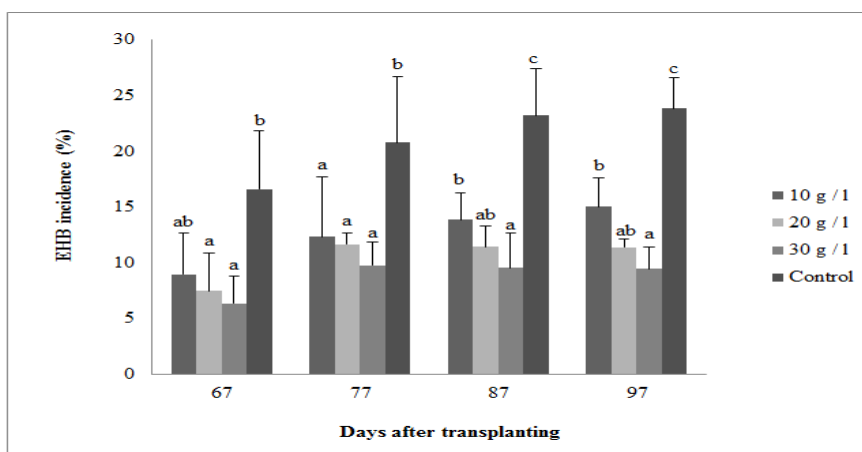


Figure 4. The incidence by earhead bug, *leptocorisa oratorius* (%) on rice at span time of 67 days until 97 days after treatment by formulated *Calotropis gigantea* extract in concentration of 10 g/l, 20 g/l, and 30 g/l. Means in the same day followed by same letter are not significantly different according to 5% DMRT

The incidence was observed in first time at 67 days (16.2%) and the highest was observed at 87 days (23.2%) and 97 days (23.8%) after planting. Treatment by formulated *C. gigantea* with concentration of 10 g/l at the days mentioned above was respectively 9.0%, 13.9%, 15.0% and by comparing to the control, the decrease of incidence was respectively 44.4%, 40.1%, and 37.0%. With the concentration of 20 g/l, the incidence was respectively 7.5%, 11.4%, and 11.4% and this correspond with the decrease of incidence by 53.7%, 50.9%, and 52.1%. While, with concentration of 30g/l was respectively 6.4%, 9.6%, and 9.5% or the decrease of incidence was respectively 60.5%, 58.6%, and 60.1% (Figure 4). Statistic analysis showed that control was significantly different ($P \leq 0.05$) with *C. gigantea* treatment of 10g/l, 20g/l and 30g/l, while between treatment, the significantly different was just observed between 10g/l and 30g/l at all times above.

DISCUSSION

White stem borer (WSB) and earhead bug (EHB) was presence during early vegetative stage of rice at 33 days after transplanting. WSB population increased rapidly for reaching a peak at 53 days and then decreased gradually. While EHB took 50 days for reaching the peak population. This dynamic population of two pests correlated to the climatic condition and the source of food (11,12). WSB infest rice at vegetative stage causing death of tillers and at the generative stage causing empty panicles and its growth and development was supported by rainy season (11,1) as occurring in this research. EHB infest the the grains soon after emergence of earheads and continued until these grains get hardened and due to sucking of its milky juice resulted in partial or complete chaffiness of grains (6). Therefore, the population curve of these two pests was different.

Application of formulated *C. gigantea* offered an impact in changing of WSB population dynamic from curve with peak to curve without any peak due to reduction continuously of their population (Figure 1). While, on EHB just offered an impact on population reduction and not on population peak (Figure 3). This situation indicated that EHB was more resistant to formulated *C. gigantea* compared with WSB. The reduction of population caused consequently the decrease of rice incidence by these two pests. More concentration and more frequency of application applied in rice field, more population of WSB and EHB and incidence of rice was reduced. Two times of application was minimum for giving impact for the decrease of WSB population incidence and also was same for the decrease of EHB population, while the minimum application for decreasing EHB incidence was four times.

The percentage of population and incidence reduction by EHB after application with high concentration of *C. gigantea* at end of observation reached respectively 69.0% and 60.2%, while by WSB reached respectively 100.0% and 93.0%. This supported the hypothesis above that EHB was more resistant to *C. gigantea* than WSB. EHB is insect with piercing and sucking mouthpart and because the feeding occurred inside the grain, this insect was less likely to be killed by formulated *C. gigantea* that only coat the surface of

rice. While, formulated *C. gigantea* on the surface of rice plant would be effective to insect with biting and chewing mouthpart like WSB, as this insect consumes more the surface area before boring rice stem.

The study on insects such as *Aedes aegypti*, *Anopheles stephensi*, and *Culex quinquefasciatus* showed the action mode of *Calotropis procera* extract, another species of Asclepiadaceae family was insecticidal activity, ovicidal activity, repellent, and fumigant (13,14). While, the study on post harvest insect of *Tribolium castaneum* with *C. gigantea* just showed insecticidal activity and repellent (9) and on *Sitophilus zeamais* was development-inhibiting activity (10). In this field trial, insecticidal, development-inhibiting and repellent activities of formulated *C. gigantea* were apparently occurred since the population and the incidence by WSB and EHB decrease significantly.

The results showed the efficacy of formulated *C. gigantea* for controlling WSB and EHB in rice field. However, in this trial we applied seven times of spraying, therefore, for offering more efficiency notably for EHB, the frequency of application could be reduced. If we observe the relation between population of WSB and EHB and their incidences on non treated rice, the crucial time and number of insect for initiating an important damage was 33 days after transplanting with population of 0.15 adult/hill for WSB and 63 days after transplanting with population of 0.24 nymph and adult/hill for EHB. These data can be used as starting point of formulated application in rice environment of Sulawesi.

Comparing to synthetic insecticide, botanical insecticide such as formulated *C. gigantea* is more safe for the environment, less expensive, easily to be processed and used by farmer and small-scale industries. Formulation of this leaves extract is one step for production in small-scale industry. In addition, the use of leaves extract as used in this trial is more practical and efficient than the use of other part of plant, because we can harvest any time without giving any damage to plant.

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