Biopesticidal Effect of Widuri (Calotropis gigantea L.) and Krinyuh (Chromolaena odorata L.) Leaves to Control Corn Fall Armyworm (Spodoptera frugiperda)

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***Abstract*. *Spodoptera frugiperda* is the main pest that attacks corn plants. This pest attack can cause damage to the leaves so it has the potential to reduce maize production. This study aimed to obtain the response of vegetable insecticides to the leaf extract of widuri and krinyuh leaf and its combination in reducing the attack intensity and population of the armyworm (*S. frugiperda* J. E. Smith) and its effect on corn production. This research was conducted in Oloboju Village, Sigi Biromaru District, Sigi Regency, Central Sulawesi Province. The time of study started from March to May 2022. This study used a Randomized Block Design (RAK) consisting of 4 treatments which were repeated 4 times to obtain 16 experimental units. The treatments were P0 = (control), P1 = widuri leaf extract at 8% concentration, P2 = krinyuh leaf extract at 8% concentration, and P3 = widuri leaf extract + krinyuh leaf extract at 8% concentration. The results showed that the treatment of extracts of widuri and krinyuh leaves and their combination had a significant effect on the intensity of attack and the population of Spodoptera frugiperda and maize production. The treatment of thistle leaf extract can reduce the intensity of the attack by an average of 7.53% and the population by an average of 0.97 tails, and increase corn production with an average production of 13.09 tons/ha.**

Keywords: Corn, Thistle Leaf and Krinyuh Leaf Extract, *S. frugiperda*

I. INTRODUCTION

Corn is one of the leading food crops in Indonesia. Aside from being a food ingredient, corn is also used as animal feed and industrial materials such as snacks and flour (Megasari and Khoiri, 2021). Corn has a high content of carbohydrates, protein, nutrients, and fibre, so in some areas, corn is used as the main staple ingredient to replace rice.

Corn production and productivity in Central Sulawesi change every year. The Central Statistics Agency (BPS) noted that corn production and productivity decreased in 2016-2017. Production in 2016 was 173,698 tons, with a productivity of 6.44 tons/ha. In 2017 corn production and productivity decreased of 163,057 tonnes with a productivity of 5.33 tonnes/ha (BPS, 2018).

There are still several significant obstacles to achieving optimum maize production. One factor inhibiting yield potential from corn production is the high attack of pests and disease factors (Fattah and Hamka, 2011).

S. frugiperda attacks corn plants from various stages, namely the vegetative and early generative phases. The attack begins at the top of the plant, drilling holes from the margins to the center of the leaves. Heavy attacks that occur in the vegetative phase can cause a decrease in production at harvest by 15-73% (Ranaweera, et al., 2021).

The primary control that farmers usually carry out to reduce S. frugiperda attacks is to use synthetic insecticides because they are more effective and results are known quickly and are easier to apply. However, using chemical insecticides can cause impacts such as environmental pollution, pest resurgence, and resistance and can cause pests to become tolerant to chemical pesticides (Gu. et al., 2018).

The use of vegetable insecticides is an alternative that can be carried out in an integrated manner to overcome the problem of the impact of the use of chemical pesticides. Botanical insecticides are natural pesticides derived from plant extracts containing secondary metabolites.\

Types of plants with secondary metabolites that can be used as vegetable insecticides are thistle leaves (Calotropis gigantea L.) and krinyuh leaves (Chromolaena odorata L.). Thistle leaves contain active compounds, namely flavonoids, tannins, polyphenols, saponins, and calcium oxalate, which are not liked by pests (Adhayani and Wiwi, 2021). Krisyuh leaves contain secondary metabolite compounds in flavonoids, alkaloids, tannins, terpenoids, and saponins (Siharis, et al., 2018).

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II. RESEARCH METHODS

Study site and design

This research was conducted in Oloboju Village, Sigi Biromaru District, Sigi District, Central Sulawesi Province. The time of research starts from March to May 2022.

This research was arranged using a randomized block design (RBD) with four treatments repeated four times to obtain 16 experimental treatment units. P0 = control (without giving any treatment), P1 = Thistle leaf extract with a concentration of 8%, P2 = Thistle leaf extract with a concentration of 8%, P3 = Thistle leaf extract + Crisnyuh leaf extract with a concentration of 8%.

Extract Manufacturing Stage

The extract is made by preparing thistle and krinyuh leaves according to what is needed. Furthermore, the thistle and krinyuh leaves are cleaned under running water and air-dried for approximately 5 hours. The thistle and krinyuh leaves are weighed as much as 500 g, then chopped into small pieces using a knife and crushed using a blender. Next, the crushed leaves are put into each jerry can containing 3 litres. To take the extract, compound leaves are soaked using 1 litre of clean water with a ratio (2:1), then stored in a room for 1 × 24 hours. Before being applied, it is first filtered using a delicate cloth to get the extract.

Extract Application Stage

The application of the extract uses a sprayer and is carried out according to each treatment by spraying the entire corn plant. Spraying was carried out when the plants were 21 days after planting (Hst), with spraying intervals once a week until the plants were 42 Hst.

Observational Variables

1. Attack Intensity. The intensity of S. frugiperda attacks was observed by observing the damage to each leaf of the sample plant. The number of sample plants was ten plants per bed. Observations were made on corn plants aged 24 HST, 31 HST, 38 HST, and 45 HST. To calculate the amount of damage caused by S. frugiperda, the formula put forward by (Hendrival, et al., 2013) is used.

$$\mathbf{I} = \frac{\sum(\boldsymbol{n}.\boldsymbol{v})}{\boldsymbol{Z}.\boldsymbol{N}} \times \mathbf{100\%}$$

Description:

I: The intensity of the attack

n: Number of samples observed for each attack category

v: The scale value of each attack category

Z: The highest damage scale value

N: Number of samples observed

2. Population Density. The population of S. frugiperda larvae was counted directly for every 10 sample plants per bed. Observations were made randomly. Population observations were made on corn plants aged 24 HST, 31 HST, 38 HST and 48 HST.

3. Production of Corn Plants. The yield per hectare is obtained using the formula (Maruapay, 2012). The size of the treatment beds is 2 x 3 m with a spacing of 40 x 80 cm.

$$\textbf{Production} = \frac{\mathbf{8.000}\ (\boldsymbol{m}^2)}{\mathbf{a}\ (\boldsymbol{m}^2)} \times \frac{\mathbf{b}\ (\mathbf{kg})}{\mathbf{1.000}}$$

Description:
a: Size of the plot area (m2)
b: Fruit weight per plot (kg)

Data analysis

Observational data were analyzed using a variance. If the variance results showed a significant or very significant effect, then it was continued with the Honestly Significant Difference Test at the 5% level.

III. RESULTS AND DISCUSSION

A. Results

The intensity of Attack: The results of observing the intensity of attack showed that the treatment of thistle leaf extract, krinyuh leaf extract, and combined extracts showed different results from the control treatment at various plant ages (Table 1).

A decrease in attack intensity was seen from all treatments at various observation times. However, the thistle extract treatment tended to show a more significant reduction in attack intensity, although it did not appear to be any different from the krinyuh extract treatment. The decrease in attack intensity in the thistle extract treatment was 17.50%, 15.00%, 10.00% and 7.53%. The combined extract treatment showed a relatively high intensity of attack when compared to the thistle extract and krinyuh extract treatments. However, the results of the attack intensity in the combined extract treatment were lower when compared to the control.

Table 1. Average Attack Intensity (%) of S. frugiperda at various Ages of Corn Plants / 10 plants.

Treatments	Day after planting			
	24	31	38	45
P0	46,25[a]	35,00[a]	26,25[a]	18,75 (19,72)[a]
P1	17,50[c]	15,00[c]	10,00[b]	5,00 (7,53)[b]
P2	20,00[bc]	17,50[bc]	13,75[b]	7,50 (10,46)[b]
P3	23,75[b]	21,25[b]	16,25[b]	10,00 (12,41)[ab]
HSD 5%	6,37	6,21	7,41	8,10

Note: Numbers followed by the same letter in the same column not significantly different in the BNJ test at the 5% level. The number in brackets is the result of the transformation √(x +0.5)

Table 2. Average population density of S. frugiperda larvae (tail) at various ages of corn plants/10 plants

Treatment	Day after planting

	24	31	38	45
P0	11,25^{a}	10,00^{a}	7,75^{a}	3,75 (3,91)^{a}
P1	4,50^{c}	4,25^{c}	3,50^{c}	1,00 (0,97)^{b}
P2	6,50^{bc}	6,00^{b}	5,00^{b}	1,25 (1,28)^{b}
P3	7,25^{b}	6,25^{b}	5,50^{b}	2,50 (2,36)^{ab}
BNJ 5%	2,47	1,69	1,00	2,03

Note: Numbers followed by the same letter in the same column not significantly different in the BNJ test at the 5% level. The number in brackets is the result of the transformation $\sqrt{(x + 0.5)}$

b) Population Density. The results of population density observations showed that the thistle extract, akrinyuh extract, and combined extract treatments gave different results from the control (Table 2).

Thistle extract treatment gave the lowest population densities at various plant ages, namely 4.50 individuals, 4.25 individuals, 3.50 individuals, and 0.97 individuals. A decrease in population density tends to occur in all treatments, but it differs from the control.

c) Corn Production. The results of observations of corn production converted to tons per hectare in various extract treatments showed that all extract treatments gave different production results from the control (Table 3).

The thistle extract treatment gave the highest corn production, namely 13.09 tons/ha, followed by a crunchy treatment of 12.31 tons/ha, and the combination treatment showed 11.36 tons/ha. The lowest production was in control, which was 9.85 tons. /Ha.

TABLE 3. Average Yield of Corn Production (tonnes/ha)

Treatments	Production (Ton/Ha)
P0	9,85^{c}
P1	13,09^{a}
P2	12,31^{ab}
P3	11,36^{b}
BNJ 5%	1,50

Note: Numbers followed by the same letter in the same column not significantly different in the BNJ test at the 5% level.

The decrease in attack intensity and population density in each extract treatment at various observation times (age of corn plants) may be influenced by the plant's phenology from the vegetative phase to the generative phase, also influenced by the compound content present in each extract.

Prabhu et al. (2012) stated that thistle leaf extract contains toxic and antifeedant compounds. These compounds are cardenolides, glycosides, flavonoids, gigantic (Seniya, et al., 2011), tannins, saponins, steroids, and terpenoids. In krinyuh leaf extract, the secondary metabolites are flavonoids, alkaloids, tannins, triterpenoids, and saponins (Vijayaraghavan, et al., 2017).

The content of saponins in thistle leaves plays a role in reducing the activity of protoaze enzymes in the digestive tract so that the digestive system becomes disturbed and inhibits the development of insects. The tannin and saponin compounds contained in thistle leaves give a bitter taste so that they become food repellents for insects (Roopashree and Naik, 2019).

The tannin compounds in krinyuh leaves can also act as antifeedants and contact poisons. These compounds enter through the moulting process by breaking through the semipermeable walls that protect the larval body and then enter the epidermal cells in the stomach and intestines of insects, causing lysis and reducing nutrient absorption (Barbehenn and Peter, 2011).

There was a significant decrease in attack intensity and population density at 45 DAP observations because the plants had entered the generative phase. In that phase, the plants had issued flowers so there were no longer young leaves as food for S. frugiperda. Supartha, et al. (2021) stated that the peak of S. frugiperda attacks occurred when the corn plants were four weeks old and would continue to decline, until the attacks became very low. S. frugiperda pest populations will generally peak in the second and third weeks after planting, but after entering the sixth week of age, the population will significantly decrease (Herlinda, et al., 2022).

Treatment using a combination of thistle and krinyuh leaf extracts gave results of attack intensity and low population density compared to single extracts of thistle and krinyuh leaves at various observation times. This is thought to be caused by antagonistic properties due to mixing thistle and krinyuh extracts. Dada, et al. (2007) stated that mixing several active plant compounds can cause antagonistic, synergistic, and neutral properties of extract activity. The results of Yuswanti and Prijono's research (2004) stated that mixing the acetyl acetate fraction of Aglaia hamsiana seeds with Dysoxilium acutangulum leaf stalks had a synergistic effect on P. xylostella instar three larvae at LC50 but was antagonistic at LC95.

The low attack rate of S. frugiperda in treatment P1 (thistle leaf extract) is thought to be due to the presence of the compound giganticine glycosides. It contains gigantic and glycoside compounds. Glycosides are compounds that can decompose into thiocyanate compounds, these compounds can work as contact poisons, stomach poisons, and nerves that can inhibit the respiratory system and the central nervous and respiratory organs of insects (Hasanah, et al., 2012).

The presence of glycosides in the extract used can cause behavioural changes in insects. Changes in behaviour occur in the form of the reduced active power of insects, lack of appetite, and paralysis. In addition, glycosides can also cause morphology and colour changes in the larvae's body from light brown to dark brown. Changes in morphology and colour changes are indications of poisoning, and disturbances in the bodies of the larvae which can eventually lead to death (Rustam and Fitri, 2022).

Differences in S. frugiperda pest attacks and larval population densities in each treatment caused the difference in corn production. High pest attacks on plants can reduce production yields. This is due to damage to plant leaves so that the leaf surface area for photosynthesis is reduced. Reduced photosynthetic results can cause a decrease in production (Septian, et al., 2021).

IV. CONCLUSIONS

Treatment application of thistle and krinyuh leaf extracts and a combination of thistle and krinyuh leaf extracts on corn plantations significantly affected the low attack intensity of S. frugiperda and population density of S. frugiperda. They increased maize production compared to the control (without treatment).

The application of thistle leaf extract treatment resulted in lower attack intensity and population density of S.frugiperda and higher production than other extract treatments.

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