Population of *Aceria guerreronis* Keifer (Acari: Eriophydae) and damage of the coconut fruit in South Sulawesi, Indonesia

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**Abstract.** Coconut mite *Aceria guerreronis* Keifer (Acari: Eriophydae) as important pest in coconut plantation around the world. The population density of *A. guerreronis* has many impacts to coconut fruit damage. The purpose of research is to study population density of *A. guerreronis*, the coconut fruit damage and correlation population density in different coconut plantation at South Sulawesi. The information about presence of *A. guerreronis* is very useful to manage *A. guerreronis* for the development coconut plantation in South Sulawesi. The research was conducted in coconut plantation near the beach at three regencies of South Sulawesi namely Jeneponto, Wajo and Luwu. The observation of *A. guerreronis* population was held in laboratory at Plant Pest and Disease Department, Faculty of Agriculture, Universitas Hasanuddin Makassar from July to October 2019. Population of coconut mite *A. guerreronis* observed with washing twice all of coconut petals. First washing (P1) and second washing (P2) used 30 mL detergent solution. 1 mL of the washing water was collected observed used binocular microscope. The coconut petals after washing process observed under stereo microscope. The results show that the average damage of coconut fruit at Jeneponto was 20.35%, Wajo 14.6% and Luwu 10.6%. Population of adult and eggs of *A. guerreronis* at Jeneponto (2,566.45 individual and 828.95 eggs), Wajo (1,548 individual and 452.8 eggs) and Luwu (1,078.7 individual and 360.3 eggs). Findings of research show that there was a very strong correlation between population with damage level with R value at Jeneponto (0.919), Wajo (0.954) and Luwu (0.975).

1. **Introduction**

Coconut mite or coconut perianth mite (*Acaria guerreronis* Keifer), family Eriophyidae, is known as Eriophyidae mites on coconut [1, 2]. In 1960, coconut mite was first reported attacking coconut plants in Guerrero State, Mexico and Brazil in 1976 [3]. In 1997, the coconut mite was first reported attacking coconut plantation in Sri Lanka. Few years later, exactly at 1988, coconut mite *A. guerreronis* was first reported attacking coconut plants in Ernakulam and Kerala areas. The colony of *A. guerreronis* very faster spread to Andhra Pradesh, Karnataka, Kerala, Lakshadweep islands and Tamil Nadu as important coconut growing areas in India [3, 4].

Coconut mite *A. guerreronis* has characteristics specific different from another mite species including adult body shape of *A. guerreronis* forming vermiform, body length about 205 - 255 μm, width 36 - 52 μm [5, 6], white body transparent, two pairs of legs. Body parts appear several long setae. Genitalia opening structures for male and female mites are located behind the legs. Female
mites laying eggs around 200 eggs in a supporting environment and host plant. After hatching from the egg, immature stages of *A. guerreronis* develop in two nymph stages and become adult [7].

The presence and symptom of *A. guerreronis* in coconut plantation will detection damage of coconut. Commonly the damage of coconut fruit caused by adult and nymph of *A. guerreronis*. In situation without monitoring of damage condition, heavy infection of coconut fruit surrounding plantation contain *A. guerreronis* forming many colonies at petals and spread to another areas [5, 8, 9]. Presence of coconut mite *A. guerreronis* made some injuries in coconut fruit surface and finally coconut fall before harvest time. Infection coconut fruit change color surface from green to dark brown. Colony of *A. guerreronis* in mature coconut will cause crack and longitudinal pieces along outer surface of coconut fiber. *A. guerreronis* produced gummy exudates at damage coconut and out from the crack in fruit surface. Infection coconut results in hard skin related to decreasing quality of coconut flesh as main source of copra and coconut fiber [10].

In Indonesia, the symptom such as damage by *A. guerreronis* was started in the middle of 2012 at Winuri village, East Likupang, Minahasa District, North Sulawesi [10]. Based government regulation Indonesian Ministry of Agriculture Nomor 51/Permentan/KR.010/9/2015 explain that the coconut mite *A. gurreronis* have been in Indonesia especially Sulawesi, Riau Island, East Kalimatan, Ternate and Papua. In South Sulawesi, *A. Guerreronis* cause damaged in coconut plantation at few district areas such as: Sidrap, Selayar island, Bone and Bulukumba (Nurariaty, unpublished data). The presence of *A. guerreronis* in another district of coconut production at Jeneponto, Wajo and Luwu unidentified. A few important factors that impact of population of *A. guerreronisi* including age and fruit size. The young coconut fruit with small size has population average higher than medium and mature [11].

Climate condition including weather as important abiotic factor supporting population outbreak of *A. guerreronis*. Commonly population of *A. guerreronis* higher in dry condition than wet season [4, 8, 12]. The damage of coconut fruit at surrounding coastal areas in high risk attacked by *A. guerreronis* such as Jeneponto and another plantation in South Sulawesi. Beside climate condition, the ecology factor including presence suitable food (host plant of *A. guerreronis*) and natural enemis has many contribute increasing population of *A. guerreronis*. Essential oils of aromatic and medicinal plants as alternative botanical biocide management for coconut mite *A. guerreronis*. The methods safety for environment and consumers [1, 8, 9].

Based information damage at coconut plantation in South Sulawesi as a strong reason exploring presence of *A. gurreronis*. The purpose of research is to study population density of *A. guerreronis*, the coconut fruit damage and correlation population density at different coconut plantation at South Sulawesi. The information about presence of *A. guerreronis* very useful manage *A. guerreronis* for development coconut plantation in South Sulawesi.

2. Research methods

2.1. Research site

The research was conducted in coconut plantation near the beach at three district of South Sulawesi such as: Jeneponto, Wajo and Luwu. The observation of *A. guerreronis* population was held in laboratory at Plant Pest and Disease Department, Faculty of Agriculture, Universitas Hasanuddin Makassar in July to October 2019.

2.2. Population density of *A. guerreronis*

Coconut mite’s *A. guerreronis* living on the coconut petals that source of food and protected colony from sunlight. Washing coconut mites at coconut petals as their niche need 8-10 drops of Tween 80 then solution are dissolved in 250 mL of distilled water. A funnel mounted on a transparent tube (length 5-8 cm) as tool collected the washing solution from coconut petals. Coconut fruit age 4 and 7 months randomly selected from the tree at three different plantation. The coconut sample removed all of petals then washed by spraying separately used 30 mL of detergent solution. The result of first washing (P1) shaken at 5 second and total number of *A. guerreronis* in 1 mL suspension was counted
under binocular microscope. Then repeat the coconut treatment in the second washing (P2) for every coconut petal in order to cleaning remains all of *A. guerreronis*. All of coconut petals after two washing treatments were observed under a stereo microscope.

Siriwardena et al. [17] state the formula used counting the real number of *A. guerreronis* at coconut:

\[
Y = \sum_{i=1}^{30} (A) + \sum_{i=1}^{30} (B) + C
\]

Y : Number all of *A. guerreronis*
A : Number of *A. guerreronis* in 1 mL at first washing (P1).
B : Number of *A. guerreronis* in 1 mL at second washing (P2)
C : Remains all of *A. guerreronis* at coconut petals after washing treatment

2.3. Coconut damage of *A. guerreronis*
Sampling carried out in three different coconut plantations at South Sulawesi was conducted using a purposive sampling. Ten coconut trees in every location, indicated *A. guerreronis* symptoms, were chosen as source samplings. Sampling locations were in coconut plantations that grow in coastal areas. For each sample tree, scoring was carried out on two coconut bunches aged 4 and 7 months. From each of the coconut bunch, the one of coconut showed symptomatic attacked area of *A. guerreronis* was taken and observed with magnifying glass. The level of coconut damage was observed by counting the symptomatic portion in the coconut fruit due attack of *A. guerreronis* [11, 13].

2.4. Correlation between *A. guerreronis* population density and coconut fruit damage
The correlation between population density of *A. guerreronis* and the damage level of coconuts at three locations in Jeneponto, Wajo and Luwu are expressed in simple linear regression equations:

\[
Y = a + bX
\]

Y = damage of fruit coconut
X = population of *A. guerreronis*
A = constant
B = coefficient of regression

Test of significant correlation of the collected data, a population density regression (X) with coconut fruit damage (Y) was analyzed using a statistically significant = 0.05 (confidence level 95%).

Table 1. Correlation level values category

| No. | Value   | Correlation level |
|-----|---------|-------------------|
| 1   | 0.00 – 0.199 | very low          |
| 2   | 0.20 – 0.399 | low              |
| 3   | 0.40 – 0.599 | medium           |
| 4   | 0.60 – 0.799 | strong           |
| 5   | 0.80 – 1.000 | very strong      |

2.5. Data analysis
The research used randomized block design. All of the data collected were analysed using ANOVA. A significant difference among treatments was detected then the treatment means were separated using a Duncan’s Multiple Range Test at 0.05.
3. Results and discussion

3.1. Population density of coconut mite A. guereronis

The highest population of A. guereronis was detected at Jeneponto, in contrast the lowest population of A. guereronis in Luwu. The average of eggs and adult of coconut mite of A. guereronis in coconut age 4 and 7 months from different coconut plantation in South Sulawesi was showed in table 2.

| Coconut plantation | Coconut fruit age (months) | Average of coconut mite population (individual per 20 coconut fruit) |
|---------------------|----------------------------|---------------------------------------------------------------------|
| Jeneponto           | 4 and 7                    | 828.95<sup>a</sup> 2,566.45<sup>a</sup> |
| Wajo                | 4 and 7                    | 452.8<sup>b</sup> 1,548.00<sup>b</sup> |
| Luwu                | 4 and 7                    | 360.3<sup>b</sup> 1,078.70<sup>b</sup> |

Numbers in same column followed by same letters are not significantly different (P=0.05 Duncan Multiple Range Test).

The analysis of table 2 shows that the average number of A. guereronis eggs found in Jeneponto regency was about 828.95 eggs. The number of coconut mite eggs found in Jeneponto was significantly different to the average eggs number found in Wajo (452.8 eggs) and Luwu (360.3 eggs). In contrast, results found in coconut plantation at Wajo was not significantly differed to coconut plantation in Luwu regency. The average number of adult coconut mite population at Jeneponto was about 2,566.45 individuals which significantly different with adult population found in Wajo (1,548 individuals) and Luwu (1,078.7 individuals). Lawson-Balagbo et al. [8] reported that total of A. Guereronis from 360 coconut approximately 728,659 individuals (average 2,024 coconut mite per coconut). In this study, only 29 coconut (8%) was not attacked by A. guereronis.

The one of important factors that impacts the population density of A. guereronis is rainfall in coconut plantation. According to Lawson-Balagbo et al. [8] coconut mite population are generally lower in wet season. The monthly rainfall from every coconut plantation has a broad variety at June 2018 (age 4 month of coconut fruit). According to Fauziah [11], the rainfall in Jeneponto was relatively lower (about 88 mm/month). In contrast, the rainfall in the coconut plantation during June 2018 was higher in Wajo and Luwu regencies with rainfall of 409 mm/month and 281 mm/month, respectively. In March 2018 (age 7 month of coconut fruit), Jeneponto had lower rainfall (about 5 mm/month) similar to Wajo (89 mm/month) and Luwu in moderate rainfall (183 mm/month).

The rainfall and presence of A. guereronis in coconut plantation has a strong relation with the season and population of coconut mites decreasing when rainfall is higher [8, 12, 14]. The higher the rainfall, the lower the population of coconut mite and more coconut population attacked in dry season. The one important factor causing higher population of A. guereronis in Jeneponto was relatively lower rainfall and dry condition than coconut plantation areas in Wajo and Luwu.

Herniwati and Syarifuddin [15] state that the amount of rainfall will increase more than 100 mm in every years at coconut plantation. Based on treatment in this research including the first washing (P1), second washing (P2) and coconut petals observation, the population of A. guereronis shown to be varied in number. The different population density of A. guereronis indicate the total of adult and eggs in Jeneponto were higher than Wajo and Luwu (figure 1).

The calculation of A. guereronis population was carried out step by step on coconuts fruit such as: first washing (P1), second washing (P2) and observation of the remains of A. guereronis on the coconut petals. Based on the average of total distribution of A. guereronis in every treatment from the different research sites, it shows higher population density in Jeneponto (figure 1A).
A

COCONUT MITES (%)

First Washing  Second washing  Petals

COCONUT NUMBER

B

COCONUT MITES (%)

First Washing  Second washing  Petals

COCONUT NUMBER
In the treatment of first washing (P1), the total of *A. guerreronis* adults found was about 36,213 individuals (70.55%) and 12,256 eggs (73.93%), the number of *A. guerreronis* at second washing (P2) was 15,107 individuals (29.43%) and 4,322 eggs (26.07%). The results show number of *A. guerreronis* remains on the coconut petals were 9 individuals (0.02%) per 20 coconut fruit samples.

Higher population of *A. guerreronis* in Wajo at the first washing (P1) was found with the total number of 22,875 individuals (73.89%) and 6,460 eggs (71.33%), total number from second washing (P2) was 8,016 individuals (25.89%) and 2,596 eggs (28.67%). In coconut petals the total of *A. guerreronis* was 69 individuals (0.22%) per 20 coconut fruit samples in observation. In another result from Luwu, the higher population density of *A. guerreronis* was showed at first washing (P1) with a total of 16,515 individuals (76.55%) and 5,461 eggs (75.78%), second washing (P2) about 4,866 individuals (22.55%) and 1,745 (24.22%) eggs. Observation remains *A. guerreronis* in coconut petals about 193 individuals (0.89%) per 20 coconut fruit samples.

Based on observation from three different coconut plantation, it shows that population of *A. guerreronis* was the highest in first washing (P1). The findings of research are suitable with Siriwardena et al. [13] reported that the number of *A. guerreronis* in first washing about 94.3% (average: 90.1 - 99.8%) and the result in second washing (P2) about 4.7% (0.3-8.8%). The number remains of *A. guerreronis* in coconut petals not significant than washing activities. This method gives useful information that washing treatment of coconut petals more efficient and effective in prediction population density of *A. guerreronis* in coconut fruit.

### 3.2. Damage of coconut fruit by presence of *A. guerreronis*

The presence of coconut mite *A. guerreronis* caused a varied damage on the coconut fruit. Percentage of damage of the coconut fruit by *A. guerreronis* activities in three coconut plantations in South Sulawesi is shown in table 3.
Table 3. The damage of coconut fruit in different plantation at South Sulawesi (%)

| Coconut plantation | Coconut fruit age (months) | Damage (%) |
|--------------------|----------------------------|------------|
| Jeneponto           | 4 and 7                    | 20.35a     |
| Wajo               | 4 and 7                    | 14.6b      |
| Luwu              | 4 and 7                    | 10.6c      |

Numbers in same column followed by same letters are not significantly different (P=0.05 Duncan Multiple Range Test).

The analysis of data at table 3 shows that damage of coconut fruit in Jeneponto was about 20.35%, significantly different to damage levels in Wajo (14.6%) and Luwu (10.6%). The main factor caused coconut fruit damage is due to the development of *A. guererroronis* in coconut plantation and difficulties in monitoring the presence of the coconut mite. The damage percentage of coconut fruit varied with every coconut plantation. According to Hosang et al. [10], *A. guererroronis* attack the coconut fruit during ages of 1 – 2 months, the damage will be increased during the development of the coconut fruit. The damage will decrease the quality of fruit and cause loss in harvest. According to Negloh et al. [16], the level of damage of the coconut fruit increased following age and development process of the fruit. Presence of *A. guererroronis* will cause more weight loss of coconut fruit since 7 to 12 months. The *A. guererroronis* lives and develops under coconut petals, damaged meristem tissue and another soft part of the plant. Initially, young coconut will show symptoms such as pale small triangle in surface of fruit. The symptom will spread and cover major of fruit surface especially in dry condition. The damage of coconut skin will change color from green to brown. *A. guererroronis* attacked mature coconut fruit, the symptom forming brown cracks [1, 10]. The heavy damage in coconut will change the shape into wrinkles and fall before harvest time [7].

3.3. Density population of *A. guererroronis* correlation to coconut damage

The correlation between density population of coconut mite *A. guererroronis* with coconut damage from three different research site in Jeneponto, Wajo and Luwu has a positive correlation. The higher number of *A. guererroronis* will caused heavy damage along development of coconut fruit (figure 2).

![Figure 2](image-url)
The correlation between population densities with damage of coconut fruit at Jeneponto was shown in figure 3A. The mathematic formulas $Y=0.0049x$, $R = 0.919$ and $R^2 = 0.845$ explain the individual of $A. guerreronis$ will damage coconut fruit about 0.0049%. Correlation between population density and coconut level damage was very strong (91.9%) then impact of population density to coconut fruit damage about 84.5%. Explained results from Wajo (figure 3B) was showed that $Y=0.0073x$, $R = 0.954$ and $R^2 = 0.910$. The presence individual of $A. guerreronis$ will caused damage 0.0073%, the population density and coconut level damage very strong (95.4%), impact population density and damage about 91%. Finally, the result activities of $A. guerreronis$ at Luwu coconut plantation (figure 3C) $Y=0.011x$, $R = 0.975$ and $R^2 = 0.951$. The individual $A. guerreronis$ will cause damage 0.011%, population damage and coconut level damage were very strong (97.5%) and their impact was significant (95.1%).

The data from all of coconut plantation indicate that the presence of $A. guerreronis$ has positive correlation to coconut fruit damages. This fact suggests based R value from Jeneponto (91.9%), Wajo (95.4%) and Luwu (97.5%), respectively. The R value from three different coconut plantation has correlation more than 80% indicated very strong. According to Purba et al. [17] state that variable dependent (X) to independent variable (Y) at position level 0.80-1.000 resulted very strong correlation. Based the result of the research, need more observation about presence natural enemies of $A. guerreronis$ and supporting factor surrounding coconut plantation to control presence of coconut mite in South Sulawesi.

4. Conclusions

The average population adult and eggs of $A. guerreronis$ in three different coconut plantation at Jeneponto (2,566.45 individual and 828.95 eggs), Wajo (1,548 individual and 452.8 eggs) and Luwu (1,078 individual and 360.3 eggs), respectively. The level coconut fruit damage by activities of $A. guerreronis$ at Jeneponto (20.35%), Wajo (14.6%) and Luwu (10.6%), respectively. The correlation between population density of $A. guerreronis$ with level of coconut damage from three different plantation in Jeneponto ($R = 0.919$ and $R^2 = 0.845$), Wajo ($R = 0.954$ and $R^2 = 0.910$) and Luwu ($R = 0.975$ and $R^2 = 0.951$).

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