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# *Abundance, Spatial Distribution, And Population Dynamics Of Aphis Craccivora In Peanut Cultivation In The Small Islands Of Maluku, Indonesia*

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**Abstract: Aphis craccivora Koch is an important pest of peanut plants whose population fluctuates over time and shows varied spatial distribution patterns. Information on this species' population characteristics in the agroecosystem of small islands in Maluku remains limited. This study aims to analyse the abundance, spatial distribution, and population dynamics of A. craccivora in peanut plants on Saparua Island and Nusalaut Island, Central Maluku Regency, Maluku Province, Indonesia. We conducted the study in April-June 2026 using a quantitative descriptive survey. We established five observation plots at each location and selected five plants per plot using a diagonal sampling pattern. We calculated the A. craccivora population every 7 days. We analysed spatial distribution using the Morisita Index and evaluated population dynamics based on growth rate (r). The average A. craccivora population was higher in Saparua (154 individuals) than in Nusalaut (101 individuals). The population distribution in Saparua was clustered (Moran's I index 1.427), while in Nusalaut it was close to random with a weak tendency to cluster (1.035). The population growth rate fluctuated across periods, with values of r −1.035 to 1.299 in Saparua and −0.112 to 0.579 in Nusalaut. This information can inform the development of pest monitoring that accounts for spatial and temporal variation.**

**Keywords: Aphis craccivora, peanuts, population abundance, spatial distribution, population dynamics, small islands, Maluku.**

## 1. Introduction

Peanuts (*Arachis hypogaea* L.) are an important food crop that provides vegetable protein and oil and has economic value for the community. This plant also has an ecological function through symbiosis with nitrogen-fixing bacteria, giving it the potential to support sustainable land productivity [1]. However, peanut productivity at the farmer level still faces various obstacles, including attacks by plant pest organisms (OPT). Among the various pests that attack peanuts, *Aphis craccivora* Koch (Hemiptera: Aphididae) is one of the important pests because its activity of sucking phloem sap can interfere with plant growth and reduce crop yields. This species also acts as a vector of viral diseases in host plants [2], [3].

*Aphis craccivora* has a high reproductive rate, so its population can increase rapidly when host plant and environmental conditions are favourable. Plant quality, environmental conditions, and other biotic factors influence its population dynamics. Research on peanut cultivation suggests that aphid development during the growing season may be related to weather conditions, plant phenology, and the presence of natural enemies [4], [5], [6]. Weather conditions, including temperature, humidity,

precipitation, sunlight, and wind speed, may also relate to changes in *A. craccivora* populations [7]. Therefore, temporal observations are needed to describe periods of population increase and decline during plant growth.

In addition to the temporal dimension, spatial distribution is an important component of understanding insect population ecology. Individual pests can have clustered, random, or uniform distribution patterns related to resource heterogeneity, microhabitat conditions, plant structure, reproductive behaviour, and interactions between individuals [8]. In aphids, clustering can occur because individuals tend to survive and form colonies on suitable plants. In contrast, winged individuals help displace and colonise new habitats [9]. Habitat heterogeneity also shapes spatial variation in insect populations [10]. Thus, spatial distribution information can help explain population characteristics and support the development of more representative monitoring methods.

Spatial and temporal dimensions are becoming increasingly relevant in small island agroecosystems. Insular systems have characteristics such as limited habitat area, geographical isolation, land fragmentation, and different environmental conditions between islands. Island characteristics, including habitat isolation and configuration, can influence colonization, distribution, and the presence of organisms in insular systems [11]. In agricultural systems, these characteristics relate to host-plant availability, habitat structure, insect movement, and interactions with other organisms. Peanut cultivation itself has been carried out in coastal areas and small islands in Indonesia [12].

In Maluku, peanuts are cultivated in various agroecosystems with different land characteristics and cropping systems. However, information integrating the abundance, spatial distribution, and temporal dynamics of *A. craccivora* in peanut plants in small-island agroecosystems is still limited. Previous research has provided information on pest dynamics in peanuts and their relationship to environmental conditions [5], [6], [7], but information on how these populations are distributed in space and change over time in small-island agricultural systems still needs to be studied.

Understanding abundance, spatial distribution patterns, and population dynamics is needed to produce ecological information that can support pest monitoring and Integrated Pest Management (IPM). The Morisita Index can identify spatial distribution patterns, while population growth rates can describe population trends between observation periods. Based on these problems, this study aims to analyze population abundance, spatial distribution patterns, and population dynamics of *A. craccivora* in peanut plants on Saparua Island and Nusalaut Island, Central Maluku Regency, Maluku Province, Indonesia. The results are expected to provide ecological information to support the development of a more adaptive pest monitoring system in small-island agroecosystems.

## 2. Materials and Methods

### 2.1 Location and Time of The Study

The research was carried out on peanut plantations owned by farmers in Saparua and Nusalaut Districts, Central Maluku Regency, Maluku Province, Indonesia (Figure 1). The research lasted for three months, namely April-June 2026. Observation of *Aphis craccivora* populations was carried out periodically from the time the plants were 2 weeks old after planting (MST) until the end of the observation period.

Peanut cultivation in Saparua is on open land, while in Nusalaut peanuts are cultivated intercropped with corn. The difference in planting system is treated as a characteristic of the field agroecosystem, which is the context for interpreting the difference in abundance and population dynamics of *A. craccivora*, not as an experimental treatment.

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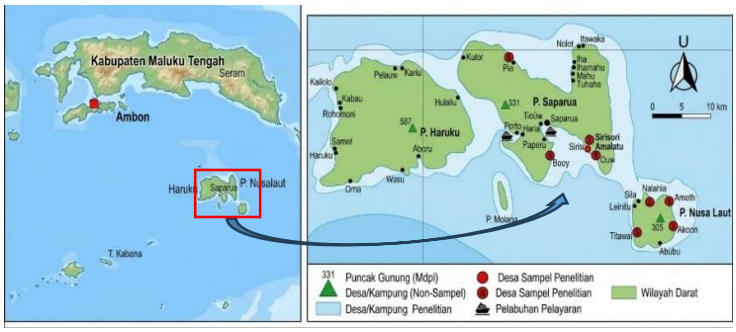



Figure 1. Map of the Research Site

**2.2 Sampling and Population Observation Design**

This study used a field survey with a quantitative descriptive approach to examine the abundance, dynamics, and spatial distribution of *A. craccivora*. Five observation plots were set at each location. Plant sampling was carried out systematically with a diagonal pattern. From each plot, five sample plants were randomly selected, and each plant was marked using ajir to facilitate observation in the next period.

Population observations were carried out every 7 days. In each sample plant, all *A. craccivora* individuals found on the plant section were counted directly using a magnifying glass and a manual counter. Observations were repeated on the marked sample plants. The main variable observed was the number of *A. craccivora* individuals per sample plant.

The equipment used includes stationery and record sheets, digital cameras or smartphones, magnifying glasses, meters, plant labels or ajir, thermohemometers, and manual counters. The average population is calculated based on the number of individuals found on all sample plants with the equation:

$$\bar{X} = \frac{\sum X_i}{n}$$

where is the average population of $\bar{X}$ *A. craccivora*, is the number of individuals found in all sample plants, and the number of sample plants. $\sum X_i \ n$ a

**2.3 Analysis of Population Dynamics**

The population dynamics of *A. craccivora* were analyzed based on changes in the number of individuals between observation periods. Population growth rate (*r*) was used to describe the tendency of population increase or decrease from one period to the next.

The value of *r* is calculated using the equation:

$$r = \frac{\ln(N_t) - ln(N_0)}{t}$$

With *r* being the population growth rate, *Nt* is the population size at the end of the observation period, is the population size at the beginning of the observation period, is the observation time interval $N_0 t$ *ln* is the natural logarithm.

Values indicate that the population is increasing during the observation interval, while indicating a population decrease. Values close to zero indicate relatively small population changes.$r > 0$ $r < 0$ $r$

### 2.4 Spatial Distribution Analysis

The spatial distribution pattern of *A. craccivora* was analyzed using the Morisita Index. The analysis was carried out based on the distribution of individuals in the sample unit. The interpretation of the index refers to Morisita [12], namely, an index value < 1 indicates a uniform pattern, a value of about 1 indicates a random pattern, and a value > 1 indicates a clustering pattern.

In this study, the value of the Morisita Index was used to compare the characteristics of the spatial distribution of *A. craccivora* in peanut plants in Saparua and Nusalaut. The spatial distribution was analyzed using the Dispersion Index (DI) or the Morisita Index.: The Morisita Index was calculated using the formula:

$$I_\delta = \frac{n\sum x_i(x_i - 1)}{N(N-1)}$$

Description:

- $I_\delta$= Morisita Index
- $n$= total sample units (squares)
- $x_i$= number of individuals in square i
- $N$= total individual of the entire plot

Interpretation Criteria according to Morisita (1959):

- $I_\delta < 1 \rightarrow$ Uniform distribution
- $I_\delta = 1 \rightarrow$ Random distribution
- $I_\delta > 1 \rightarrow$ Clustering distribution

### 2.5 Data analysis

The observational data were analyzed in a quantitative descriptive manner. *A. craccivora* population abundance was presented as the average value of the number of individuals in the sample plants for each location and observation period. Population changes over time were analyzed based on the value of the population growth rate ($r$), while the spatial distribution pattern was determined based on the value of the Morisita Index.

The results of the analysis are presented in the form of tables and graphs to show the differences in population abundance between sites, population changes during the observation period, and the spatial distribution pattern of *A. craccivora*. The interpretation of the results was carried out by taking into account the characteristics of the cropping system at each location.

## 3. Results

### 3.1 General Overview of The Study Area

Saparua Island and Nusalaut Island are part of the Lease Islands Group in Central Maluku Regency, Maluku Province. In general, these two islands have a landscape typical of small-scale archipelagos, dominated by gently sloping coastal lowlands to rolling hills with elevations ranging from 0–300 meters above sea level (masl). This topography, which varies from flat to slightly sloping, forms micro-zoning that influences land use patterns by local communities, particularly in the food agriculture and smallholder plantation sectors.

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Peanuts (*A. hypogaea* L.) on Saparua Island and Nusalaut Island are generally cultivated by local farmers as secondary food crops (secondary crops). The cultivation patterns applied are usually small- to medium-scale (subsistence to local commercial) in garden or yard systems.

### 3.2 Population abundance *Aphis craccivora*

The observation results showed that the abundance of *A. craccivora* populations differed between Saparua (PSp) and Nusalaut (PNt). The average population reported in this study was 154 individuals in Saparua and 101 individuals in Nusalaut. Thus, the population abundance observed in Saparua was higher to Nusalaut during the observation period (Figure 2).

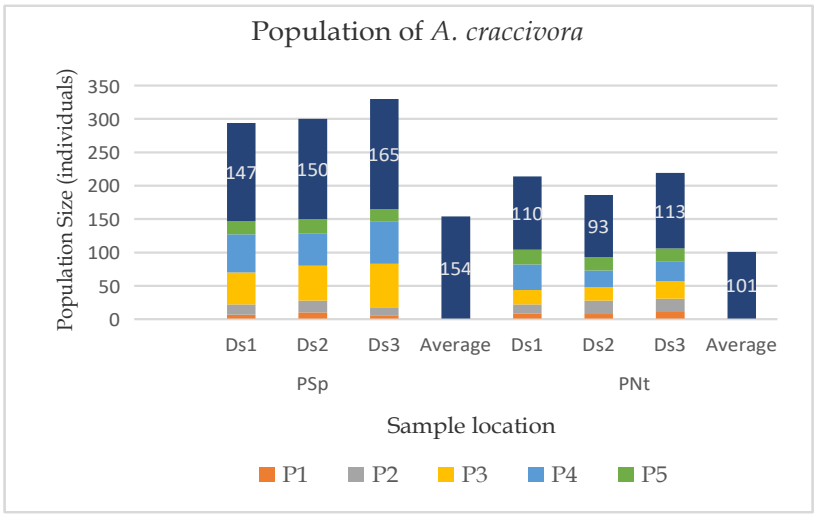



Figure 2. Average abundance of *A. craccivora* population in peanut cultivation in Saparua (PSp) and Nusalaut (PNt).

### 3.3 Distribusi spasial *Aphis craccivora*

Spatial distribution analysis using the Morisita Index showed a difference in the distribution pattern of *A. craccivora* between the two locations. In Saparua, the Morisita Index value was 1.427, which indicates a pattern of grouped distribution. In Nusalaut, the index value was 1.035, which is very close to the value of .1, thus indicating a pattern that is close to random with a very weak tendency to aggregation. Thus, the population aggregation of *A. craccivora* is stronger in Saparua compared to in Nusalaut.

### 3.4 Population dynamics and growth rate

The population of *A. craccivora* showed changes between observation periods in both locations. In Saparua, the positive r values were 0.667, 1.299, and 0.023, while the negative values were −1.035. In Nusalaut, the positive *r* values were 0.579, 0.272, and 0.196, while the negative r values were −0.112 (Figure 3).

The change in the *r*-value from positive to negative indicates a phase of increase and decrease in the population during the observation period.

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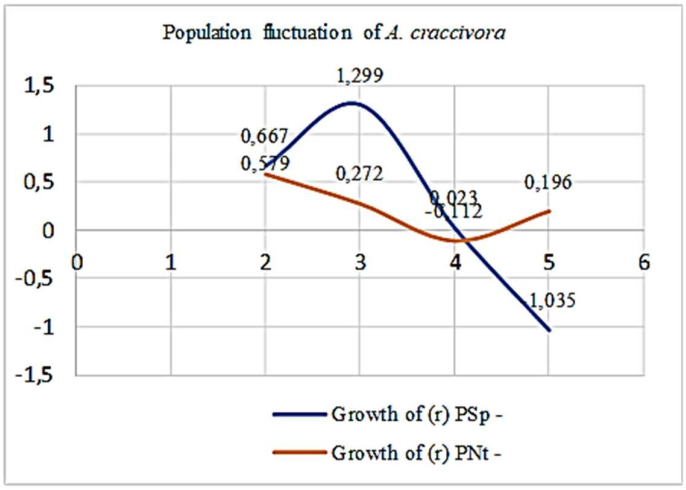



Figure 3. Fluctuations in the Population of *A. craccivora* in Saparua (PSp) and Nusalaut (PNt) Districts.

## 4. Discussion

### 4.1 Differences in *Aphis craccivora* Population Abundance Between Locations

The higher abundance of *A. craccivora* in Saparua compared to Nusalaut indicates a difference in population character between the two agroecosystems. Saparua is a peanut plantation on open land, while Nusalaut uses an intercropping system of peanuts with corn. These differences in vegetation structure can result in different microhabitat conditions and are potentially related to the development of aphid populations. However, this study did not statistically test the influence of microclimate or vegetation structure, so these differences cannot be interpreted as a cause-and-effect relationship.

*A. craccivora* population development can be related to environmental conditions and plant development. Referensi [6] showed that pest dynamics in peanut plants are related to environmental conditions and plant development. Plant and environmental conditions as important components in pest development in peanuts [5]. Weather conditions can also be related to changes in *A. craccivora* populations [7].

Differences in plant growth phases also need to be considered. At the time of observation, plants in Saparua were in the flowering phase, while plants in Nusalaut were still about 14 days old after planting. Thus, the two populations were not observed under the same plant phenological conditions. Plant conditions and the quality of plant resources can affect aphid development [2], [14. Therefore, the observed abundance differences are likely to reflect a combination of plant conditions, plant systems, and the local environment, but the contribution of each factor cannot be quantitatively separated.

### 4.2 Spatial Distribution Pattern of *Aphis craccivora*

The Morisita Index value of 1.427 in Saparua indicates a clustered distribution pattern. The pattern suggests that *A. craccivora* individuals tend to be concentrated in specific spatial units. Grouped distribution is a common pattern in insect populations because resources, microhabitat conditions, and habitat structure are not always homogeneous [9], [15].

In aphids, the aggregation pattern can be related to the tendency of individuals to stay on suitable plants and form colonies. The quality of food sources, including the nutritional characteristics of phloems, can influence aphid development [14]. Winged

individuals also play a role in the displacement and colonization of new habitats [9]. However, this study did not measure plant quality, microclimate, or distribution of natural enemies in each sample unit, so these factors could not be established as a direct cause of aggregation.

In Nusalaut, the value of the Morisita Index of 1.035 is very close to 1. These results show a pattern that is close to random, with a tendency for very weak aggregation. The value shows that the grouping of individuals in the observation unit is not as strong as that found in Saparua. Differences in spatial patterns can be related to habitat heterogeneity, vegetation structure, microclimate, and resource availability [10].

Thus, the difference in distribution patterns between Saparua and Nusalaut shows a difference in the spatial structure of the *A. craccivora* population. Different planting systems are one of the ecological contexts that accompany these differences, but this study has not been designed to test the influence of intercropping systems experimentally.

### 4.3 Dinamika Temporal Populasi *Aphis craccivora*

A change in the growth rate value ($r$) from positive to negative indicates that the population of *A. craccivora* experienced temporal dynamics during the observation period. A positive $r$-value indicates an increase in population, while a negative value indicates a decrease in population. Thus, the aphid population does not develop linearly but changes from one period to the next.

In Saparua, an $r$-value of 1.299 indicates the highest population increase, while a value of −1.035 indicates the largest population decrease. Population increases can occur when plant and environmental conditions favour aphid development, while declines can be related to changes in plant quality, mortality, pressure from natural enemies, or individual displacement. However, this study did not measure mortality, natural enemies, or migration, so the mechanism cannot be ascertained based on the data obtained.

In Nusalaut, the amplitude of population change is relatively smaller, with positive $r$-values of 0.579, 0.272, and 0.196, and a negative value of −0.112. The pattern shows several periods of increase and one period of decrease in the population.

Ecologically, changes in $r$-values indicate the existence of a dynamic balance between factors that support population growth and factors that limit it. Supporting factors can be related to resource availability and environmental conditions, while limiting factors can be changes in plant quality, competition, mortality, natural enemies, and dispersion. The ecological framework of the population places factors derived from host plants and factors derived from natural enemies as important components in insect population dynamics [15]. In this study, the relative contribution of each factor could not be determined because it was not directly measured.

### 4.4 Ecological implications for Integrated Pest Monitoring and Control

Differences in abundance, spatial distribution, and temporal dynamics suggest that monitoring of *A. craccivora* in peanut cultivation needs to consider the dimensions of space and time simultaneously. Populations with clustering patterns such as in Saparua may have different sampling characteristics than populations with near-random distributions such as in Nusalaut.

Spatial distribution information can be used to determine more representative observation units, while temporal information can help identify periods of population increase. The approach is in line with the principles of insect ecology that place population distribution information as the basis for pest sampling and management [15. More accurate population data can also support the use of more rational control strategies [16], [17].

Thus, this study provides preliminary information on the population characteristics of *A. craccivora* in two agroecosystems on small islands. The development of more specific PHT recommendations still requires further research by including weather factors, plant phenology, natural enemies, and vegetation structure as explanatory variables.

## 5. Conclusion

Research shows that *Aphis craccivora* populations in peanut plantations on Saparua Island and Nusalaut Island have differences in abundance, spatial distribution, and temporal dynamics. The reported population abundance is higher in Saparua, with an average of 154 individuals, compared to 101 individuals in Nusalaut. The spatial distribution in Saparua shows a clustering

pattern with a Morisita Index of 1.427, while Nusalaut has a value of 1.035, indicating a near-random distribution with very weak aggregation. The population experiences temporal fluctuations in both locations, which is indicated by the change in the growth rate (*r*) value from positive to negative. These results show that the population character of *A. craccivora* in small island agroecosystems varies in space and time. The information on abundance, spatial distribution, and temporal dynamics can be the basis for the development of more adaptive pest monitoring to support Integrated Pest Control in peanut cultivation on small islands.

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