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The Influence of Environmental Factors to The Abundance of Scales (Hemiptera: Diaspididae) Population on Apple Crop

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ABSTRACT

This research aims to assess the environmental factors that affect the abundance of scales populations on the apple crop. The study was conducted in July 2012 to January 2013. The study was conducted at two sites with different altitude. Bumiaji village's altitude is ±900 m and Tulungrejo village's altitude is ±1,515 m asl. Multiple linear regression analysis was conducted to determine the environmental factors that affect the abundance of scales populations on the apple crop. Based on the results of the regression analysis, air temperature and humidity affect the abundance of scales populations in Binangun while rainfall and long solar radiation have no effect. Scales population abundance of the apple crop in Binangun was influenced by air temperature and humidity one week before. Based on the results of the regression analysis, air temperature, air humidity and rainfall affect the abundance of scales population in Tulungrejo while long solar radiation has no effect. Scales population abundance of the apple crop in Tulungrejo was affected by air temperature two weeks before, while humidity and rainfall were affected one week before. The higher air temperature scales, flea population level will increase. And the higher relative humidity, scales population levels will increase.

Keywords: *apple crops, environmental factors, population abundance, scales*

INTRODUCTION

Scales pest infestation on the apple crop is a problem that has yet to be controlled. Scales attack apple crop in Batu, Malang, and Pasuruan. Apple crop in Batu, Malang, East Java during the period of last five years continues to decline. The number of productive trees in 2004 as many as 2.603.086 trees and decreased until 2008 to 1.595.772 trees. Apple production from 2004 to 2007 increased from 919,01 tons to 1425,12 tons, but in 2008 decreased production to 868.10 tons [1]. The views stated that the decrease in the number of trees and apple crop production in Malang and Pasuruan regency caused by scales pest infestation [1,2].

Scales control conducted by apple farmers in Malang and Pasuruan is using excessive insecticide. Scales control by farmers still did not succeed. To overcome the loss of agricultural production and the difficulty in controlling scales pest infestation, the integrated pest management is an appropriate alternative to answer pest problems.

Information about the abundance of pest populations and environmental conditions is needed in IPM. Some things to know and become the basis for pest control are understanding the plant and environmental conditions [3]. Understanding the factors that affect the development of pest populations and the factors that have correlation with the pest [4,5]. Abiotic factors that affect scales ranging from the emergence of crawler which can move freely until adult stage is climate (especially air temperature and humidity) [6-9]. The optimum conditions for the development of scales are the temperature (ranging from 23 to 27,5°C) and humidity (70 to 80%) [10]. The preventive actions can be done by managing the plant environment like that, so the environtment less suitable for the pest development but strongly support the development of plants and natural enemies [3,11].

This research aims to assess the environmental factors that affect the abundance of scales population on the apple crop. The results are expected to be a reference in formulating strategies in an integrated pest

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management (IPM) infestation of scales pest on the apple crop in order to increase production and income of apple farmers.

MATERIALS AND METHODS

The research was conducted from July 2012 to January 2013. The study was conducted at two sites with different altitude. In Bumiaji village that have altitude ±900 m and in Tulungrejo village that having altitude ±1.515 m asl.

The experimental field at each location is divided into four plots. For each plot, 5 points were determined randomly as a point to put the environmental factors observer tool. Air temperature and humidity were observed by thermohydrometer, rainfall intensity was observed by ombrometer, duration of solar radiation data obtained from climatology station Karangploso, Malang.

Scales population and environmental factors observation carried out continuously during the apple crop harvesting season with one-week interval of observation. The first observation carried out one week before the apple plant leaves were cut, whereas the last observation carried out one week after apple crop harvesting. To determine the environmental factors that affect the abundance of scales populations on the apple crop, multiple linear regression analysis was conducted. The design of this study was an experimental study, conducted at the Laboratory of Parasitology and Laboratory of Biomedical, Faculty of Medicine, University of Brawijaya, Malang. This study had been approved by the Ethical Committee of Health Research Faculty of Medicine University of Brawijaya (No. 104/EC/KEPK).

RESULTS AND DISCUSSION

The air temperatures in Binangun and Tulungrejo from July to September 2012 are relatively low, it was 21°C in Binangun and 18°C in Tulungrejo. The scales population level also showed a low level, it was nearly 1,5 individuals/10 cm in Binangun and 1,2 individuals/10 cm in Tulungrejo. However, from October to December 2012 the air temperatures in Binangun and Tulungrejo are relatively high, it reached nearly 24°C in Binangun and reached approximately 19,5°C in Tulungrejo. The scales population level showed a low level that is almost 8 individuals/10 cm in Binangun and 6 individuals/10 cm in Tulungrejo.

Regression equation of environmental factors that affect scales populations on the apple crop in the Binangun is $Y_t = 13{,}933\ X1_{t-1} + 3{,}187\ X2_{t-1} + 0{,}488\ X3_{t-1} - 10{,}743\ X4_{t-2} + a_t$. Y_t is scales population variable, X1 is air temperature variable (°C), X2 is humidity variable (%), X3 is rainfall intensity variable (mm/day), X4 is duration of solar radiation variable (hours/day). a_t are other factors variables that are not included in the model (not recorded), or other factors that can not be controlled.

Based on the results of the regression analysis, air temperature and humidity affect the scales population in Binangun while rainfall intensity and duration of solar radiation did not affect the scales population. Scales population on the apple crop in Binangun is affected by air temperature and humidity in one week before.

In July to early August 2012, the air humidity in Binangun and Tulungrejo are relatively high, reached approximately 75% in Binangun and 80% in Tulungrejo. The scales population level also showed a low level of approximately 1,3 individuals/10 cm in Binangun and nearly 1,1 individuals/10 cm in Tulungrejo.

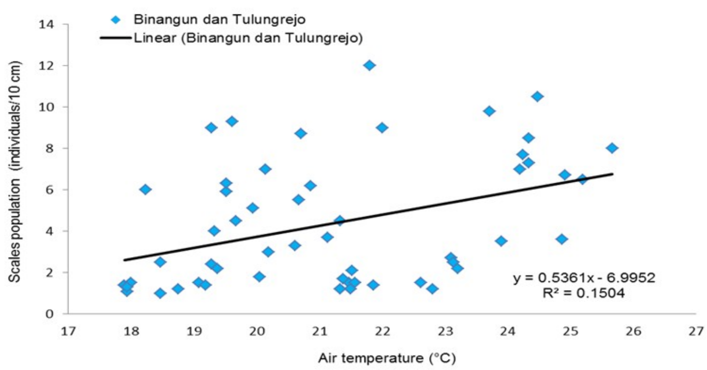

Figure 1. The air temperature relationship on the scales population in Binangun and Tulungrejo, the higher air temperature scales flea population level will increase.

Then, in August to early October 2012 air humidity in Binangun and Tulungrejo are small, reached nearly 69% in Binangun and 75% in Tulungrejo. The scales population level showed a low level of less than 3,5 individuals/10 cm in Binangun and approximately 2,5 individuals/10 cm in Tulungrejo.

During October to December 2012, the air humidity in Binangun and Tulungrejo increased to nearly 80% in Binangun and 89% in Tulungrejo. The level of scales population showed a high level that is almost 9 individuals/10 cm in Binangun and nearly 7 individuals/10 cm in Tulungrejo.

Regression equation of environmental factors that affect scales populations on the apple crop on the Tulungrejo is $Y_t = 2{,}398\ X1_{t-2} + 0{,}867\ X2_{t-1} + 0{,}500\ X3_{t-1} - 1{,}759\ X4_{t-1} + a_t$. Y_t is scales population variable, X1 is air temperature variable (°C), X2 is humidity variable (%), X3 is rainfall intensity variable (mm/day), X4 is duration of solar radiation variable (hours/day). a_t is the other factors variables that are not included in the model (not recorded), or other factors that can not be controlled.

Based on the results of the regression analysis, air temperature, air humidity and rainfall intensity affect the scales population, while duration of solar radiation did not affect the scales population. Scales population on the apple crop in Tulungrejo was affected by air temperature two weeks before, air humidity and rainfall intensity one week before.

Air temperature relationship with the scales population in Binangun and Tulungrejo is positive (Fig. 1). It means the higher the air temperature, scales population level will increase. Relation equation to the air temperature in the scales population Binangun and Tulungrejo is Y= 0,5361x – 6,9952 with R^2 value= 0,1504.

Relationship of air humidity on the scales population in Binangun and Tulungrejo is positive (Fig. 2). It means, the higher the air humidity scales population level will increase. Equation relation to the air humidity in the scales population in Binangun and Tulungrejo is Y= 0,1662x – 8,7451 with R^2 value= 0,1205.

Climatic factors are able to trigger pest population explosion, it can not be separated with herbivores physiological factors. Climate components that have the most influence to the development of insect populations are temperature and air humidity. According [12] climatic factors that affect the rest of which are the air temperature, air humidity, rainfall intensity, and wind. [13] reported that some of temperature condition and air humidity can change the pest populations, due to changes in physiological development, migration and dispersal, causing the local population explosion. Specific air temperature and humidity at planting (microclimate) occurs due to planting conditions that are the result of agronomic practices in the cultivation of plants, such as plant spacing, plant population, and fertilization. High plant population and planting distance resulted in the plants grow very dense, so microclimate occurs at planting (high air temperature and humidity) which highly susceptible to herbivores infestation.

Temperature is the climatic factor that affects scales, ranging from the emergence of nymphs that can move freely until adult. First, second and third instar are the most resistant to low temperatures while females and crawler are resistant to medium temperature. Male molting, pra pupae and pupae are very vulnerable to low temperatures. The low temperature is the most decisive factor in abundance and spread of scales [14].

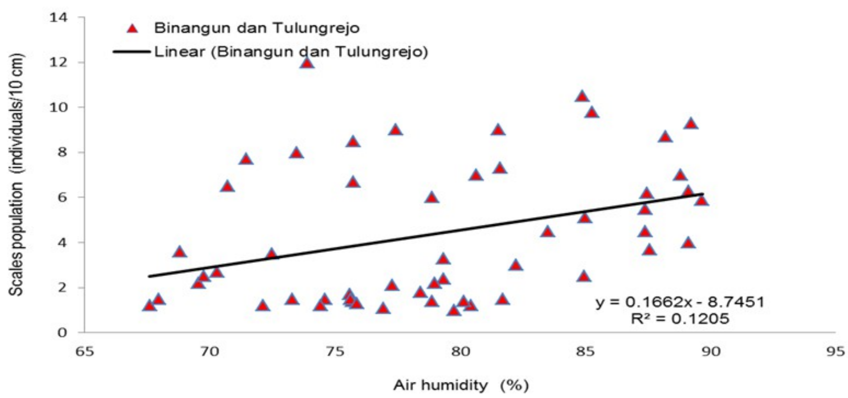

Figure 2. Relationship air humidity on the scales population in Binangun and Tulungrejo, the higher air humidity scales flea pop lation level will increase.

First, second and third Instar female are resistant to low temperatures while males are molting, pra pupae and pupae are very vulnerable low temperatures. Low temperatures also affect the length of the scale life cycle. At low temperatures, the length of the scale life cycle is longer. Females complete its life cycle during 44,3 days and males during 25,2 days at 29°C, whereas at 15°C it takes 209 days for females and 149 days for males. Temperature also affects the fertility of female scales. Adult females produce 267 nymphs per female at a temperature of 30°C and 46 nymphs per female at a temperature of 15°C [15]. High temperatures in the summer led to a decrease in the size of the real scales body [6].

Temperature is expressed in degrees of heat and sources at ground level are derived from solar radiation. High and low light intensity is directly proportional to the high and low temperatures. Light intensity affects insects's life Daily fluctuations affect the air temperature, humidity and food. The influence of light on the behavior of insects is vary between insects that are active during the day (diurnal) with insects that are active at night (nocturnal). In insects that are active during the day, the activity will be stimulated by the state of the intensity and wavelength of light around it. In contrast, night insects of certain light conditions may inhibit the activity. If the light intensity is increased into certain insect that has a habit of living with minimum and weak light, this will lead to insect depressesion and vice versa. Increasing the intensity of the light can accelerate the maturity of insects and shorten adult lifespan [16].

Insects are poikilothermic species whose body temperature depends on the temperature of the ambient air environment. Ambient air temperature will affect the metabolic processes of insects. Insect activity will be faster and more efficient at high temperatures, but will reduce the length of life of insects. Some insects can adapt to extreme environments through diapause. Insect development and activity will return to normal if the air temperature is suitable [17]. Effect of temperature on pests includes controlling the growth, survival and spread of insects. All species of insects have certain air temperature range in order to survive. This range will be different in each species of insects. When the air temperature is below or above the optimal condition, it will cause the death of the insect in the near future [16].

Air humidity affects the abundance of scales population in Tulungrejo and Binangun. Air humidity affects the biologic process of insect, where the optimum humidity range is around 73-100%. the air humidity that too high or too low can inhibit the activity and insect life, except in some insect species that used to live in wet places. The insects optimum moisture is different by type and level of life in each development. Air temperature and humidity affect the scales population fluctuation pattern in Binangun and Tulungrejo because the air temperature and humidity in Binangun and Tulungrejo support the development of the scales population. The air temperature is ±23,23°C in Binangun with air humidity ±74,31%. While the temperature in Tulungrejo is ±19,55°C with air humidity ±82,86%. According [10], the optimum conditions for the development of scales are the air temperature from 23 to 27,5°C and humidity of 70-80%. However, scales develop at 30-38°C and low humidity in Australia [7]. An increase in the level of scales population are affected by air humidity [18].

CONCLUSIONS

Based on the research that has been carried out, we can concluded that the abundance of scales on the apple crop at two elevations was not significantly differen and the relationship between air temperature and humidity of the abundance of scales population on two elevations is positive which means that the higher the air temperature and humidity, the level of scales population will increase. The abundance of scales in Binangun influenced by air temperature and humidity, while in Tulungrejo affected by air temperature, air humidity, and rainfalls intensity.

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