Pertanika J. Trop. Agric. Sci. 31(2): 191 - 196 (2008)

ISSN: 1511-3701

Population Fluctuation of *Helopeltis antonii* Signoret on Cashew *Anacarcium occidentalle* L., in Java, Indonesia

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ABSTRACT

Population fluctuation of *Helopeltis antonii* was studied in a cashew smallholding in Wonogiri, Indonesia for two years beginning March 2004 to May 2006. Observation of *H. antonii* population was carried out systematically on 60 sample plants in 2 ha cashew smallholding every two weeks for 2 years in relation to the number of shoots and inflorescence, number of damaged shoots, inflorescence and fruits. Local rainfall, temperature and relative humidity, number of natural enemies, and fruit yield harvested were also considered. The *H. antonii* population fluctuated in a cyclical pattern with the peak population in July. The population began to increase at the end of the rainy season and was high during periods of low and intermittent rainfall. No insects were found during high rainfall. Number of shoots and inflorescences of cashew significantly influenced the number of *H. antonii* population. This trend of population abundance was not directly associated with rainfall, but rainfall influenced the physiology of shoot flushes and inflorescence production. Results of correlation and regression analysis showed that rainfall is not significantly correlated to *H. antonii* population and does not significantly contribute to the number of *H. antonii* population on cashew. However, the availability of food in the form of number of shoots and inflorescence positively correlated with the abundance of *H. antonii* population. The analysis between rainfall and number of shoots and inflorescence revealed that these parameters were negatively correlated. This indicated that rainfall did not directly influence the number of *H. antonii* population, but appears to influence the number of shoots and inflorescence.

Keywords: Population, fluctuation, *Helopeltis antonii*, cashew

INTRODUCTION

Helopeltis antonii Signoret is one of the most important insect pests of cashew in most cashew growing areas in Indonesia. It is also a major pest on cocoa, tea and neem (Stonedahl, 1991; Sundararaju and Babu, 1996; Onkarappa and Kumar, 1997). Both the nymph and adult feed on young and succulent parts of cashew such as the shoots, young leaves, inflorescence and fruits. Their feeding causes the drying up of new flushes resulting in a scorched appearance to the trees, shrivelling and abortion of immature nuts (Singh and Pillai, 1984).

An insect population always fluctuates according to the dynamic condition of its environment. Both physical (abiotic) and biotic factors are believed to be the factors responsible for the change in a population. Andrewartha and Birch (1954) stated four components of the environment that influenced animal or insect populations, namely weather conditions, food, other insects and organisms causing disease, and a place in which to live. Climatic factors such as rainfall and humidity have been known to greatly influence the population change of *Helopeltis* spp. (Roepke, 1916 in Geisberger, 1983; Swaine, 1959; Pillai *et al.*, 1979; Muhamad, 1990; Muhamad and Chung, 1993; Karmawati *et al.*, 1999). Other factors include natural enemies (Roepke, 1916 in Geisberger, 1983; Karmawati *et al.*, 1999; Peng *et al.*, 1999), temperature (Pillai *et al.*, 1979), and food supply (Swaine,

Received: 24 July 2007
Accepted: 26 August 2008
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1959; Pillai *et al.*, 1979). Knowledge of the seasonal abundance and trends in the population build up of pest has become important for effective control schedules. This study reports the seasonal population fluctuation of *H. antonii* and determines the influence of various environmental factors on its population in a cashew smallholding.

MATERIALS AND METHODS

Study Site

The study was carried out from March 2004 to May 2006 in a pesticide free cashew smallholding in Wonorejo, Ngadirojo District, Wonogiri, Central Java, Indonesia. The cashew trees were 12 - 15 years old and spaced 10 x 8 m apart. In general not much care was given to cashews. Manuring was done only on the intercrops such as groundnut (*Arachis hypogaea*), soybean (*Glycine max*), corn (*Zea mays*) and cassava (*Manihot utilisima*) which were planted during the wet season, while in the dry season only a few old cassava plants were intercropped. The observation plot was chosen in the centre of the cashew grove of 2 ha and consisted of trees of homogenous size and age. The plot was divided into 60 area units (15 x 4 m) and one sample plant was chosen per sample unit. Therefore, a total of 60 sample plants were selected for the study. Observations were done at 2 weekly intervals for two consecutive production cycles of two years. The number of *H. antonii,* specifically the eggs, nymphs and adults on each sample plant were recorded from the lower canopy up to about 2.5 m height. The number of healthy shoots and inflorescence, and number of shoots, inflorescence and fruits damaged by *H. antonii* were also recorded. Data on local rainfall, temperature and relative humidity were obtained from the local/nearest meteorological station. Other parameters observed were the number of possible natural enemies of *H. antonii,* other dominant insect pests and number of fruits produced by the sample plants. Observations were done between 0630 to 1100 hr. Data representation was done by plotting the data for parameters observed against time. Correlation among the parameters measured was statistically compared using Pearson Correlation Coefficients and Stepwise regression analysis was also performed between *H. antonii* population (dependent variable) and the environmental parameters measured using PC-SAS (Anonymous, 1999).

RESULTS AND DISCUSSION

The presence of *H. antonii* population on cashews coincided with the abundance of food supply in the form of shoots and inflorescence. *Fig.1* shows population abundance of *H. antonii* on cashews in relation to the numbers of shoots and inflorescence and other environmental factors between March 2004 and May 2006. *Helopeltis antonii* numbers began to increase soon after rainfall ceased and reached its peak during low and intermittent rainfalls. The number began to drop at the inception of a new rainy season and then completely disappeared at the height of the rainy season. This cycle of population rise and fall was repeated during the second year of the study.

Based on cashew plant phenology or crop season, the flushes of shoots and inflorescence correlated positively with the abundance of *H. antonii* except during the first post-flowering season (September 2004 - March 2005). Other factors were not significantly correlated except for the temperature which was negatively correlated during the first flushing-flowering season (Table 1). Pooled data for the two seasons revealed that *H. antonii* population correlated negatively with rainfall and temperature, but correlated positively with shoots and inflorescence. Stepwise regression analysis (Table 2) confirmed that the shoots and inflorescence were the contributing factors to the population fluctuation of *H. antonii* except for the post-flowering season. A higher temperature also contributed to the presence of *H. antonii* population in the first flushing-flowering season, while an increased relative humidity was a contributory factor during the second flushing-flowering season. However, their contribution was comparatively low. Pooled season data revealed that only shoots and inflorescence were the significant contributors to the population fluctuation and abundance of *H. antonii* in cashew.

The trend of population fluctuation of the mirid bug was not directly associated with rainfall, but the physiology of the cashew plant to produce flushes/shoots and then inflorescence was in response to increase in rainfall. Correlation and regression analyses showed that rainfall did not significantly contribute to *H. antonii* population abundance on cashews. However, the availability of food in the form of increased number of shoots and inflorescence positively correlated

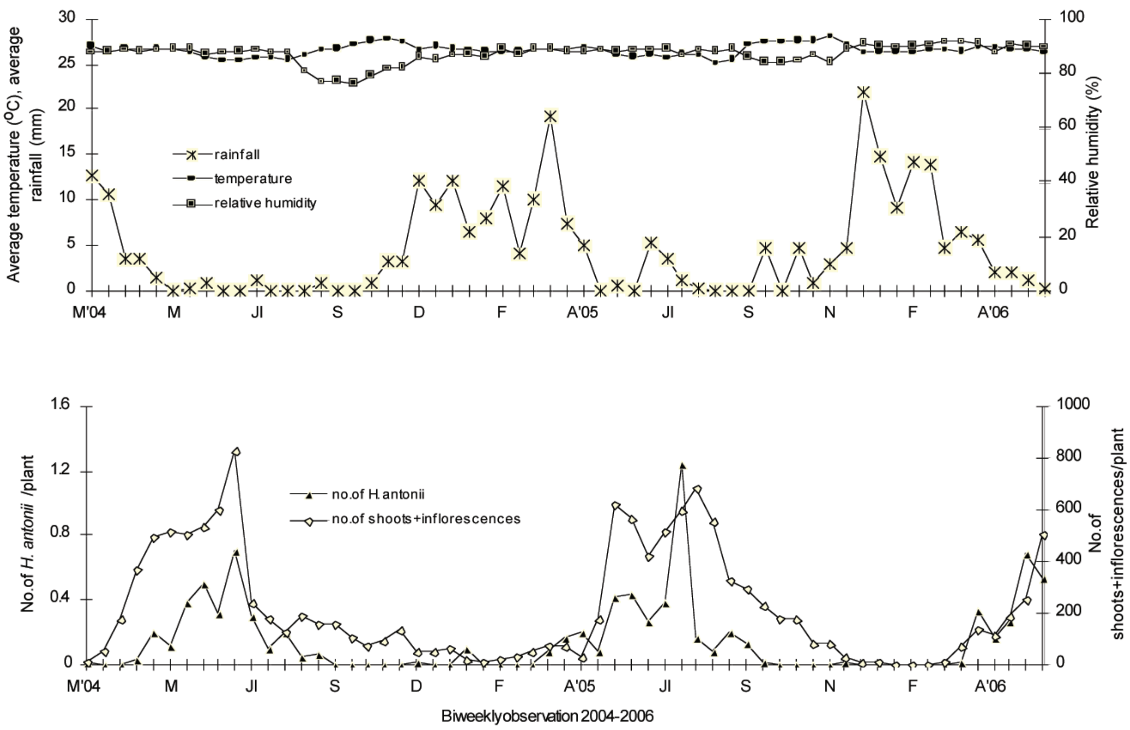

Fig. 1: Population abundance of Helopeltis antonii *on cashews in relation to the number of shoots and inflorescence, and rainfall, temperature and relative humidity between March 2004 and May 2006*

with the abundance of *H. antonii* population (Table 1). On the contrary, correlation analysis between rainfall and number of shoot and inflorescence revealed that these parameters produced negative correlation (r= -0.55*), indicating that rainfall influenced the growth of shoots and inflorescences but did not directly influence the number of *H. antonii* population. Regression analysis, however, suggested that the number of shoots and inflorescence of cashew plants (R^2 = 0.40) were the contributors to the increase in *H. antonii* population.

During the rainy season between October to March, with a relative humidity of 79-91.5%, temperature of 26.3-28.1°C, rainfall of 0.69-21.77mm/day and reduced number of shoots and inflorescence, the population of *H. antonii* became very low or absent. This trend of population fluctuation of *H. antonii* on cashew plants appeared to be cyclical with the population peaking in July. The increase of *H. antonii* population positively correlated with the availability of shoots and inflorescence as this was their food source. Mujiono (1987) also observed a cyclical population fluctuation of *H. antonii* on cocoa in East Java, Indonesia and it was related to the abundance of cocoa pods. The reduction or absence of *H. antonii* population was also reported by other researchers (Giesberger, 1983; Mujiono, 1987; Karmawati *et al.*, 1999). It is known that *H. antonii* is a polyphagous insect, with a wide range of host plants (Devasahayam and Nair, 1986; Stonedahl, 1991). However, in this study, there was no observation of insects feeding on weeds and other plants in the vicinity of the cashew smallholding except on cocoa. Cocoa is also known as one of the major host plants of *H. antonii* which are usually sparcely planted in farmer's homestead. During the dry season some new flushes could still be found together with a few cherelles and young pods. The presence of *H. antonii* on cocoa coincided with the abundance of the insect on cashew. When the insects were absent on cashew, they were also not found on other plants.

Predators did not play a significant role in influencing the number of *H. antonii*. Observations in the field showed that the population of the black ant, *Dolichoderus thoracicus*

TABLE 1
Coefficient of correlation (r) between *Helopeltis antonii* population and rainfall, temperature and relative humidity during two consecutive flushing-flowering stages of 2004-2005 and 2005-2006

Planting stage	Month	Rainfall	Temperature	Relative Humidity	Shoots+ Inflorescence	Predator
Flushing-flowering	March-Sept. 2004	(ns)	-0.61 *	(ns)	0.73 **	(ns)
Post flowering	Sept-March 2004-2005	(ns)	(ns)	(ns)	(ns)	(ns)
Flushing-flowering	March-Nov 2005	(ns)	(ns)	(ns)	0.50 *	(ns)
Post flowering	Nov-April 2005-2006	(ns)	(ns)	(ns)	0.78 **	(ns)
Pooled stages	March-May 2004-2006	-0.37 **	-0.41 *	(ns)	0.63 **	(ns)

ns not significant
* significant at $P \le 0.05$
** significant at $P \le 0.01$

TABLE 2
Stepwise regression for *Helopeltis antonii* population against rainfall, temperature and relative humidity during two consecutive flushing-flowering stages of 2004-2005 and 2005-2006

Planting stage	Month	Regression parameter			
		Intercept (a)	Gradient (b) of variable selected	R^2	Significance Pr>F
Flushing-flowering	March-Sept 2004	199.48	1. shoot+inflorescence: 0.0004 2. temperature: -7.550	0.540 0.132	0.0018 0.0484
Post flowering	Sept-March 2004-2005	-	-	-	-
Flushing-flowering	March-Nov 2005	-0.145	1. shoot+inflorescence: 0.0007	0.250	0.0411
Post flowering	Nov-April 2005-2006	-118.99	1. shoot+inflorescence: 0.002 2. relative humidity : 1.299	0.603 0.187	0.0030 0.0196
Pooled stages	March-May 2004-2006	-49.73	1. shoot+inflorescence: 0.0006 2. relative humidity : 0.577	0.396 0.023	<.0001 0.1405

was always high, with an average of 314 ants per plant (46 - 596). The role of *D. thoracicus* to control *Helopeltis* spp. has been extensively studied and well understood (Giesberger, 1983; Way dan Khoo, 1991). The predatory ant, *Oecophylla smaragdina*, was also found in high numbers for each observation and no *H. antonii* was found on cashew plants occupied by this ant. In Northern Australia, *O. smaragdina* has been used to control *H. pernicialis* on cashews (Peng *et al.*, 1995; 1997a,b; 1999a,b). Other predators frequently found in quite high numbers were arachnids and to a lesser extent mantids and coccinellids. Apart from *H. antonii*, other pest species such as aphids (*Toxoptera* sp.), leaf miners (*Conopomorpha* sp.) and chrysomellid beetles were also found but in relatively low numbers.

Previous observations by Karmawati *et al.* (1999) showed that relative humidity and the presence of predators influenced *H. antonii* population with $R^2 = 0.35$. A study by Pillai *et al* (1979) in India suggested that the population build up of *H. antonii* was negatively correlated with minimum temperature, minimum relative humidity and rainfall but was positively correlated with sunshine. However, the most favourable period for rapid multiplication and population build up was during abundant supply of succulent plant parts, which is similar to the results of this study. Swaine (1959) observed that *H. anacardii* was absent during rainy season but increased in number during the flushing period after rainy season. This also suggests that the number of *H. antonii* population was positively correlated with cashew damage, although the population did not influence cashew yield since it was very low with mean yields less than one *H. antonii* per tree (Table 3).

TABLE 3
Coefficient of correlation (r) between cashew yield and rainfall, temperature and relative humidity during two consecutive flushing-flowering stages of 2004-2005 and 2005-2006

Planting stage	Month	Rainfall	Temperature	Relative Humidity	*H.antonii* population	*H.antonii* damage
Flushing-flowering	March-Sept 2004	(ns)	-0.64 **	0.53 **	(ns)	(ns)
Post flowering	Sept-March 2004-2005	-0.70 **	0.73 **	-0.88 **	(ns)	(ns)
Flushing-flowering	March-Nov 2005	(ns)	(ns)	-0.57 *	(ns)	(ns)
Post flowering	Nov-April 2005-2006	(ns)	0.75 **	-0.66 *	(ns)	(ns)
Pooled stages	March-May 2004-2006	-0.39 **	(ns)	-0.41 **	(ns)	(ns)

ns = not significant
* = significant at P≤ 0.05
** = significant at P≤ 0.01

CONCLUSIONS

The population fluctuation of *H. antonii* on cashew plants was cyclical reaching a peak in July. The population increased just after the end of rains and reached a peak when rainfall was intermittently low. The population dropped when the rainfall was persistently low, and absent with increased rainfall until peak rainfall. Number of shoots and inflorescence of cashew plants showed a significant influence on the population of *H. antonii*.

ACKNOWLEDGEMENTS

This work was supported by funds from IPMSECP (Integrated Pest Management for Smallholder Estate Crop Project) and AARD (Agriculture Agency for Research and Development) under Indonesian Agriculture Departrment.

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