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Several ecological factors that determine the survival of temperature resistant *Phytoseius amba*

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Abstract. The ability of the predatory mite *Phytoseius amba* resistant temperature (results of superior applied research in 2018-2019) in controlling the spider mite *Tetranychus urticae* has not been stable in the long dry conditions in 2019. The instability of ability indicated by the decreased survival of temperature-resistant *P. amba* is closely related to various ecological factors, namely temperature, humidity, rainfall, sunshine intensity, leaf angle, density, and size cassava cultivar trichome and intra- and inter-species competition. Augmentation is an effort to release the mass of temperature-resistant *P. amba* predatory mites based on ecological factors. This biocontrol agent is still useful in playing a role in global warming conditions. The first-year research (2020) aims to determine the survival of *P. amba* resistant to temperature on a field scale and obtain key ecological factors that determine the survival of temperature-resistant *P. amba* local predator mites in cassava gardens in Banyumas Regency. The method used in the first year (2020) field-scale research was a survey with a random sampling technique. Samples were taken from the leaves of the Martapura cultivar in Cilacap. Data were analyzed using a randomized model variance analysis at an error rate of 0.1. The variance analysis results showed that among the temperature, humidity, rainfall, the density of adult *T. urticae*, nymphs, larvae, and eggs, the density factor of adult *T. urticae* mites was an ecological factor that determined the density of temperature-resistant *P. amba* mites on the field scale.

1. Introduction

Cassava ranks third after rice and corn. One of these important export materials can be tapioca flour, cassava, various types of food, and animal feed. In recent years, it has been intensively developed as alternative fuel oil. Banyumas Regency itself plans to establish a bioethanol factory whose essential ingredients come from cassava

Although it is an export material with an extensive range of uses, agricultural experts pay very little attention to controlling various plant pests. Very rarely or never, cassava plants receive treatment in the form of pesticide spraying. More than 200 species of pests of the cassava plant, especially from the phylum Arthropoda, have long been known. Although most of them are minor pests, which cause little or no economic loss, some are classified as major pests that reduce cassava [1]. Of the various main pests, the *Tetranychus urticae* mite is a pest mite that causes the most losses and can reduce productivity by up to 60% of crop yields [2].



Tetranychus urticae mites are initially found on the leaves' underside and cause yellow spots and fins. From this place, the mites spread to all parts of the leaf so that the color of the leaves becomes reddish, brown, or like rust. These pest mites form webs on leaves and between leaves. This web is the place for the eggs' oviposition until they hatch into the immature feeding stage. A severe attack can cause the entire crown of leaves to fall off so that the plant becomes bald [3].

The results of [2] research show that *Phytoseius amba* mites are potential predatory mites against *T. urticae* mites. This predatory mite belongs to the family Phytoseiidae with an average length of 332 um, and an exact body color if it has not yet got prey. [4] suggests that *P. amba*'s life cycle includes egg, larva, protonimfa, deutonymph, and adult stages. The life cycle of predatory mites from eggs to return to eggs takes 12 days. However, the life cycle of *T. urticae* mites can be longer than predatory mites and can take up to 14 days (from egg to egg return).

The research results show the potential of *P. amba* predatory mites against *T. urticae*, but until now, very few studies have revealed the factors that determine their predatory ability against each stage of *T. urticae* on a field scale [5][3]. Apart from only suggesting that *P. amba* is a potential predator for *T. urticae* mites, these researchers also only revealed that several environmental factors affect the productivity of cassava plants and their influence on several stages of pest mites.

The spider mite, *T. urticae*, affected the decrease in yields of cassava. More common during periods of prolonged dry seasons in tropical countries [6]. On the other hand, in general, the egg stage of predatory mites is susceptible to lower humidity in the dry season than the pest mites [7].

Resistance (resistance) to low humidity conditions and generally in several other environmental factors such as temperature and rainfall indicates predatory mites' adaptability. The high ability to scatter, find, and consume pest mites on a field scale determines its success rate as a biological control agent. [8] stated that various factors such as plant cultivar type, temperature, relative humidity, rainfall, and season affect not only the population dynamics of *T. urticae* mites but also the predatory mite population of *P. amba* itself. The prey-predator relationship can be volatile or stable depending on one or several factors as described. In addition to the factor of temperature resistance, predatory mites' susceptibility as biological control agents is generally also related to the density of the pest mites. The pest mites' density level is reflected in their distribution pattern, which in the conditions before global warming took place had a clustered pattern. The results of [2] suggest that the *T. urticae* mite pollution pattern in cassava plantations has a regular pattern (at certain distances), which shows its high adaptability in overcoming global warming conditions. On the other hand, the predatory mite scattering pattern in global warming conditions should follow a regular pattern; however, the predatory mites are more susceptible to temperature increases and tend to have a clustered or even random scatter pattern. The scattering pattern that is clustered or random is thought to affect the effectiveness of predatory mite predation ability.

The research results show that *P. amba* has the highest survival ability at a temperature of 27°C compared to a temperature of 29°C [2]. Nonetheless, continuous temperature exposure until this report was written indicates an increased survival rate and has reached a resistance level of 29°C. The resistance level at 29°C is the same as the average temperature around the cassava leaf crown cover. Based on various assumptions, the problem that can be formulated is whether *P. amba*, which is resistant to the tested temperature range, still has high survival rates in different ecological conditions. The research objective was to determine the state of the ecological factors that determine *P. amba*'s survival on a field scale.

2. Research Methods

2.1. Time and Place of Research

The research was conducted in Cassava Plantation, Karanglewas, Kebasen, and Gumelar Subdistricts, Banyumas Regency, Central Java. The study was conducted from April to August 2020. The sampling results were taken to the Entomology-Parasitology Laboratory, Faculty of Biology, Unsoed,

Purwokerto. The method used in the first year (2020) field-scale research was a survey with a random sampling technique.

Cassava leaves are taken from the bottom five stalks and then put into a box filled with ice to reduce mite mobility. Samples were taken from every corner and center of the garden so that the total sampling points were 5. In addition to sampling, ecological factors were also measured, namely temperature, humidity, and rainfall (data were taken from the local agricultural agency). Determination of the density of pest and predatory mites In the laboratory, all leaf samples were checked for the number of each stage of pest mites, namely *Tetranychus urticae* and predatory mites *Phytoseius amba* that were temperature resistant as a result of the previous release.

3. Results And Discussion

The multivariate analysis of variance showed that among the temperature, humidity, rainfall, the density of adult *T. urticae*, nymphs, larvae, and eggs, the density factor of adult *T. urticae* mites was the key factor determining the survival of the temperature-resistant *P. amba* mites on the field scale. ($P < 0.10$; Table 4.1).

Table 1. Ecological factors that determine the survival of *P. amba* resistance to temperature on the field scale

Source	Dependent Variable	Type III Sum of Squares	df	Mean square	F	Sig.
<i>P. amba</i> density	Temperature	101.424	10	10.142	.609	.803
	Humidity	1020.184	10	102.018	.487	.896
	Rainfall	9938.826	10	993.883	.594	.816
	Density of adult <i>T. urticae</i>	78.822	10	7.882	1.850	.059
	Density of nymph <i>T. urticae</i>	4.977	10	.498	.531	.866
	Density of larvae <i>T. urticae</i>	21.613	10	2.161	.660	.759
	Density of egg <i>T. urticae</i>	85.383	10	8.538	.614	.799
Error	Temperature	2063.684	124	16.643		
	Humidity	25974.86	124	209.475		
	Rainfall	207315.6	124	1671.900		
	Density of adult <i>T. urticae</i>	528.412	124	4.261		
	Density of nymph <i>T. urticae</i>	116.283	124	.938		
	Density of larvae <i>T. urticae</i>	405.828	124	3.273		
	Density of egg <i>T. urticae</i>	1723.907	124	13.902		
Total	Temperature	143203.1	135			
	Humidity	422168.5	135			
	Rainfall	7862480.	135			
	Density of adult <i>T. urticae</i>	880.870	135			
	Density of nymph <i>T. urticae</i>	146.609	135			
	Density of larvae <i>T. urticae</i>	533.079	135			
	Density of egg <i>T. urticae</i>	2548.122	135			

At the research time, the sampling site's air temperature was between 28 - 40 °C, humidity 32 - 79%, with monthly rainfall of 273.58 mm/ month. In general, these environmental factors are good enough to support the high survival of predatory mites, although the effect is not too significant. This means that the sampling site's ecological factors are still within the range of

environmental conditions that can be tolerated for the survival of temperature resistant *P. amba* mites.

Table 1 informed that at an error rate of 0.1 survival (in terms of density), *P. amba*'s temperature resistance was influenced by the density of *T. urticae* in the adult stage. The density of *T. urticae* in adult stages had an effect of 13% on the density of temperature resistant *P. amba* (the average density was only 0.270 ± 0.149). This is consistent with the statement of [2] and [9] an increase always follows a decrease in the number of predatory mites in general in the number of pest mites.

Table 1 also informs that low humidity as an ecological factor greatly determines the temperature-resistant *P. amba* density by falling closer to the soil surface. This effort causes the ecological factor of humidity not yet or perhaps not the ecological factor that determines temperature-resistant *P. amba* mites' survival. According to [3], predatory mites from the family Phytoseiidae are susceptible to low humidity conditions. At very low humidity, predatory mites are very vulnerable to water loss that occurs through evaporation of their skin, and generally, predatory mites are unable to compensate for water loss from his body so that it will significantly affect his fecundity and can even result in death.

Not only humidity but the results of the analysis of variance also showed that the rainfall had no significant effect on the density of temperature resistant *P. amba* by 0.046%. This is not according to [6] statement, which states that predatory mite populations are higher during the rainy season compared to the dry season. The decrease in the number of predatory mites in the dry season is generally always followed by an increase in pest mites.

Apart from humidity and rainfall, the results of the analysis of variance showed that temperature had no significant effect on the density of temperature resistant *P. amba*. This is presumably because, at the time of sampling, the mites moved to look for a suitable temperature and avoided too high a temperature because it could cause death. As [5] stated, at temperatures above 35°C the predatory mite *P. persimilis* can only survive for 16 hours then die. Also, the temperature has more or less the same effect on predatory mites and pest mites than humidity ([2] [10]).

4. Conclusion

The density factor of *T. urticae* mites in the adult stage is a factor that determines the survival of temperature-resistant *P. amba* predatory mites on a field scale.

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References

- [1] Fountain M T and Medd N 2015 Integrating pesticides and predatory mites in soft fruit crops 657–67
- [2] Budianto B H and Basuki E 2013 Kemampuan predasi tungau predator **13** 35–41
- [3] Puchalska E K and Kozak M 2016 Phytoseiidae) as potential biocontrol agents against spider mites (Acari : Tetranychidae) inhabiting willows : laboratory studies on predator

development *Exp. Appl. Acarol.* **68** 39–53

- [4] Suidasidae A 2013 Life table parameters and capture success ratio studies of *Typhlodromips swirskii* (Acari : Phytoseiidae) to the factitious prey *Suidasia medanensis* 69–78
- [5] Hassan M F 2015 Efficacy of Two Phytoseiid Predators and a Biopesticide Against *Tetranychus cucurbitacearum* (Sayed) (Acari : Tetranychidae) on Eggplant at Ismailia Governorate , Egypt **25** 71–4
- [6] Calvo F J, Knapp M, Houten Y M Van and Belda E 2015 *Amblyseius swirskii* : What made this predatory mite such a successful biocontrol agent ? 419–33
- [7] Sarkar P K, Roy D and Chakraborty G 2016 Cost-effective and eco-friendly management of *Oligonychus coffeae* , *Calacarus carinatus* and *Acaphylla theae* on tea with a pyridazinone molecule fenpyroximate 5 % EC **9** 877–85
- [8] Goleva I and Zebitz C P W 2013 Suitability of different pollen as alternative food for the predatory mite *Amblyseius swirskii* 259–83
- [9] Hewitt L C, Shipp L and Buitenhuis R 2015 Seasonal climatic variations influence the efficacy of predatory mites used for control of western flower thrips in greenhouse ornamental crops 435–50
- [10] Buitenhuis R, Murphy G, Shipp L and Scott-dupree C 2015 *Amblyseius swirskii* in greenhouse production systems : a floricultural perspective 451–64