Predation Capacity of *Phytoseius crinitus* Swirski Et Schebter on Each Stage of *Tetranychus urticae* and Alternative Food for Laboratory Mass Rearing

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Predation Capacity of *Phytoseius crinitus* Swirski Et Schebter on Each Stage of *Tetranychus urticae* and Alternative Food for Laboratory Mass Rearing

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Abstract. Providing a sensible breeding stock of predatory mites for a biological control system is important. For this purpose, the predatory mites need high feeding capacity on every stage of pest mites and high survival rates on alternative food. This research aimed at testing the predation capacity of *P. crinitus* on each stage of development of pest mites *T. urticae,* and investigating appropriate alternative food for laboratory rearing of predatory mites *P. crinitus.* Completely Randomized Design (CRD) was used in this research. For investigating the predation capacity of *P. crinitus,* we performed 20 experiments consisted of treatments with eggs, larvae, nymphs, and adults of *T. urticae*, with five replicates. The variable for these experiments was the number of individuals of each stage of *T. urticae* consumed by *P. crinitus* during the period of 24. For investigating the proper alternative food for predatory mites, *P. crinitus* were given a free choice between pollen of *Euphorbia pulcherrima* Willd and pollen of *Hibiscus rosa-sinensis* L, with six replicates. The variables of survival rate, facundity, duration of oviposition, and the length of the life cycle of *P. crinitus* were recorded for each alternative food. All experiments were conducted in room temperatures (-) and rH (-). The data were analyzed using the F test and followed by Least Significant Difference (LSD) with error levels of 5% and 1%. The results indicated that predatory mites *P. crinitus* consumed eggs more than other developmental stages of *T. urticae*. In terms of alternative food, the pollen of *Euphorbia pulcherrima* was more suitable for laboratory mass rearing of *P. crinitus*.

1. Introduction

Pest mites, *Tetranychus urticae,* live by sucking the sap then cause necrosis of the tissues on the leaf bottom surface of the host plants. This necrosis may appear like rusts alongside the leaf nervations. In severe cases, *e.g.*, in Cassava, necrosis may spread all over the leaves and cause them to fall off and cause a significant reduction of the crop [1]. Thus, controlling the population of pest mites is mandatory.

Naturally, the population of *T. urticae* is controlled by predatory mites *Phytoseius crinitus*. In a normal situation, the mites population is dynamically maintained. In a biologically controlled plantation, their populations are ideally in the state of equilibrium under an economic injury level [2]. However, during the condition where the population of the pest mites drops to a level that is too low to support the existence of the predatory mites in the field, then alternative food is required to maintain the population of the predatory mites [3].

In reality, most current biological control programs are not sustainable because of ignoring the importance of the availability of proper alternative food [4]. Thus, investigating suitable alternative

foods to provide in the field during the lack of the main food as well as laboratory rearing for mass production of the predatory mites for providing breeding stocks of biological control agent in a case that reintroduction is required.

For the quality of laboratory-reared biological control agents, some characters of the predatory mites must be maintained. These important characters are predation capacity, number of prey consumed per unit time, duration of a life cycle, survival, fecundity, and food preference [5]. Preference is the ability of a predatory mite to choose prey [6]. The more active a predatory mite is in searching its prey, the less time required for the predator to detect, to catch, and to consume the prey [1]. The laboratory rearing system also has to be able to maintain the reproductive rates of the predatory mites. Thus, a quality alternative food is the food that can maintain good characters of predatory mites as good as when they consume their primary food [7].

This research aimed at investigating the predation capacity of *P. crinitus* on each stadium of *T. urticae,* and exploring appropriate alternative food for laboratory mass rearing of *P. crinitus.*

2. Methods

Laboratory Rearing of Predatory Mites *P. crinitus* was conducted using the procedure of Calvo et al. [8]. The mites were collected from Cassava leaves under a binocular-stereoscopic microscope in the Laboratory. These leaves were taken from the Cassava field in the northern Purwokerto sub-district. The collected *P. crinitus* mites were then moved to the rearing regime. Each unit of this regime consisted of a plastic tray (15 x 5 cm^2) containing water and a sponge (20 x 10 cm^2). A black tile with perfume-free tissue on its edge was placed above the moist sponge. The edge of the tissue touched the water, and above the tissue, a barrier made of Tangle Foot glue surrounding the black tile to prevent the predatory mites *P. crinitus* from escaping the arena.

In order to provide a breeding stock of *T. urticae,* a laboratory rearing was performed following the procedure of Howard et al. [9] using potted Red Bean. These plants were arranged with a 50cm space between each other. The pest mites *T. urticae* were inoculated onto the leaves of the potted Red Bean where a barrier of Tangle Foot glue was made surround the petiole at the proximal edge of the leaf to prevent the mites from escaping from the leaf. Watering the potted plants was performed directly onto the soil to prevent the mites from being washed away from the leaves. In addition, the ventilation of the greenhouse were closed to prevent the mites from being blown away by the wind.

For providing a stock of pollen as alternative food of *P. crinitus,* the procedure of Goleva and Zebitz [10] was employed. This involved collection of anthers of String Bean (*Vigna sinensis*), Kastuba (*Euphorbia pulcherrima* Willd), and of *Hibiscus rosa-sinensis* L. flowers, and placing the anthers in Petri dishes. These anther-containing petri dishes were then sterilized in an incubator with a temperature of 60 ^oC for 12 h. The pollens were then separated from the anthers using a smooth brush, and then put into vials for storage in the fridge. Theoretically, these stored pollens may last up to one year.

For testing the predation capacity, *P. crinitus* and the pest mites *T. urticae* were placed at the opposite edge of the arena. This research employed a Completely Randomized Design. Each of 4 predatory mites was given 4 individuals [11] of each stage of development (eggs, larvae, nymphs and adults) of pest mites *T. urticae* respectively. The number of individuals of *T. urticae* that one individual of *P. crinitus* could consume during a period of 24 hours as well as the predation time (second) were recorded. These experiments were repeated 5 times.

In order to investigate the most proper alternative food for a laboratory rearing of predatory mites *P. crinitus*, pollens of String Bean (*Vigna sinensis*), pollen of Kastuba (*Euphorbia pulcherrima* Willd), and pollen of *Hibiscus rosa-sinensis* L. were given *ad libitum* to *P. crinitus*. Each of these experiments was repeated 6 times, so there were 18 units of tests. In these experiments, parameters measured were survival, fecundity, oviposition time, and the duration of the life cycle of predatory mites *P. crinitus* in each alternative food.

All the experiments were conducted under room temperature, and the range of temperature during experiments was recorded. The relative humidity rH was also recorded. The data were analysed using

ANOVA (Analysis of Variance) (F test). If there is a significant difference, then the analysis was continued with LSD (Least Significant Difference) with error levels of 5% and 1%.

3. Results

The variance analysis resulted that the number of *T. urticae* consumed by *P. crinitus* depended on the stage of development of *T. urticae* ($P < 0,01$). Further analysis to determine the most consumed stage of *T. urticae*, using LSD Test (5% error level), revealed that *P. crinitus* eggs were the most consumed, followed by larvae, nymphs, and adults ($P < 0,05$, Table 1).

Table 1. The average number of individuals of *T. urticae* consumed by one individual of *P. crinitus* during a 24 h period.

T. urticae	The average number of *T. urticae* consumed by *P. crinitus* ± SD
Egg	3,984 ± 0,021 a
Larva	1,968 ± 0,042 b
Nymph	1,200 ± 0,067 bc
Adult	0,933 ± 0,009 c

Different characters after the numbers indicate a significant difference at the error level of 5%.

Since laboratory rearing of predatory mites is an essential way of providing stock for biological control agents, determining an alternative food that is cheap and easier to find has to results in a healthy life for predatory mites *P. crinitus*. In order to guaranty that using alternative food does not negatively affect the predatory mite performance, several assessments were conducted on every stage of development, survival, and fecundity.

The data indicated that the pollen of *Euphorbia pulcherrima* resulted in 1.5 - 2.75 days shorter of the life cycle of *P. crinitus* compared to other pollen (Table 2).

Table 2. Durations of developmental stages of *P. crinitus* fed with alternative foods

P. crinitus	Duration (day) of developmental stages of *P.crinitus* fed on pollen of:		
	Vigna sinensis	*Euphorbia pulcherrima*	*Hibiscus rosa-sinensis*
Egg	1,5 ± 0,58	1,5 ± 0,58	1,25 ± 0,50
Larvae	2 ± 0,82	1,75 ± 0,50	1,75 ± 0,50
Nimph	7,25 ± 0,50	6,50 ± 0,58	9,25 ± 0,50
Adult	2,75 ± 0,50	2,25 ± 0,50	2,50 ± 0,58

Base the survival, the larval stage of *P. crinitus* was the most critical when fed with the pollen of *E. pulcherrima* compared to the pollen of *V. sinensis* and *H. rosa-sinensis* (Table 3).

Table 3. Survival (%) of each developmental stage of *P. crinitus* fed with alternative foods

P. crinitus	Survival (%) of *P. crinitus* fed with pollen of:		
	Vigna sinensis	*Euphorbia pulcherrima*	*Hibiscus rosa-sinensis*
Egg	100 ± 0	100 ± 0	100 ± 0
Larvae	95 ± 5,78	92,5 ± 5,0	97,5 ± 5,0
Nymph	62,5 ± 9,58	72,50 ± 5,0	67,5 ± 9,58
Adult	87,5 ± 5,0	92,5 ± 9,58	90,0 ± 8,16

The pollen of *E. pulcherrima* did not only result in better survival of *P. crinitus*, but also resulted in higher facundity compared to the other kinds of pollen (Table 4).

Table 4. Fecundity of *P. crinitus* fed with alternative food (Σ eggs/female/day)

No.	Pollen	Average Fecundity ± SD
1	*Vigna sinensis*	1,33 ± 0,52
2	*Euphorbia pulcherrima*	2,00 ± 0,63
3	*Hibiscus rosa-sinensis*	1,67 ± 0,82

4. Discussion

Table 1 shows that one individual predatory mite *P. crinitus* was able to consume 3.98 eggs of *T. urticae* per 24 h period. The predatory mite *P. crinitus* consumed more eggs than other stages of *T. urticae*, maybe because eggs are immobile, so less energy to spend for P. *crinitus* to handle and to consume than other stages of *T. urticae* [12]. The predation capacity of *P. crinitus* was higher (3.98 eggs/24 h) than that of *P. amba*, which only up to 2 eggs/24 h [11], although their predation capacity on larvae, nymphs and adults were more or less the same. Thus, *P. crinitus* is more promising as a biological control agent.

Table 2 shows that if the larval stage can be passed, then the survival of the following stages was higher than if fed with the other two kinds pollen. Based on the duration of each stage of development, survival, and fecundity of *P. crinitus*, the pollen of *Euphorbia pulcherrima* resulted in better performance for laboratory rearing. This may be not only that this kind of pollen contains appropriate nutritional elements, but also smoother (no spine) exine that makes *P. crinitus* easier to consume than that of *Hibiscus rosa-sinensis* pollen where whose exine is so spiny [10].

5. Conclusion

The predation capacity of *P. crinitus* on the eggs of *T. urticae* was higher than on the other stages (3.98 eggs/1 individual *P. crinitus*). Pollen of *E. pulcherrima* was more suitable as an alternative food for *P. crinitus* compared to the pollen of *V. sinensis* and *H. rosa-sinensis.*

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