

Feeding potential of predatory mite, *Amblyseius finlandicus* (Oudemans) (Acari: Phytoseiidae) on different mite hosts

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ABSTRACT

A laboratory experiment was carried out to know the feeding potential of predatory mite, *A. finlandicus* on three species of plant mites. In its entire life period the predator *A. finlandicus* consumed 19.07 ± 1.49 , 14.60 ± 1.06 and 9.00 ± 1.19 eggs, mixed stages and adults of *O. indicus*, 16.03 ± 1.14 , 10.37 ± 1.44 and 8.40 ± 1.06 eggs, mixed stages and adults of *P. latus* and 42.03 ± 3.99 , 21.50 ± 2.22 and 15.87 ± 1.38 eggs, mixed stages and adults of *T. urticae*, respectively. While, the female predator consumed 23.70 ± 1.79 , 16.57 ± 1.14 and 9.7 ± 1.14 eggs, mixed stages and adults of *O. indicus*, 19.27 ± 1.49 , 11.83 ± 1.28 and 10.47 ± 1.32 eggs, mixed stages and adults of *P. latus* and 51.83 ± 5.06 , 26.63 ± 1.85 and 18.63 ± 1.35 eggs, mixed stages and adults of *T. urticae*, respectively.

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INTRODUCTION

The predatory mite, *Amblyseius finlandicus* (Oudemans) is widely distributed and has been recorded in many countries throughout Europe, Asia and North America (Kropczynska and Petanovic, 1987; Kropczynska and Tuovinen, 1988 and McMurtry and Croft, 1997). It has been found on *Prunus* sp., *Pyrus* sp. and *Juglans* sp. forest and orchard trees (Ragusa-Di Chiara *et al.*, 1995). *A. finlandicus* has a typical mesostigmatic mite and life cycle comprised with an egg, three active immature stages (larva, protonymph and deutonymph) and adult. Their potential feeding on prey has been rarely addressed (Cox *et al.*, 2006). Certain

characteristics of Phytoseiidae mites may render them promising biological control agents for both conservation and augmentative biological control. They bear all advantageous traits of generalist predatory mites *i.e.* they survive and reproduce on a variety of mites as well as insects and also on alternative food sources, such as pollen and honey (McMurtry and Croft 1997, Mandape and Shukla, 2017a and b). The ability of a generalist predator like phytoseiids to feed on more than one pest could prove beneficial for the outcome of biological control through the increase in its densities, as well as the positive effects of mixed diets on the predator's performance (Messelink *et al.*, 2008; 2010 and 2013 and

Momen and El-Borolossy, 2010). So far, very little information is available on the feeding potential of the predatory mite like *A. finlandicus* on different species of phytophagous mites. Therefore, the present paper reports the feeding potential of phytoseiid predator *A. finlandicus* as bio-control agents of some most important plant mites under laboratory conditions.

MATERIAL AND METHODS

The present study on feeding potential of predatory mite *A. alstoniae* was conducted on three different species of plant mites viz. *Tetranychus urticae* Koch, *Polyphagotarsonemus latus* Banks and *Oligonychus indicus* Hirst. The details of the experiment were as follows:

Nucleus culture of phytoseiid mite, *A. finlandicus*:

The field collected adults of predatory mite, *A. finlandicus* was brought to the laboratory and these adults were sexed and released in the pair on french bean leaves already infested by *T. urticae*. After 48 hours, the eggs laid by the pairs were collected and placed separately and reared on french bean leaves already infested by *T. urticae*. The adults thus obtained were released and placed for mating and the next progeny obtained from this culture were used for further experiment.

Laboratory culture of prey mites (*T. urticae* and *P. latus*):

The laboratory culture of *T. urticae* and *P. latus* was maintained on french bean leaves and on potted plants of french bean in Polycarbonate house of Department of Entomology, Navsari Agricultural University, Navsari. In case of laboratory culture, the leaf bit method was used. In this a leaf bit of 2 cm² was placed on a cotton swab already saturated with the water for maintaining the turgidity of the leaves. The gravid females were placed on these leaf bits singly and after 24-hours these females were removed from these leaf bits. The eggs thus laid by these females were used for the further multiplication and experiment.

Laboratory culture of sorghum mite (*O. indicus*):

The laboratory culture of sorghum mite was maintained on sorghum leaves and on potted plants of sorghum in Polycarbonate house of Department of

Entomology, Navsari Agricultural University, Navsari. The laboratory culture of *O. indicus* was maintained on leaf bits of sorghum (2 cm²). A gravid female of sorghum mite was released on this leaf bit for 24 hours for egg laying. The female was removed after 24 hours and the eggs thus, laid by these females were used for the further multiplication and experiments.

Feeding potential:

The newly emerged predatory mite, *A. finlandicus* were kept separately in petri dishes. A set of 50 adults for each of three prey mite species viz., *T. urticae*, *P. latus* and *O. indicus* was maintained. The different stages (larvae, protonymph, deutonymph and adult) of predatory mites were provided with counted number of various stages of prey mites i.e. eggs, mixed stages and adults. Number of various stages of prey mites consumed by the developing and adult stages of predatory mites during entire life period as well as in 24 hours was recorded and the various stages of prey mites were provided daily. In this way the feeding potential of predatory mite, *A. finlandicus* was recorded on three prey mite species.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under the following heads:

O. indicus as prey:

The data presented in the Table 1 represents that, during the year 2014-15, the larva of *A. finlandicus* consumed 4.07±1.03 eggs, 3.53±0.64 mixed stages and 2.00±0.76 adults of *O. indicus*, while the protonymph consumed 3.67±0.49 eggs 4.13±0.74 mixed stages and 2.27±0.46 adults of *O. indicus*, the deutonymph consumed 4.60±0.74 eggs, 3.67±0.62 mixed stages and 2.67±0.49 adults of *O. indicus*. The adult male consumed 5.67±0.62 eggs, 2.27±0.46 mixed stages and 1.33±0.49 adults of *O. indicus* while female consumed 10.00±0.76 eggs, 4.40±0.63 mixed stages and 2.00±0.76 adults of *O. indicus*. Male in its entire life consumed 18.00±1.25 eggs, 13.60±1.06 mixed stages and 8.27±1.22 adults while, the female consumed 22.40±1.64 eggs, 15.73±1.16 mixed stages and 8.93±1.03 adults of *O. indicus*.

During the year 2015-16, the larva of *A. finlandicus* larvae consumed, 5.20±0.86, 4.13±0.64 and 2.53±0.52

eggs, mixed stages and adults of *O. indicus*, respectively, while the protonymph consumed 4.00 ± 0.53 , 4.27 ± 0.59 and 2.60 ± 0.74 eggs, mixed stages and adults of *O. indicus*, respectively, while, the deutonymph consumed 5.33 ± 0.82 , 4.40 ± 0.63 and 3.13 ± 0.83 eggs, mixed stages and adults of *O. indicus*. Similarly, the adult male consumed 5.60 ± 0.51 , 2.80 ± 0.68 and 1.47 ± 0.52 eggs, mixed stages and adults of *O. indicus*, respectively while the female consumed 10.47 ± 0.64 , 4.60 ± 0.63 and 2.20 ± 0.68 eggs, mixed stages and adults of *O. indicus*. During the entire life period the male predator consumed

20.13 ± 1.73 , 15.60 ± 1.06 and 9.73 ± 1.16 eggs, mixed stages and adults of *O. indicus*, respectively. While, the female predatory mite consumed 25.00 ± 1.93 , 17.40 ± 1.12 and 10.47 ± 1.25 eggs, mixed stages and adults of its prey, *O. indicus*, respectively.

The pooled data over the years revealed that the larva, protonymph, deutonymph, adult male and female of the predatory mite *A. finlandicus* consumed 4.64 ± 0.95 , 3.84 ± 0.51 , 4.97 ± 0.78 , 5.64 ± 0.57 , 10.24 ± 0.70 eggs of *O. indicus*, 3.83 ± 0.64 , 4.20 ± 0.67 , 4.04 ± 0.63 , 2.54 ± 0.57 , 4.50 ± 0.63 mixed stages of *O. indicus*, and

Table 1: Feeding potential of predatory mite, *A. finlandicus* on *O. indicus*

Predatory mite	Consumption of different stages of <i>O. indicus</i> (Mean± SD)									
	2014-15			2015-16			Pooled			
	Eggs	Mixed	Adult	Eggs	Mixed	Adult	Eggs	Mixed	Adult	
Larva	4.07±1.03	3.53±0.64	2.00±0.76	5.20±0.86	4.13±0.64	2.53±0.52	4.64±0.95	3.83±0.64	2.27±0.64	
Protonymphs	3.67±0.49	4.13±0.74	2.27±0.46	4.00±0.53	4.27±0.59	2.60±0.74	3.84±0.51	4.20±0.67	2.44±0.60	
Deutonymphs	4.60±0.74	3.67±0.62	2.67±0.49	5.33±0.82	4.40±0.63	3.13±0.83	4.97±0.78	4.04±0.63	2.90±0.66	
Adult	Male	5.67±0.62	2.27±0.46	1.33±0.49	5.60±0.51	2.80±0.68	1.47±0.52	5.64±0.57	2.54±0.57	1.40±0.51
	Female	10.00±0.76	4.40±0.63	2.00±0.76	10.47±0.64	4.60±0.63	2.20±0.68	10.24±0.70	4.50±0.63	2.10±0.72
Total	Male	18.00±1.25	13.60±1.06	8.27±1.22	20.13±1.73	15.60±1.06	9.73±1.16	19.07±1.49	14.60±1.06	9.00±1.19
	Female	22.40±1.64	15.73±1.16	8.93±1.03	25.00±1.93	17.40±1.12	10.47±1.25	23.70±1.79	16.57±1.14	9.7±1.14

Table 2: Feeding potential of predatory mite, *A. finlandicus* on *P. latus*

Predatory mite	Consumption of different stages of <i>P. latus</i> (Mean± SD)									
	2014-15			2015-16			Pooled			
	Eggs	Mixed	Adult	Eggs	Mixed	Adult	Eggs	Mixed	Adult	
Larva	5.07±0.88	2.00±0.65	1.67±0.49	5.07±0.80	2.40±0.51	1.87±0.64	5.07±0.84	2.20±0.58	1.77±0.57	
Protonymphs	2.33±0.49	2.47±0.64	2.20±0.56	3.00±0.85	3.20±0.86	2.60±0.74	2.67±0.67	2.84±0.75	2.20±0.65	
Deutonymphs	4.60±0.63	3.07±0.59	2.33±0.49	5.27±0.70	3.53±0.64	2.40±0.51	4.94±0.67	3.30±0.62	2.37±0.50	
Adult	Male	3.33±0.49	1.73±0.59	1.87±0.35	3.40±0.51	2.33±0.49	1.87±0.52	3.37±0.50	2.03±0.54	1.87±0.44
	Female	5.60±1.24	3.60±0.63	3.80±0.68	6.27±0.80	3.40±0.51	4.07±0.70	5.94±1.02	3.50±0.57	3.94±0.69
Total	Male	15.33±1.05	9.27±1.58	8.07±0.96	16.73±1.22	11.47±1.30	8.73±1.16	16.03±1.14	10.37±1.44	8.40±1.06
	Female	18.93±1.33	11.13±1.25	10.00±1.31	19.60±1.64	12.53±1.30	10.93±1.33	19.27±1.49	11.83±1.28	10.47±1.32

Table 3: Feeding potential of predatory mite, *A. finlandicus* on *T. urticae*

Predatory mite	Consumption of different stages of <i>T. urticae</i> (Mean± SD)									
	2014-15			2015-16			Pooled			
	Eggs	Mixed	Adult	Eggs	Mixed	Adult	Eggs	Mixed	Adult	
Larva	8.13±1.06	5.13±0.83	2.67±0.72	8.27±0.96	4.47±1.13	2.93±0.70	8.20±1.01	4.80±0.98	2.80±0.71	
Protonymphs	12.67±2.55	6.00±0.65	5.07±0.96	11.80±3.03	6.20±0.86	5.27±0.80	12.23±2.79	6.10±0.76	5.17±0.88	
Deutonymphs	14.87±2.20	6.87±0.92	4.40±0.51	13.00±1.96	6.33±0.62	4.47±0.64	13.93±2.08	6.60±0.77	4.43±0.57	
Adult	Male	7.87±1.19	4.07±1.53	3.53±0.52	7.47±0.83	3.93±0.96	3.40±0.51	17.67±1.01	4.00±1.25	3.47±0.51
	Female	12.53±1.85	9.00±1.07	6.73±0.59	13.40±1.24	9.27±1.16	5.73±0.59	12.97±1.54	9.13±1.12	6.23±0.59
Total	Male	43.53±3.89	22.07±2.58	15.67±1.23	40.53±4.09	20.93±1.87	16.07±1.53	42.03±3.99	21.50±2.22	15.87±1.38
	Female	57.20±5.19	27.00±2.27	18.87±1.25	46.47±4.94	26.27±1.44	18.40±1.45	51.83±5.06	26.63±1.85	18.63±1.35

2.27±0.64, 2.44±0.60, 2.90±0.66, 1.40±0.51, 2.10±0.72 adults of *O. indicus*, respectively. In their entire life period, the male *A. finlandicus* consumed 19.07±1.49, 14.60±1.06 and 9.00±1.19 eggs, mixed stages and adults of prey *i. e. O. indicus*, respectively. While, the female predator consumed 23.70±1.79, 16.57±1.14 and 9.7±1.14 eggs, mixed stages and adults of *O. indicus*, respectively.

***P. latus* as prey:**

The data on feeding potential of *A. finlandicus* when prey upon *P. latus* is presented in Table 2. The data revealed that in the year 2014-15, the larva of *A. finlandicus* consumed 5.07±0.88 eggs, 2.00±0.65 mixed stages and 1.67±0.49 adults of *P. latus*, while the protonymph of *A. finlandicus* consumed 2.33±0.49 eggs, 2.47±0.64 mixed stages and 2.20±0.56 adults of *P. latus*. The deutonymph of the predator consumed 4.60±0.63 eggs, 3.07±0.59 mixed stages and 2.33±0.49 adults of *P. latus*. The adult male consumed 3.33±0.49 eggs, 1.73±0.59 mixed stages and 1.87±0.35 adults of *P. latus*, while the female predator consumed 5.60±1.24 eggs, 3.60±0.63 mixed stages and 3.80±0.68 adults of *P. latus*. Male in its entire life consumed 15.33±1.05 eggs, 9.27±1.58 mixed stages and 8.07±0.96 adults while, the female predatory mite consumed 18.93±1.33 eggs, 11.13±1.25 mixed stages and 10.00±1.31 adults of *P. latus*.

In the year 2015-16, the predatory mite, *A. finlandicus* larvae consumed, 5.07±0.80, 2.40±0.51 and 1.87±0.64 eggs, mixed stages and adults of *P. latus*, respectively, while the protonymph consumed 3.00±0.85, 3.20±0.86 and 2.60±0.74 eggs mixed stages and adults of *P. latus*, respectively. The deutonymph consumed 5.27±0.70, 3.53±0.64 and 2.40±0.51 eggs, mixed stages and adults of *P. latus*. Similarly, the adult male consumed 3.40±0.51, 2.33±0.49 and 1.87±0.52 eggs, mixed stages and adults of *P. latus*, respectively whereas the female consumed 6.27±0.80, 3.40±0.51 and 4.07±0.70 eggs, mixed stages and adults of *P. latus*. During the entire life period, the male consumed 16.73±1.22, 11.47±1.30 and 8.73±1.16 eggs, mixed stages and adults of *P. latus*, respectively. While, the female predator consumed 19.60±1.64, 12.53±1.30 and 10.93±1.33 eggs, mixed stages and adults of *P. latus*, respectively.

The pooled data revealed that the larva, protonymph, deutonymph, adult male and female of the predatory mite, *A. finlandicus* consumed 5.07±0.84, 2.67±0.67,

4.94±0.67, 3.37±0.50, 5.94±1.02 eggs of *P. latus*, 2.20±0.58, 2.84±0.75, 3.30±0.62, 2.03±0.54, 3.50±0.57 mixed stages of *P. latus*, and 1.77±0.57, 2.20±0.65, 2.37±0.50, 1.87±0.44, 3.94±0.69 adults of *P. latus*, respectively. During the entire life period the male *A. finlandicus* consumed 16.03±1.14, 10.37±1.44 and 8.40±1.06 eggs, mixed stages and adults, respectively. While, the female predatory mite consumed 19.27±1.49, 11.83±1.28 and 10.47±1.32 eggs, mixed stages and adults of *P. latus*, respectively.

***T. urticae* as prey:**

The data presented in Table 3 indicated that during the year 2014-15 the larva of *A. finlandicus* consumed 8.13±1.06 eggs, 5.13±0.83 mixed stages and 2.67±0.72 adults of *T. urticae*. The protonymph consumed 12.67±2.55 eggs 6.00±0.65 mixed stages and 5.07±0.96 adults of *T. urticae*, whereas the deutonymph consumed 14.87±2.20 eggs, 6.87±0.92 mixed stages and 4.40±0.51 adults of *T. urticae*. The adult male predator consumed 7.87±1.19 eggs, 4.07±1.53 mixed stages and 3.53±0.52 adults of *T. urticae*, whereas the female predator consumed 12.53±1.85 eggs, 9.00±1.07 mixed stages and 6.73±0.59 adults of *T. urticae*. The male in its entire life span consumed 43.53±3.89 eggs, 22.07±2.58 mixed stages and 15.67±1.23 adults while, the female in her life consumed 57.20±5.19 eggs, 27.00±2.27 mixed stages and 18.87±1.25 adults of *T. urticae*.

During the year 2015-16, the larvae of the *A. finlandicus* consumed, 8.27±0.96, 4.47±1.13 and 2.93±0.70 eggs, mixed stages and adults of *T. urticae*, respectively, while the protonymph consumed 11.80±3.03, 6.20±0.86 and 5.27±0.80 eggs mixed stages and adults of *T. urticae*, respectively. However, the predator deutonymph consumed 13.00±1.96, 6.33±0.62 and 4.47±0.64 eggs, mixed stages and adults of *T. urticae*. Similarly, the adult male consumed 7.47±0.83, 3.93±0.96 and 3.40±0.51 eggs, mixed stages and adults of *T. urticae*, respectively while the female predatory mite consumed 13.40±1.24, 9.27±1.16 and 5.73±0.59 eggs, mixed stages and adults of *T. urticae*. During entire life period the male consumed 40.53±4.09, 20.93±1.87 and 16.07±1.53 eggs, mixed stages and adults of *T. urticae*, respectively. While, the female consumed 46.47±4.94, 26.27±1.44 and 18.40±1.45 eggs, mixed stages and adults of its prey *i. e. T. urticae*, respectively.

Pooled data of two years revealed that the larvae, protonymph, deutonymph, adult male and female of the

predatory mite, *A. finlandicus* consumed 8.20 ± 1.01 , 12.23 ± 2.79 , 13.93 ± 2.08 , 17.67 ± 1.01 and 12.97 ± 1.54 eggs of *T. urticae*, 4.80 ± 0.98 , 6.10 ± 0.76 , 6.60 ± 0.77 , 4.00 ± 1.25 and 9.13 ± 1.12 mixed stages of *T. urticae*, and 2.80 ± 0.71 , 5.17 ± 0.88 , 4.43 ± 0.57 , 3.47 ± 0.51 and 6.23 ± 0.59 adults of *T. urticae*, respectively. During the entire life period the male of predatory mite, *A. finlandicus* consumed 42.03 ± 3.99 , 21.50 ± 2.22 and 15.87 ± 1.38 eggs, mixed stages and adults, respectively. While, the female predatory mite consumed 51.83 ± 5.06 , 26.63 ± 1.85 and 18.63 ± 1.35 eggs, mixed stages and adults of *T. urticae*, respectively. Kumari (1981) while studying the feeding potential of *A. finlandicus* she found that *A. finlandicus* consumed eggs, larvae, protonymph, deutonymphs and adults stages of prey *E. orientalis*. The predator preferred to feed on eggs of *E. orientalis* as compared to other stages. However, the predator consumed less numbers of various stages of *E. orientalis* as compared to present findings, this may be due to change of prey mites and location. Puchalska and Kozak (2016) also found that predatory mite, *N. finlandicus* prey upon spider mites (*S. schizopus*, *S. garmani* and *T. urticae*) and it prefer to feed on eggs as compared to mobile stages. The immature and adult stages of *N. finlandicus* feed maximum number of eggs followed by mobile stages and adults of its prey. Thus, these findings are closely support the present findings.

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