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Cohort Development and Population Growth of *Amblydromalus hum* (Acari: Phytoseiidae) on Citrus Red Mite in Comparison to Maize Pollen

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Abstract: Phytoseiidae mites suppress pest mites and small arthropods below injury levels. A study on cohort life stage of *Amblydromalus hum* Pritchard & Baker was carried out to determine development and growth of the Phytosiidae mite. General observation showed a lower turnover of the larval stage to the Protonymph stage from the 12th day onward, probably this could be attributed to some cannibalism taking place where adults could prey on the larvae and the nymphal stages. Significantly, the larvae were most abundant within 21 days when *A. hum* was fed *E. africanus* showing a cohort life stage composition of 39% overall population among other motile life stages. Similarly, same larvae appeared significantly most abundant when feed on maize pollen at 61% over other cohort life stage within a period of 4 days. Female adults starved death by 3rd day and were found not to lay eggs within the period. It was observed that female adult *A. hum* did not live beyond the 3rd day when 100% mortalities occurred where maize. The study results showed that *A. hum* preference for *E, africanus* prey over maize pollen limited the predator's survival in the absence of the preferred diet and hence need to explore alternative substrates in citrus orchards to boost information on how to conserve the beneficial predator in citrus production.

Keywords: *Amblydromalus hum*, *Eutetranychus africanus*, Population Density, Feed Rate, Eggs

1. Introduction

Predacious mites play important roles of suppressing phytophagous mites and other small insect pests of different crops [1-3]. Worldwide different predacious mites are reported to suppress injury levels of specific pests below economic thresholds, even for citrus [4, 5]. Their development and population density growth in various niche agro ecosystems would enable understanding on how bio-control augmentation or conservation methods would be employed to achieve pest mite management in preventing injury levels in citrus [6, 7]. Various species of predatory mites have already been identified in citrus in Kenya (Kiptoo et al. in press). One of these predatory mites was selected for evaluation for biological control of citrus mite pest; *Amblydromalus hum* Pritchard & Baker. The species *A. hum* was studied for its abundance and occurrence among different localities of citrus production in Kenya and found most suitable for augmentation and conservation for suppression of red mites and small sized insect pests on citrus [8]. Out of six varied agro climatic conditions of low coastal and midlands regions where citrus is grown *A. hum* occurrence was at 56% of the total specimens collected hence befitting evaluation for suppression of citrus red mite pest, *Eutetranychus africanus* Tucker among other pests on citrus [9].

Conversely, the choice of a predator for augmentation or introduction to a citrus orchard would bring in the consideration of a range of diverse feed options like pollen [10] and plant substrate in the absence of the presumed prey in this case being *E. africanus*. Various workers have shown how different plant pollens supplement food alternative of two predators, *Amblyseius aerialis* and *Iphiseiodes zuluagai* in Brazilian citrus orchards. As demonstrated in the study, the two Phytoseeidae predators would have alternative feed option in case prey densities dropped too low or cultural management methods render reduction of prey numbers as during weeding of crop plot [10, 11]. Elsewhere, studies on optimum agro climatic conditions have been shown to enhance presence and effective prey-predator ratio to attain non injurious pest density levels [12]. The results would provide information on what level the phytoseiid mite would aid in suppressing the pest mite *E. africanus* in citrus orchards and probably the recommendation on integrated citrus crop management which farmers could adapt in their production units [13]. The present study was aimed at assessing maize pollen performance as feed alternative to natural prey *E. africanus* of predacious mite *A. hum* found on citrus plants.

2. Methodology

2.1. Mass Rearing in Greenhouse

The basic optimum conditions were tested by use of Electronic Data Loggers 10-minute record- range of temperature, relative humidity and once found similar to the bio-ecological requirement of host red mites (Figure 1). Determined hydro-climatic conditions were as follows: temperature 29.6±9.6 °C, while RH (%) was 57.2±20.8% with water vapouring point at 18.7±3.1°C. The low RH (%) was suitable for fast growth of red mites, *Eutetranychus africanus* (Author) on citrus plants. Once cultures of test predatory mite were set up for observation, feed rations of 20 host mites of *E. africanus* would be transferred after every 12hrs to determine feed rate by the test predator.

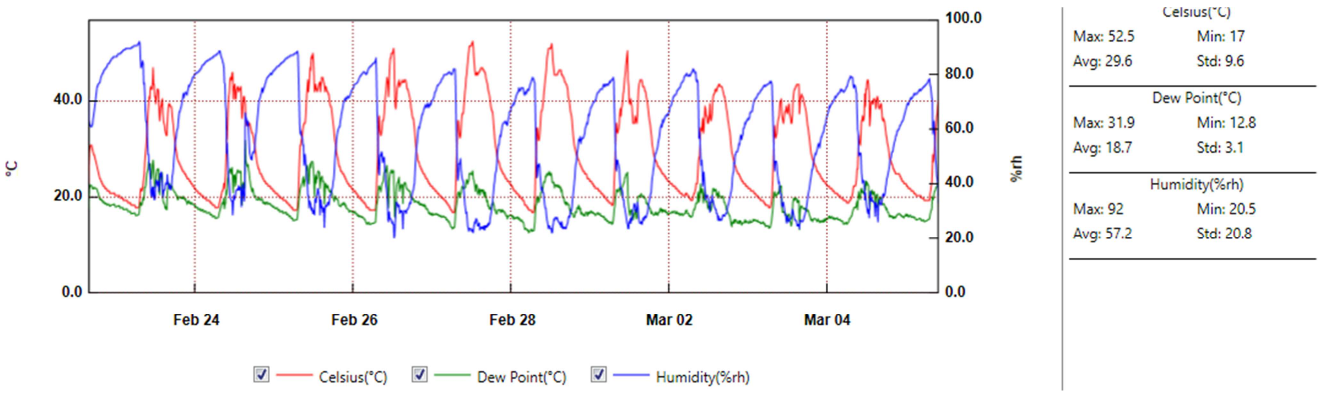

Figure 1. *Greenhouse prevailing hydrometer parameters at KALRO Katumani April 2021.*

2.2. Predatory Life Stage Evaluation

A review on the life cycle of the expected life history of the phytoseiid life stage motile stages as larva protonymph, deutonymph and adult was determined. It showed that a duration of 11 days would be required for an egg to hatch in 3-4 days, larval development of 2-3 days, larvae to Protonymph one day, Protonymph to Deutonymph 1-2 days and pre-adult of 1-2 days. The actual record duration was carried out for each life stage to determine practical detail life history. Two life stage motile cohorts were evaluated being the Nymphs and Adults. The number of red citrus mite individuals, *E. africanus*, fed on by each of the two main cohort life stages namely, nymphal and adult stages.

Earlier on maize pollen was harvested and kept at 4°C in fridge conditions for later determination of alternative feed for predacious mites on citrus plants. Harvest of citrus red mites were carried out as designed experimental requirement of evaluating, (i) adult feed rate of the selected Phytoseiidae species of *Amblydromalus hum* collected from nearby citrus plants, (ii) number of eggs (fecundity) of females, (iii) Egg development time to hatching, (iv) life stage developmental time for Larva, Protonymph, Deutonymph, and (v) female life span. Parallel to that was similar evaluation on maize pollen and pure water substrate diets. Single female mite, *A. hum* were subjected to controlled temperature, RH% and dew point water vapour evaluation in a KALRO Katumani Laboratory temp-RH controlled-temperature (CT) room. An electronic data logger was used to determine parameter regime range stabilization of parameters (Figure 2). Once the temp-RH conditions were stabilized in the CT-Room where the experimental evaluations were started in 4-replicates. Average temperature score was 26±1.3 °C, while RH (%) was 78.2±7.1%. Water vapouring point was at 21.9±2.5 °C in the experimental room.

Experimental units of comparable 20 mite hosts and maize pollen were observed in the CT Room conditions. The experimental units were replicated 4-times for reliability of the results (Figure 3).

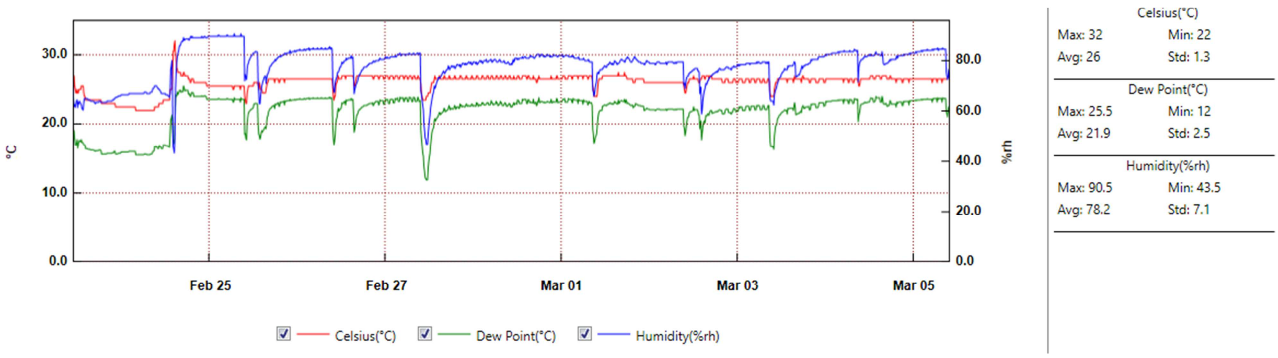

Figure 2. *Sample hygrometer parameter (temperature, RH% and dew point) determination in CT-Room at KALRO-Katumani March April 2021.*

i). Phytoseiid *Amblydromalus hum* life stage observation on citrus red mite host feed evaluation

ii). Maize pollen feed observation disk on life stage development of phytoseiid *Amblydromalus hum*

Figure 3. *Comparative feed alternative of Amblydromalus hum on citrus red mite and maize pollen.*

3. Results

3.1. Growth on Red Citrus Mite

Results of feeding of *A. hum* on the red citrus mite, *E. africanus* showed an exponential growth in the first 20 days with the larval stage leading other cohorts (Figure 4). General observation showed a lower turnover of the larval stage to the Protonymph stage from the 12th day onward, when combined 4 replicate population density of the phytoseiid were considered. Probably this could be attributed to some cannibalism taking place where adults could prey on the larvae and the nymphal stages.

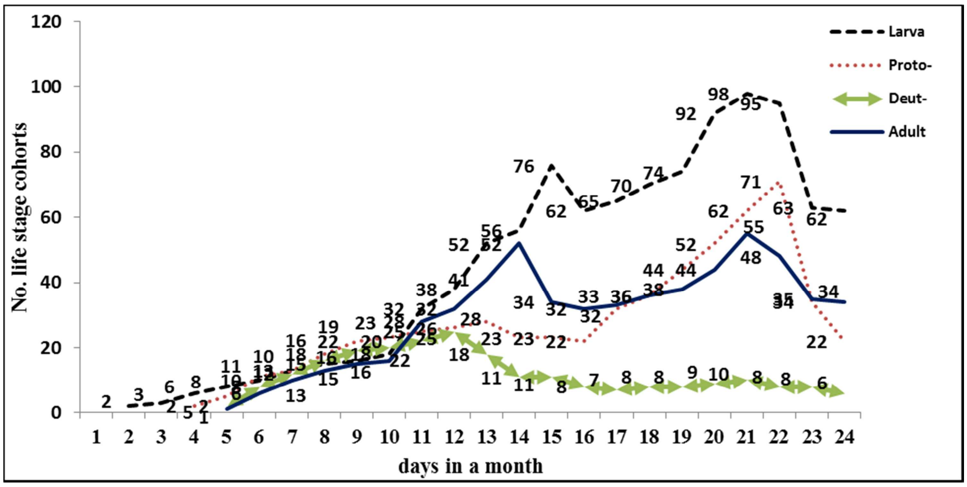

Figure 4. *Combined population of growth of Amblydromalus hum from 4 replicate rearing disks in 24±4°C and 78.2±7.1%.*

Significantly (p=< 0.05) higher feed rate was observed on the female *A. hum* adults than the nymphal stages as shown on Table 1. Number of feed rate on *E. africanus* during the five-period intervals appeared to be at <16.0 > 15.0 for the adult females while for nymphs was at < 7.5 > 6.5. This could be due to body requirement of the life stage and ability to kill the prey.

Table 1. *Comparative three-day period feed intervals to 15th day of motile and nymphal stage of predacious mite Amblydromalus hum on red citrus mite (RCM), Eutetranychus africanus at 26±1.3 °C, while RH (%) was 78.2±7.1%.*

Cohort	3 Days		6 Days		9 Days		12 Days		15 Days	
	Nymph	Adult	Nymph	Adult	Nymph	Adult	Nymph	Adult	Nymph	Adult
No. RCM	7.5±2.3b	15.3±2.5a	7.3±4.4b	16.0±2.3a	6.5±1.8b	15.2±2.9a	7.3±3.2b	16.0±4.a	8.3±2.7b	15.0±3.1a
F	106.8		50.4		79.34		114.93		146.93	
t	4.34		7.10		8.91		10.72		12.12	
r	0.962		0.876		0.879		0.887		0.888	
p	0.028		< 0.001		< 0.001		< 0.001		< 0.001	
df	1,7		1,15		1,23		1,31		1,39	

3.2. Cohort Developmental Growth

Significantly ($p < 0.05$, $F_{3, 31}$=38.03) the larvae were most abundant within 21 days when *A. hum* was fed *E. africanus* showing a cohort composition of 39% (Table 2). Similarly, same larvae appeared significantly ($p < 0.05$, $F_{3, 15}$=40.5) most abundant when feed on maize pollen at 61% over other cohort life stage within a period of 4 days. Female adults starved to die by 3rd day and were found not to lay eggs within the period. Likewise egg oviposition was significantly ($p < 0.005$, $F_{1, 7}$=34.3) achieved on *E. africanus* diet but not on comparative maize pollen.

Table 2. *Cohort development days from egg to adult stage on red citrus mite and pollen at 26±1.3 °C, while RH (%) was 78.2±7.1%.*

Cohort stage	Red citrus mite diet		Eggs/female	Maize pollen diet		Eggs/female	*F*	*P*
	Range-21 days	%		Rang- 4 days	%			
	No. Phytoseiid			No. Phytoseiid				
Larva	24.5±3.2 a ^{A}	39		4.6±2.2 a ^{B}	61		21.6	< 0.001
Protonymph	15.3±2.8 b ^{A}	23		1.3±0.5 b ^{B}	18		44.4	< 0.001
Deutonymph	10.0±3.4 c ^{A}	16		1.0±0.2 b ^{B}	14		56.2	< 0.001
Adult	13.8±2.6 b ^{A}	22	2.1^{A}	0 c ^{B}	7	0 ^{B}	34.3	< 0.001
F	38.03			40.5				
P	< 0.0001			< 0.0001				

Similar letters small letters within column denote no significant ($p < 0.05$) difference in numbers of cohort population in stated observation days in diet of red citrus mite and maize pollen at 5% level. Similar transcript letters among type of diet showed no significance difference in the same level.

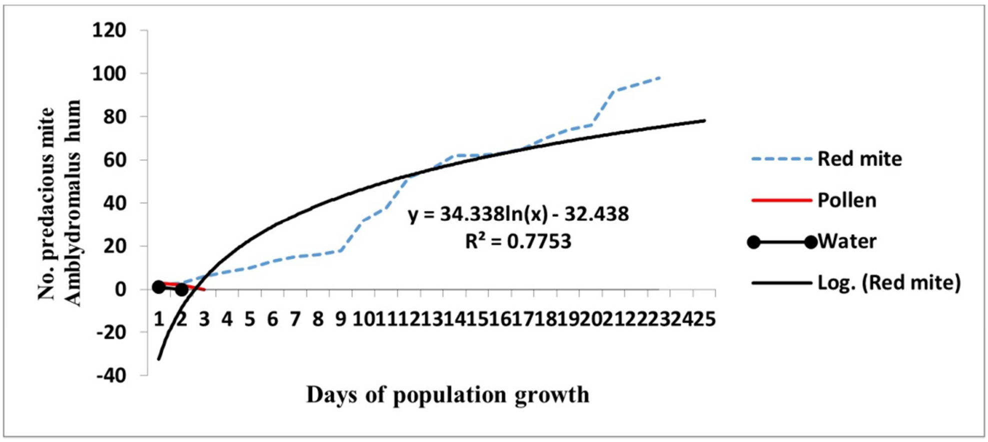

Figure 5. *Starvation point of predatory mite Amblydromalus hum fed on maize pollen in the absence of common prey Eutetranychus africanus.*

3.3. Predator Starvation Point

It was observed that female adult *A. hum* did not live beyond the 3rd day when 100% mortalities occurred as shown in Figure 5 where maize pollen supported the predator only one day extra as water fed individuals died by second day. This observation showed that from second day onward the predator *A. hum* would be starving hence *E. africanus* prey presence would save the Phytoseiidae mite.

4. Discussion

The results of the present study on life stage of *A. hum* on diet of *E. africanus* showed how cohort stage and general population growth occurs from larvae to adults. There was an indication of exponential growth from 12th day when more female eggs were hatching and more motile stages increased. Within such a controlled area, drop of growth reached a plateau on 20th day and dropped by 23rd day as mortality increased. This high mortality could be attributed to cannibalism of the juvenile stages as the mature female searched for more food. Reports by some workers have reported that where mass rearing space is limited also cannibalism increase results [14]. As shown in the study predator cohort development for larvae appeared to grow significantly ($p < 0.05$) higher on *E. africanus* than pollen. All life stages showed exponential growth when fed diet of *E. africanus* than maize pollen. The unsuitability of maize pollen was shown whereby on day three all motile life stages suffered 100% mortality comparatively one to two days on pure water. While in some experiments predator life stage cohort is demonstrated to be supported by different plant pollens, in the present study *A. hum* appeared to gain limited development on maize pollen in the absence of the main prey *E. africanus* [15]. The starvation point of the mite *A. hum* occurred by first day on pure water and by maize pollen by third day. This could be observed to be the point at which *A.*

hum needed to be fed on the *E. africanus* prey for egg oviposition and body sustainability.

Further, the present study showed that predacious mite *A. hum* on maize pollen and *E. africanus* could be used to hypothetically analyze the predator-prey ratio requirement in citrus orchards where at least two to three *E. africanus* mites could promote survival and growth of the predacious mite. Elsewhere, it has been shown that *Typhlodromalus aripo* fed alternatively on cassava small arthropod nymphal stages of white flies and mealybugs hence need to study the same herbivores for *A. hum* diet range specifically in citrus orchards [16]. Since abiotic factors influencing increase of population density of predacious mites like *A. hum* include high humidity and warm environment it could thus be considered in management designs for specific regions when existing conditions are known [17, 18]. What would be considered is not modifying the agro-climatic conditions *per se* but options for management of *E. africanus* by enhancing *A. hum* population growth in citrus orchards. Much acaricides like Abamectin has been extensively used to prevent mite pest attack on citrus but spray regimes could be lowered when predator density population is sufficiently high [19, 20]. A further effort towards sustainable management could be achieved by conservation of predacious mites like *A. hum* in citrus orchards where judicial use of short duration acaricide molecules are considered so that after long term elimination of predator is prevented could be adapted from other similar works experimented worldwide [21-23].

The ultimate study results from exploring cohort development and growth of *A. hum* on *E. africanus* diet have shown that while the predacious mite exponentially increases its population density on the citrus herbivore, little was promising on maize pollen alternative. There could be need to study what could be the effect of citrus pollen during flowering stage of the tree. The outcome of the findings could give more information on the predacious mite relationship with the citrus plants at tri-tropic level.

5. Conclusion

The present study results showed that *A. hum* preference for *E. africanus* prey over maize pollen could limit predator to have little survival in the absence of the preferred diet and hence need to explore alternative substrates in citrus orchards. This could boost methods to conserve the beneficial predator in citrus production.

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References

[1] Tanigoshi, L. K., J. Y., Nishio-Wong, J. Fargerlund & H. J. Griffiths. (1985). Biological control of citrus thrips, *Scirtothrips citri* (Thysanoptera: Thripidae), in southern California citrus groves. Environmental Entomology 14: 733-741.

[2] Beattie, G. A. C. & Gellatley J. G. (2003). https://www.dpi.nsw.gov.au/agriculture.

[3] De Morais, M. R. (2019) PhD Thesis: Distribution, bio-ecology and management of the citrus brown mite *tegolophus brunneus* Flechtmann (Acari: Eriophyidae). Faculdade de Ciências Agrárias e Veterinárias-Unesp, Câmpus de Jaboticabal. Sao Paulo, Brazil.

[4] Abdelgayed, A. S., Eraky S. A. Neg M. W, Helal T. Y. & S. F. M. Moussa (2016) Phytophagous and Predatory Mites Inhabiting Citrus Trees in Assiut Governorate, Upper Egypt. Assiut Journal Agricultural Sciences 48, (1), 173-181.

[5] Tixier M-S. (2018) Predatory Mites (Acari: Phytoseiidae) in Agro-Ecosystems and Conservation Biological Control: A Review and Explorative Approach for Forecasting Plant-Predatory Mite Interactions and Mite Dispersal. Frontiers in Ecology and Evolution 6, 192, 1-21. www.frontiersin.org.

[6] Fang X. D., Ouyang G. C., Lu H. L., Guo M. F. & Wei Wu N. (2017) Ecological control of citrus pests primarily using predatory mites and the bio-rational pesticide matrine, International Journal of Pest Management 64: 3, 262-270. https://doi.org/10.1080/09670874.2017.1394507.

[7] Grout T. G & Ueckermann E. A. (1999) Predatory mites (Acari) found under citrus trees in the South African Lowveld. International Journal of Acarology 25 (3): 235-238.

[8] Kiptoo J. J., Mutisya D. L., Ndegwa P. N. & Irungu L. (in press, Int. J. Acarol.).

[9] Toroitich F. J., Ueckermann E. A., Theron P. D. & Knapp M. (2009) The Tetranychid mites (Acari: Tetranychidae) of Kenya and re-description of the species *Peltanobia erasmusi* Meyer (Acari: Tetranychidae) based on males. Zootaxa 2176: 33-47.

[10] Xu X. & Enkegaard A. (2010) Prey preference of the predatory mite, Amblyseius swirskii between first instar western flower thrips, Frankliniella occidentalis and nymphs of the two-spotted spider mite Tetranychus urticae. Journal of Insect Science 10: 149, 1-11.

[11] Sahraoui H., Kreiter S., Lebdi-Grissa K. & Tixier M-S. (2016) Sustainable weed management and predatory mite (Acari: Phytoseiidae) dynamics in Tunisian citrus orchards. Acarologia 56 (4): 517–532.

[12] Fang X., Lu H., Ouyang G., Xia Y., Guo M. & Wu W. (2014). Effectiveness of two predatory mite species (Acari: Phytoseiidae) in controlling *Diaphorina citri* (Hemiptera: Liviidae). Florida Entomologist 96 (4): 1325-1333.

[13] Al Rehiayan S. M. & Fouly A. H. (2005) *Cosmolaelaps simplex* (Berlese) a Polyphagous predatory mite feeding on root-knot nematode *meloidogyne javanica* and citrus nematode *Tylenchulus semipenetrans*. Pakistani Journal of Biological Sciences 8 (1), 168-174.

[14] Ming Hui Lee & Zhi-Qiang Zhang (2018) Assessing the augmentation of Amblydromalus limonicus with the supplementation of pollen, thread, and substrates to combat greenhouse whitefly populations. Scientific Reports (Springer) 8: 12189.

[15] Ibrahim Y. B. & Yee T. S. (2000) Influence of Sublethal Exposure to Abamectin on the Biological Performance of Neoseiulus longispinosus (Acari: Phytoseiidae). Journal of Economic Entomology, Volume 93, Issue 4, 1 August 2000, Pages 1085–1089, https://doi.org/10.1603/0022-0493-93.4.1085.

[16] Zhang Z-Q,. Sanderson J. P. (1990) Relative Toxicity of Abamectin to the Predatory Mite Phytoseiulus persimilis (Acari: Phytoseiidae) and Twospotted Spider Mite (Acari: Tetranychidae). Journal of Economic Entomology, Volume 83, Pages 1783–1790, https://doi.org/10.1093/jee/83.5.1783.

[17] Reda S.& El-Banhawy E. M. (1988) Effect of avermectin and dicofol on the immatures of the predacious mite Amblyseius gossipi with a special reference to the secondary poisoning effect on the adult female [Acari: Phytoseiidae]. Entomophaga 33: 349–355.

[18] Kim S. S. & Yoo S. S. (2002) Comparative toxicity of some acaricides to the predatory mite, Phytoseiulus persimilis and the twospotted spider mite, Tetranychus urticae. BioControl volume 47: 563–573.

[19] Mansour F. A., Ascher K. R. S. & Abo-Moch F. (1997). Effects of neemgard on phytophagous and predacious mites and on Spiders. Phytoparasitica, 25, 333-367.

[20] Matías Arim, Pablo A. Marquet, (2004) Intraguild predation: a widespread interaction related to species biology, Ecology Letters (Wiley), 10.1111/j.1461-0248.2004.00613.x, 7, 7, (557-564), (2004).

[21] Holyoak M., Lawler S. P. (2005) The Contribution of Laboratory Experiments on Protists to Understanding Population and Metapopulation Dynamics, Population Dynamics and Laboratory Ecology, 10.1016/S0065-2504(04)37008-X, (245-271).

[22] Kiman Z. B., Yeargan K. V. (1985) Development and Reproduction of the Predator Orius insidiosus (Hemiptera: Anthocoridae) Reared on Diets of Selected Plant Material and Arthropod Prey. Annals of the Entomological Society of America 78: 464–467, https://doi.org/10.1093/aesa/78.4.464.

[23] Muhammad Sarwar (2016) Comparative life history characteristics of the mite predator Neoseiulus cucumeris (Oudemans) (Acari: Phytoseiidae) on mite and pollen diets. International Journal of Pest Management, Pages 140-148 | https://doi.org/10.1080/09670874.2016.1146806.