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Article

Mites associated with raspberry in Zamora and Los Reyes, Michoacán

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Abstract

Mexico ranks second in raspberry production and very little knowledge has been generated about the mites associated with this crop. In the present work, mites collected in the aerial part of raspberries produced in the municipalities of Zamora and Los Reyes de Salgado, Michoacán, Mexico from February 2018 to March 2019, were identified. In Los Reyes, 8 748 mites belonging to four families and nine species were recorded. The species found were *Amblydromalus ca. congeae*, *Neoseiulus californicus*, *Phytoseiulus persimilis*, *Typhlodromips* sp., *Euseius mesembrinus*, *Euseius* sp. (Phytoseiidae), *Tetranychus ludeni* (Tetranychidae), *Tarsonemus* sp. (Tarsonemidae), and *Tyrophagus putrescentiae* (Acaridae). A total of 4 253 adult specimens of two species were collected in Zamora, *Neoseiulus fallacis* with 235 (Phytoseiidae) and *Tetranychus ludeni* with 4 018 (Tetranychidae).

Keywords:

Acaridae, Phytoseiidae, Tarsonemidae, Tetranychidae.

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Introduction

Raspberries are berries from the family Rosaceae, characterized by their flavor, texture, and health benefits (Skrovankova *et al*., 2015). Mexico is the second largest producer of raspberries in the world, with an annual volume of 178 667 tonnes (SIAP, 2022). In Michoacán, it is grown in nine municipalities, Zamora is the first producer and Los Reyes de Salgado is the fourth most important (SIAP, 2022). Among all arthropods, mites are of utmost importance, tetranychids are important primary pests of the crop (Marié *et al*., 2018) and phytoseiids are natural enemies of mites and phytophagous insects (Amin *et al*., 2009).

In the world, the following has been reported in the aerial part of raspberry: 16 species of Phytoseiidae, 15 species of Tetranychidae, two of Tenuipalpidae, six of Eriophyidae and one species of the family Stigmaeidae, totaling 40 species. Nonetheless, in Mexico, only the presence of *Tetranychus urticae* in Chihuahua has been recorded (Parra-Quezada *et al*., 2002). Due to the relevance acquired by raspberries in Mexico and particularly in Michoacán and the little knowledge of these in the crop, the objective of this work was the taxonomic determination of the mite species in two of the most important municipalities for the production of this berry.

Materials and methods

Description of the orchards

The research was carried out in the municipality of Los Reyes, in an orchard of the Adelita variety located in the locality of San Sebastián (19° 33’ 50.02” north latitude and 102° 29’ 18.33” west longitude) at 1 306 masl. The plant was a first-year plant, grown under a high tunnel, 5 months old at the start of the first sampling.

In the municipality of Zamora, an orchard with integrated management, the “El Ibge” orchard planted with the Evita variety was selected, which is located in the locality of Ojo de Agua (19° 59’ 44.47’’ north latitude and 102° 11’ 46.04’’ west longitude) at 1 600 masl. The plant was a second-year plant, three months old at the start of the first sampling (primocane), grown under a high tunnel. Conventional management in the orchard.

Collection, preparation, and identification

Sampling was carried out monthly for six months, from October 2018 to March 2019 in Los Reyes and from February to May 2018 in Zamora. Forty samples were taken randomly, each sample consisting of leaflets, flowers, and fruits. They were placed individually in airtight plastic bags and transported to the laboratory in coolers with cooling gel bags. The preparation was done by assembling on slides (Walter and Krantz, 2009). A Leica® DM 1 000 phase-contrast optical microscope and specialized keys were used to identify the specimens.

Information analysis

The relative abundance of the species found was estimated using the formula: RA= n/N (100). Where: n is the i-th specimen and N is the total number of mites counted (Ayala-Ortega *et al*., 2019). To evaluate the population behavior in the Zamora orchard, the total population by sampling was calculated, considering the species, the data were plotted in a graph. On the basis of these same data, we calculated the exponential trend curve and the extrapolated potential curve, a line that includes for the latter the equation that fits it, for the phytophagous species.

Finally, and in order to explain the population trend of phytophages, we calculated the age class structure for eggs, immature stages, and adults, based on the proportion of each of these phases, by sampling.

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Results and discussion

Zamora

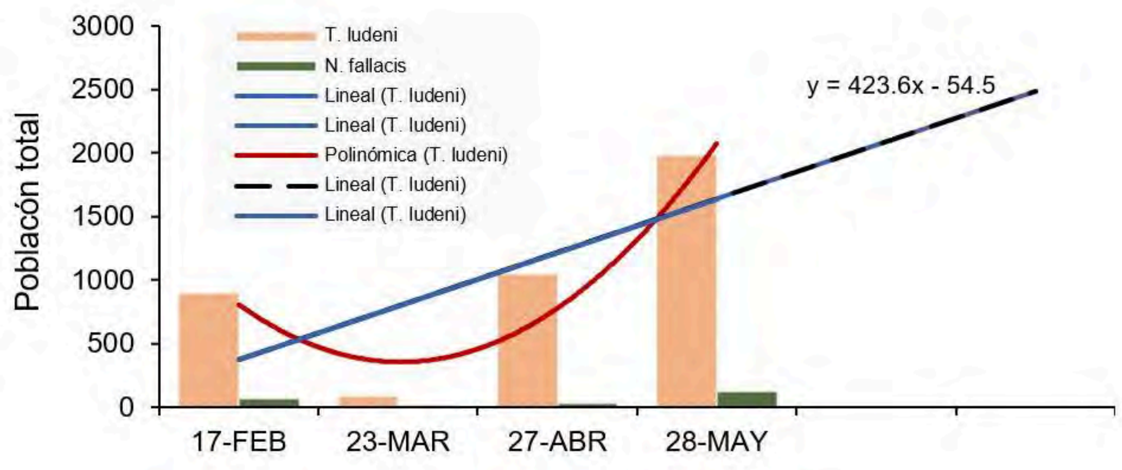
We collected a total of 4 253 adult individuals, two species, one belonging to the order Mesostigmata (*Neoseiulus fallacis* Garman from Phytoseiidae with 235 mites) and the other belonging to Trombidiformes, suborder Prostigmata (*Tetranychus ludeni* from Tetranychidae with 4 018). *N. fallacis* is a mite widely marketed for being useful in Integrated Pest Management (IPM) programs, especially in the northern and southern United States of America (Pratt *et al*., 2002). The record of *N. fallacis* is of great importance for raspberry crops and for the control of pest mites present in the crop. This is the first time it has been reported for Mexico and its relevance lies in the fact that the species is classified as an excellent generalist predatory mite of different types of mites in warm and moderately humid environments (Bounfour and Tanigoshi, 2002).

In general, *Tetranychus urticae* Koch has been identified as the most common spider mite species in berries (INTAGRI, 2017). In the morphotaxonomy analysis carried out, it is verified that this is not the mite that is present in the samples analyzed. In a taxonomic survey of tetranychids in New Zealand, Zhang (2002) reported that many specimens previously identified as *T. urticae* and *T. cinnabarinus* Boisduval were in fact *T. ludeni*, coinciding with the fact that this mite has been confused with other species of the family.

It was observed that *T. ludeni* causes chlorotic spots on the underside of the leaves, where high populations and death of the leaves are recorded, with a notorious leaf loss; the mites concentrate in the lower parts of the plants where the web becomes very abundant and when the populations increase, it can cover the entire plant.

Figure 1 shows the populations of *T. ludeni* and *N. fallacis*, by sampling, as mentioned above, one day before the second sampling, an application of an acaricide was made. It can be seen that there was a low prey-predator ratio since the levels of the pest are high and those of the phytoseiid do not correspond to the increases of the phytophage, it could seem that they behave like unrelated organisms.

Figure 1. Total population of *Tetranychus ludeni* and *Neoseiulus fallacis*. Sampling 2 after pesticide application) by sampling, exponential trend curve (blue), and linear extrapolated potential curve (dashed blue-black).



The numerical correspondence between prey and predator does not necessarily have to have a high mathematical ratio, especially if the potential biological control of *N. fallacis* described above is considered (Dos Santos *et al*., 2014; Raja *et al*., 2016). In some species of phytoseiid mites,

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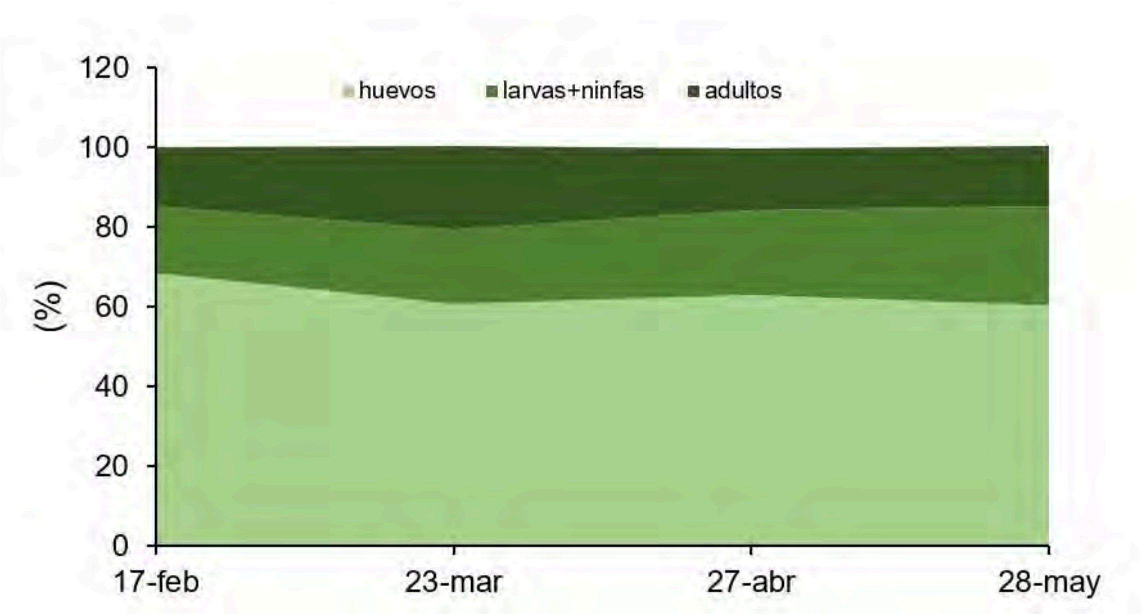
it has been reported that they can consume up to 20 prey/day, so the prey-predator ratio should always be based on their predatory capacity, which in the case of *N. fallacis* is high (Argüelles *et al*., 2013). However, the prey levels observed here appear to be so high that *N. fallacis* is not able to efficiently decrease *T. ludeni*.

Figure 1 shows the total population of *T. ludeni* by sampling, the exponential trend, and the linear extrapolated potential curve of two subsequent samples if they could have been carried out (indicated in a dashed line).

The exponential curve has a notable tendency to increase and the linear extrapolated potential curve is of the type y = ax + b, which is nothing more than a first-degree equation representing a straight line (Escobar, 2015). They show how high the population levels of the tetranychid could have been and explain why it was not possible to continue the study.

The application of the chemical treatment carried out can greatly influence the mite populations (Gillott, 2005); even though it decreased the population of the pest in the second sampling (although it recovers very significantly), it also decreased the levels of the predator, which, apparently, did not have the same capacity to increase its population. The age class structure is shown in Figure 2. The analysis of this graph explains the increase in *T. ludeni* populations observed in raspberry.

Figure 2. Age class structure of *Tetranychus ludeni* in raspberry.



In all the samples, the highest proportion was eggs, which is a clear indication that the population is increasing and the trend will be to increase, as was proven in practice. González (2012) recorded that the age class distribution of a population determines its future growth, if adult individuals predominate, in the future there will be a strong mortality, while if the majority are juveniles, the population will soon grow.

In the case of tetranychid mites in raspberries, the best option would be to apply an ovicidal product, which is harmless to predators, in order to reverse the age class structure observed and perhaps encourage the phytoseiids present in the agroecosystem to prey more efficiently. Therefore, it is important to know all the interactions generated in a plant-pest-predator system, in order to improve the effectiveness of biological control and management in general, by knowing the biology and ecology of each of the individuals that interact in this system.

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Los Reyes

A total of 8 749 mites belonging to four families and nine species were collected (Table 1), of which *Tetranychus ludeni* was the one that predominated with 92.76% and the family Phytoseiidae was the one with the highest number of species.

Table 1. Relative abundance of mite species collected in Los Reyes, Michoacán, Mexico (October 2018 to March 2019).

Order	Family	Species	No.	RA (%)
Mesostigmata	Phytoseiidae	*Amblydromalus congeae*	336	3.84
		Neoseiulus californicus	138	1.58
		Phytoseiulus persimilis	117	1.34
		Typhlodromips sp.	4	0.05
		Euseius sp.	2	0.02
		Euseius mesembrinus	1	0.01
Trombidiformes	Tetranychidae	*Tetranychus ludeni*	8 115	92.76
	Tarsoneminae	*Tarsonemus* sp.	2	0.02
Sarcoptiformes	Acaridae	*Tyrophagus putrescentiae*	33	0.38
Total			8 748	100

Family Phytoseiidae

Amblydromalus congeae. It was found in greater abundance between October 2018 and January 2019, mainly located on the underside of mature leaves, although some were among the flower structures, *A. congeae* had the highest proportion in the family.

Neoseiulus californicus was present from December 2018, with a higher proportion in January and February; they were found on mature leaves, as well as on the sepals of flowers. Even though applications are made for biological control in the orchard, its incidence is low (Table 1). *N. californicus* is a widely distributed species used for control in the world (Demite *et al*., 2020). In Mexico, it has been reported in Michoacán (Ayala-Ortega *et al*., 2019) and Jalisco (Denmark and Evans, 2011).

Phytoseiulus persimilis was found from January 2019, with higher numbers in January and February 2019; they were numerous in mature and senescent leaves, with a high presence of *Tetranychus ludeni*. This species was also used by the producer and although continuous releases were made, its incidence was low (Table 1). *P. persimilis* is present in 41 countries (Moraes *et al*., 2004; Demite *et al*., 2020).

For *Typhlodromips* sp., its abundance was low, only present in December 2018 and February 2019, located on the underside of the leaves (Table 1). Two species of the genus *Euseius* were found, one that could not be determined to species, which was present in a small proportion, with one specimen in December 2018 and another in February 2019. And another determined as *Euseius mesembrinus*, only one specimen was collected in March 2019 (Table 1).

Of the phytoseiid species that were released as part of the biological pest control tactic, only *P. persimilis* and *N. californicus* were recovered, but not *A. swirskii*. This could have been due to the fact that the latter was not established in the crop or to other factors related to the quality of the product and its way of release.

On the other hand, the low number of *Typhlodromips* sp., *Euseius* sp., and *Euseius mesembrinus* may have been caused by competition and predation of the species that were released (Müller

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and Brodeur, 2002), mainly by generalist predators (Schausberger and Croft, 2000) such as *N. californicus* or by the dominance of the other generalist phytoseiid *A. congeae* (McMurtry *et al*., 2013), which was found on the underside of leaves, a region full of trichomes (Chwil and Kostryco, 2020), unlike *Amblydromalus limonicus*, which inhabits plants that possess glabrous (without trichomes) leaves (McMurtry *et al*., 2013). The genera *Typhlodromips* and Amblydromalus constitute a new report for *R. idaeus*, while *E. mesembrinus* for the genus *Rubus*.

Family Tetranychidae

Tetranychus ludeni was the only species of this family that was collected, present during all months. The highest proportion was recorded in December 2018 and January 2019, with a non-uniform distribution in the orchard. Defoliation was observed in the patches where there was a greater number of individuals by sample. It is commonly confused with *Tetranychus urticae* (Ayala-Ortega *et al*., 2019) but differs from this and other *Tetranychus* species by the shape of the male's aedeagus, among other characteristics.

A total of 12 species of *Tetranychus* feed on *Rubus* species, among others; *Tetranychus turkestani* and *T. urticae* (Marié *et al*., 2018) feed on *Rubus idaeus*.

In the study, the highest relative proportion was for *T. ludeni*, the only species that represented the family Tetranychidae. This differs from what was found by Ayala-Ortega *et al*. (2019) on blackberry, where, in addition to *T. ludeni*, they found *T. urticae*, although the latter in low proportions. In the present study, *R. idaeus* is recorded as a new host of *T. ludeni*, although it had already been reported on *Rubus pinnatus* (Migeon and Dorkeld, 2019).

Family Tarsonemidae

Only two individuals belonging to a species of the genus *Tarsonemus* were recorded during October 2018. These were found on the undersides of recently mature leaves. Although some species of the genus *Tarsonemus* have been reported as phytophagous (Karmakar, 2016), they are not present as pests. This genus has been recorded in Brazil (*Rubus* sp. vars. *Caigangue* and *Tupy*) and Mexico (*Rubus* sp. var *Tupy*) by Marchetti and Juarez-Ferla (2011); Ayala-Ortega *et al*. (2019), respectively, but without causing apparent damage to the host.

Family Acaridae

Tyrophagus putrescentiae was identified on the upper side and underside of the leaves throughout the collection period, with the highest proportion in February and March 2019. *Tyrophagus putrescentiae* has a cosmopolitan distribution (Sánchez-Ramos, 1987). It is one of the most common species of Acaridae found in human homes (Ree *et al*., 1997). They have a high food spectrum as they can feed on fungi, grains and stored products, bulbs, plants, immature stages of coleopterans, nematodes, etc. (Dhooria, 2016).

Despite being known as a dust mite, *T. putrescentiae* has been reported feeding on soybean stems under field conditions (Oliveira *et al*., 2007). Marchetti and Juárez-Ferla (2011) reported this species on *Rubus fruticosus* in Brazil, but without causing any harm. A similar situation was observed in raspberry as no damage caused by these mites was associated.

Nevertheless, *T. putrescentiae* has been shown to be an alternative food source for generalist phytoseiids under laboratory conditions (Zou *et al*., 2016), a role it could play in crop foliage.

Other remarks

The number of species identified in the orchard was low if compared to what was reported in blackberry by Marchetti and Juárez-Ferla (2011); Ayala-Ortega *et al*. (2019), who found 26 and 18 species, respectively. However, the results of these authors agree that Phytoseiidae presented a number of species greater than other families. Phytoseiids are a diverse group in the aerial part of plants (Walter and Proctor, 2013), which explains the number of species found.

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Unlike blackberries, members of the family Diptilomiopidae were not found in raspberries, where they were the most abundant (Marchetti and Juárez, 2011; Ayala-Ortega *et al*., 2019), this is possibly due to variations in the number of trichomes present in leaves (Karley *et al*., 2016) and excretions secreted by glandular trichomes (Chwil and Kostryco, 2020), which could benefit or hinder the establishment of phytophagous species.

Conclusions

Tetranychus ludeni was identified by its taxonomic characters as the phytophagous species present in raspberry, as well as by the damage it caused, chlorotic spots on the underside of the leaves; when there are high populations, the web covers the entire plant and there is leaf loss. *T. ludeni* is the first report for raspberry crops in Mexico; it has been documented in different host plants; in Mexico it has been recorded on blackberry, confirming once again that the taxonomic determination of the "red spider mite" is necessary because not all of them are *Tetranychus urticae*.

The record of *Neoseiulus fallacis*, in the orchard that did not apply biological control with mites, is of great importance for raspberry crops as a native predator, which can be propagated for the control of pest mites present. This is the first time it has been reported for Mexico and the relevance of this record lies in the fact that the species is classified as an excellent generalist predatory mite, to control different types of mites in warm and moderately humid environments.

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Bibliography

1 Amin, M. M.; Mizell, R. F. and Flowers, R. W. 2009. Response of the predatory mite *Phytoseiulus macropilis* (Acari: Phytoseiidae) to pesticides and kairomones of three spider mite species (Acari: Tetranychidae), and non-prey food. Florida Entomologist. 92(4):554-562. Doi.org/ 10.1653/024.092.0404.

2 Argüelles, A. R.; Plazas, N. B.; Bustos, A. R.; Cantor, F. R.; Rodríguez, D. P. y Hilarion, A. M. 2013. Interacción entre dos ácaros depredadores de *Tetranychus urticae* KOCH (Acariformes: Tetranychidae) en laboratorio. Acta Biológica Colombiana. 18(1):137-144.

3 Ayala-Ortega, J. J.; Martínez-Castillo, A. M.; Pineda-Guillermo, S.; Figueroa-De la Rosa, J. I.; Acuña-Soto, J.; Ramos-Lima, M. and Vargas-Sandoval, M. 2019. Mites associated with blackberry (*Rubus* sp. cv. Tupy) in two areas of Michoacán, México. Revista Colombiana de Entomología. 45(2):45 e8480-1-10. 10.25100/socolen.v45i2.848.

4 Bounfour, M. M. and Tanigoshi, L. K. 2002. Predatory role of *Neoseiulus fallacis* (Acari: Phytoseiidae): spatial and temporal dynamics in Washington red raspberry fields. J. Econ. Entomol. 95(6):1142-50. https://doi.org/10.1603/0022-0493-95.6.1142.

5 Chwil, M. and Kostryco, M. 2020. Histochemical assays of secretory trichomes and the structure and content of mineral nutrients in *Rubus idaeus* L. leaves. Protoplasma. 257(1):119-139.

6 Demite, P. R.; Moraes, G. J.; McMurtry, J. A.; Denmark, H. A. and Castilho, R. C. 2020. Phytoseiidae Database. www.lea.esalq.usp.br/phytoseiidae.

7 Denmark, H. A. and Evans, G. A. 2011. Phytoseiidae of North America and Hawaii. Michigan, USA, Indira Publishing House. 1-451 pp.

8 Dhooria, M. S. 2016. Fundamentals of applied acarology. Ed. Springer: Singapore. 470 p.

DOI: https://doi.org/10.29312/remexca.v15i3.3660

9 Dos Santos, M. R.; Da Silva, L. G. and Juárez, N. F. 2014. A new species of *Neoseiulus* (Acari: Mesostigmata: Phytoseiidae) with a key for the Brazilian species of the genus. Zoologia. 31(3):271-274. Doi.org/ 10.1590/S1984-46702014000300009.

10 Escobar, E. N. 2015. Ecuaciones de la forma ax= b. https://es.slideshare.net/EDEyANSC/ecuaciones-de-la-forma-ax-b .

11 Gillott, C. A. 2005. Entomology. Third edition. Springer. Canada.

12 González, V. M. 2012. Distribución por edades y por sexos en una población. https://biologia.laguia2000.com/tecnicas-en-biologia/distribucion-por-edades-y-por-sexos-en-una-poblacion.

13 INTAGRI. 2017. Manejo de la araña de dos puntos en la producción de Berries. Artículos Técnicos de INTAGRI. México. Serie Fitosanidad núm. 88. 4 p. https://www.intagri.com/articulos/fitosanidad/manejo-de-la-arania-de-dos-puntosen-la-produccion-de-berries.

14 Karley, A. J.; Mitchell, C.; Brookes, C.; McNicol, J.; O'neill, T.; Roberts, H. and Johnson, S. N. 2016. Exploiting physical defense traits for crop protection: leaf trichomes of *Rubus idaeus* have deterrent effects on spider mites but not aphids. Annals of Applied Biology. 168(1):159-172. Doi.org/ 10.1111/aab.12252.

15 Karmakar, K. H. 2016. The mites of the family Tarsonemidae (Acari: Heterostigmata) in West Bengal, India. Journal of Acarological Society of Japan. 25(Supplement 1):77-81. Doi.org/ 10.2300/acari.25.Suppl-77.

16 Marchetti, M. M. y Juárez, F. N. 2011. Diversidade e flutuação populacional de ácaros (Acari) em amora-preta (*Rubus fruticosus*, Rosaceae) no estado do Rio Grande do Sul, Brasil. Iheringia Serie . 101(1-2):43-48. Doi.org/ 10.1590/S0073-47212011000100005.

17 Marié I.; Marčić, D. and Auger, P. P. 2018. Biodiversity of spider mites (Acari: Tetranychidae) in Serbia: a review, new records and key to all known species. Acarologia. 58(1):3-14. Doi.org/ 10.24349/acarologia/20184223.

18 McMurtry, J. A.; De Moraes, G. J. and Sourassou, N. F. 2013. Revision of the lifestyles of phytoseiid mites (Acari: Phytoseiidae) and implications for biological control strategies. Systematic and Applied Acarology. 18(4):297-320. Doi.org/ 10.11158/saa.18.4.1.

19 Migeon, A. and Dorkeld, F. 2019. Spider mites web: a comprehensive database for the Tetranychidae. *In*: trends in acarology: Proceedings of the 12th international congress. 557-560 pp. Springer Netherlands. http://www.montpellier.inra.fr/CBGP/spmweb.

20 Moraes, G. J.; McMurtry, J. A.; Denmark, H. A. and Campos, C. B. 2004. A revised catalog of the mite family Phytoseiidae. Zootaxa. 434(1):1-494. https://doi.org/10.11646/ZOOTAXA.434.1.1

21 Müller, C. B. and Brodeur, J. J. 2002. Intraguild predation in biological control and conservation biology. Biological Control. 25(3):216-223. Doi.org/ 10.1016/S1049-9644(02)00102-0.

22 Oliveira, C. M.; Návia, D. and Frizzas, M. R. 2007. First record of *Tyrophagus putrescentiae* (Schrank) (Acari: Acaridae) in soybean plants under no tillage in Minas Gerais, Brazil. Ciência Rural. 37(3):876-877. Doi.org/ 10.1590/S0103-84782007000300043.

23 Parra-Quezada, R. A.; Ávila-Marioni, M. R. y Ríos-Sánchez, R. 2002. Avances en el desarrollo de la frambuesa roja en el estado de Chihuahua. Folleto técnico núm. 14. SAGARPA, Chihuahua, México. 35 p.

24 Pratt, P. D.; Rosetta, R. and Croft, B. A. 2002. Plant-related factors influence the effectiveness of *Neoseiulus fallacis* (Acari: Phytoseiidae), a biological control agent of spider mites on landscape ornamental plants. Journal of Econo. Entomol. 95(6):1135-1141. Doi.org/ 10.1603/0022-0493-95.6.1135.

25 Raja, Z. R.; Vardervoort, C. C; Gut, L. J. and Whalon, M. E. 2016. Lethal time of insecticides on the predator mite *Neoseiulus fallacis* (Acari: Phytoseiidae) following topical exposure. Canadian Entomologist. 148(3):353-360. Doi.org/ 10.4039/tce.2015.67.

Revista Mexicana de Ciencias Agrícolas
REMEXCA
DOI: https://doi.org/10.29312/remexca.v15i3.3660

26 Ree, H. I.; Jeon, S. H.; Lee, I. Y.; Hong, C. S. and Lee, D. K. 1997. Fauna and geographical distribution of house dust mites in Korea. Korean Journal of Parasitology. 35(1):9-17. https://www.parahostdis.org/upload/pdf/kjp-35-9.pdf

27 Sánchez-Ramos, I. I. 1987. Biología y control de *Tyrophagus putrescentiae* (Schrank,1781) (Astigmata: Acaridae), plaga de productos almacenados. Tesis Doctoral. Universidad Complutense de Madrid. Madrid, España. 64-72 pp.

28 Schausberger, P. T. and Croft, B. A. 2000. Cannibalism and intraguild predation among Phytoseiid Mites: are aggressiveness and prey preference related to diet Specialization? Experimental and Applied Acarology. 24(1):709-725. https://doi.org/10.1023/A:1010747208519.

29 SIAP. 2022. Servicio de Información Agroalimentaria y Pesquera. Avance de siembras y cosechas. http://infosiap.siap.gob.mx:8080/agricola-siap-gobmx/AvanceNacional.

30 Skrovankova, S.; Sumczynski, D.; Mlcek, J.; Jurikova, T. and Sochor, J. 2015. Bioactive compounds and antioxidant activity in different types of berries. Internacional Journal of Molecular Science. 16(10):24673-24706. Doi.org/ 10.3390/ijms161024673.

31 Walter, D. E. and Krantz, G. W. 2009. Collecting, rearing, and preparing of specimens. *In*: Krantz, G. W. and Walter, D. E. Ed. a manual of acarology. Texas, USA: Texas Tech University Press. 83-96 pp.

32 Walter, D. E. and Proctor, H. C. 2013. Mites: ecology, evolution & behaviour. New York, USA. Springer. 281-339 pp.

33 Zhang, Z. Q. 2002. Taxonomy of *Tetranychus ludeni* (Acari: Tetranychidae) in New Zealand and its ecology on Sechium edule. New Zealand Entomologist. 25(1):27-34. Doi.org/ 10.1080/00779962.2002.9722091.

34 Zou, Z.; Min, Q.; Xiao, S.; Xin, T. and Xia, B. 2016. Effect of photoperiod on development and demographic parameters of *Neoseiulus barkeri* (Acari: Phytoseiidae) fed on *Tyrophagus putrescentiae* (Acari: Acaridae). Experimental and Applied Acarology. 70(1):45-56. Doi.org/ 10.1007/s10493-016-0065-y.

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