Predatory mite species of the family Phytoseiidae, Acari, Mesostigmata, used in biological control of agricultural pests in Colombia

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Abstract

Introduction: The control of insects and mites' pests becomes a recurring theme in crops, which are fought using chemical products and often without the expected effectiveness.

Methodology: A bibliographic search of the publications on predatory mites in Colombia was carried out in indexed journals from 2010 to 2020 in order to assess the topics addressed. In addition, the species of predatory mites reported in Colombia since the 1970s were investigated.

Results: In the last decade, eight publications were obtained in Colombia on predatory mites that record the presence or use of *Phytoseiulus persimilis, Neoseiulus anonymus, Neoseiulus californicus, Iphiseiodes zuluagai, Amblyseius herbicolus, Amblyseius* sp., *Gaeolaelaps aculeifer* and *Euseius concordis* in various crops of economic importance such as citrus, guava, mango, yucca, cotton, sugar cane, ornamentals and others, with a wide geographic dispersion.

Conclusions: Scientific publications on predatory mites are not abundant in the last decade in Colombia, however, it is corroborated that there are reported a wide diversity of *Ambliseus* species and other genera of the Phytoseidae family and that the use in the productive practice of these do not correspond to the research results.

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Keywords: agroecosystems, arthropods, agroecology, predatory activity, controlling systems, sustainable, sustainable, productivity

I. INTRODUCTION

Mites are small arthropods belonging to the Subphyllum Chelicerata, they have four pairs of legs except for the Eriophydae family (with two pairs of legs on the front part of their body), they have a body with a single region called the idiosoma from which the mouthparts and form the gnathosoma; These arthropods can have saprophagous, predatory and phytophagous eating habits; the latter causing alterations and damage to tissues in plants present in crops and wild vegetation, by sucking the cellular content using their sucking biting mouthparts [1].

Some of these small arthropods can attack plants becoming a pest, most likely caused by the excessive and inappropriate use of chemical pesticides that has caused resistance to chemical compounds and has increased the populations of these species that were not a problem before. resulting in the destruction of their natural predators [2].

The control of pest insects and mites in agriculture is a process that has been carried out for years, its management is carried out based on chemical synthesis products that act in different ways and to which a correct product rotation must be given. Consequently, the misuse of chemical products in crops leads to multiple damages that affect the development of the cultivated plant and put the health of the operators who use them at risk, as well as leading to soil degradation and loss of biological diversity.

Reason why, all these aspects are important in the development of a control method or integrated pest management and for this reason in recent years there has been an increased interest in the application and adaptation of biological control methods of phytophagous mites, Therefore, these aspects require the development of management strategies that control them, taking into account their biology and their times of greatest susceptibility to the available control actions or methods [3].

For this reason, several studies have been carried out on the bioecology of these mites and their natural enemies. It has been known for a long time that there are predatory mites that constitute biological controllers of phytophagous mites and their implementation in integrated pest management programs, to reduce the risks, environmental impact and high costs of the chemical products used. The best known and studied species of predatory mites are those belonging to the Phytoseiidae family, their individuals under breeding technology can be massively produced and used in the control of phytophagous mites in crops of agricultural importance, being important to reduce the use of chemical products and therefore the deterioration of the environment [4].

Taking this into consideration, this research aimed to assess the existing information on the species of predatory mites of the family Phytoseiidae (*Acari Mesostigmata*) used in biological control of agricultural pests in Colombia.

II. METHODOLOGY

The present investigation was carried out in the period between July and September 2020. For this, a descriptive study was carried out where articles on predatory mites in Colombia, published during the period from 2010 to 2020, were analyzed. last 10 years in the following Colombian journals: Acta Agronómica, Acta Biologico Colombia, Colombian Journal of Entomology (SOCOLEN), National Journal of Agriculture, Colombian Agronomy Journal, Sustainable Agriculture Journal, AGROSAVIA Journal of Agricultural Science and Technology, Colombian Journal of Horticultural Sciences and those of the following international journals: Revista de Protección Vegetal, REDALYC, Revista U.D.C.A Actualidad & Divulgación Científica, searching with two groups of keywords: predatory mites, biological control of pest mites. The articles found constituted units of analysis to make assessments. Subsequently, the same keywords in Spanish and English were used in the Scopus, Springerlink, Science Direct and Francis and Taylor databases of the digital library of the University of Pamplona.

In the analysis of documents, emphasis was placed on articles with theoretical or empirical results whose title indicated the use of predatory mites as an alternative for the control of agricultural pests or studies on their morphology, behavior and distribution and whose summary confirmed said content. An assessment was made of all the information collected in Colombian journals, in order to compare the research results and the practical use of predatory mites in the country. A search of the species of predatory mites reported for Colombia from the 1970s to date was also carried out to discuss the existing results on predatory mites by crop and region and their application in productive practice in the last decade with periods previous.

III. RESULTS

In Valencia orange (*Citrus sinensis L.*) crops, the damage caused to various plant tissues by the mites *Polyphagotarsonemus latus* (Banks) and *Phyllocoptruta oleivora* (Ashmead) is widely known, causing a great economic impact. A work was carried out where the effect of biological agents for the control of these pests was evaluated in the municipality of Cacedonia, Valle del Cauca, Colombia. In this work, treatments were designed as follows: (1) release of native Phytoseiidae species (*Neoseiulus anonymus, Neoseiulus californicus, Iphiseiodes zuluagai and Amblyseius herbicolus*) in populations of 500 individuals/tree; (2) release of Chrysoperla carnea larvae (100 larvae/tree); (3) localized application of cypermethrin 2 cm3/L (4) treatment used by farmers (localized application of abamectin 1.5 cm3/L). As a result, the Phytoseiidae release and *Chrysoperla* larvae release treatments were obtained. carnea were efficient in controlling P. latus as much as the abamectin treatment used by farmers. Likewise, they reported that in said study the *Phytoseiidae released* to control *Phytoseiidae oleivora* were dispersed and did not exert good control [5].

Through research at the Entomology Laboratory of the University of Caldas, the thermal requirements of *Amblyseius sp*., fed *Tetranychus urticae* at five constant temperatures (17, 20, 24, 27 and 31 °C) were studied. The predatory mite was obtained from strawberry leaves (*Fragaria x ananassa Duch*) infested with *Tetranychus urticae*. In this study it was determined that the stages of egg, larva, protonymph, deutonymph and period from egg to adult presented base temperatures of 12.6; 13.1; 11.6; 13.4 and 12.7ºC and thermal constants of 26.6; 10.2; 16.1; 13.3 and 66.1 ºD, respectively, which is important for keeping the eggs [6].

Other studies have focused on investigating the effectiveness of predatory mites of the family Phytoseiidae to control pest mites in various crops such as ornamentals, for example, the case where the effectiveness of the species *Phytoseiulus persimilis* [7] (Acari:Mesostigmata:Phytoseiidae) and *Neoseiulus californicus (*McGregor, 1954) (Acari:Mesostigmata:Phytoseiidae) was evaluated as biological control of pest mites such as *Tetranychus* spp. (Acari: Trombidiformes: Tetranychidae). In general, these mites were considered as excellent controllers for their voracity, high search capacity, location, and immobilization of prey, which can consume in adulthood of 4 to 7 prey per day being the life cycle less than that of their prey, so they can easily increase their populations and decrease those of the pest in ornamentals [8].

In a study conducted in the Bogotá plateau, the biological characteristics of the Colombian population of *Gaeolaelaps aculeifer* [9] and its capacity for predation on *Frankliniella occidentalis* (Pergande, 1895) were experimentally evaluated. Likewise, thepossibility of using a fictitious prey for its mass production or as complementary food in the release of predators in the field was evaluated. It was concluded that *G. aculeifer* can feed, develop, and reproduce in prepupae and pupae of *F. occidentalis* and that the store mite *Aleuroglyphus ovatus* serves as a small-scale complementary diet in field releases of predators [10].

On the other hand, results of the identification of the species of mites associated with the cultivation of avocado (*Persea americana* Mill.) in the main producing departments in Colombia are presented, where species of mites belonging to the families were found: Tetranychidae, Tenuipalpidae, Eriophyidae, Tarsonemidae, Phytoseiidae, Stigmaeidae, Cheyletidae, Iolinidae, Cunaxidae, Bdellidae, Ascidae, Tydeidae, Acarida and Oribatidae, in order of importance. In the report made for species with predatory type eating habits of the family Phytoseiidae, the presence of *Euseius concordis* was reported [11].

Species of the genus *Amblyseius* have been reported as biological controllers of species of the genus *Tetranychus*, through a study that evaluated the establishment and multiplication of predatory mites in rose crops (*Rosa* sp.) [4].

To evaluate the establishment and biological effectiveness of the *predators Phytoseiulus persimilis*, *Neoseiulus californicus* on *tetranychus urticae populations*, the papaya hybrid Tainung-1 was used between the vegetative growth and fruit filling stage in the municipality of Roldanillo, Valle del Cauca, Colombia. The released predators did not exert control over the populations of the *T. urticae mite* under the conditions under which the research was developed [12].

It is the opinion of some authors that the study of mites in Colombia has evidently contributed to the production of knowledge of the diversity of species. Colombian acarologists have also developed studies on the evaluation and management of phytophagous mites and have made great strides in work related to the knowledge of predatory mites. That is why it can be said that the country has basic and applied information about mites, but it is necessary to delve into some topics [13].

Table 1 shows the main species reported for Colombia, in different investigations and moments, the plant species where the findings were made, the locality and the reference.

Table 1. Main species of the family Phytoseiidae reported according to plant species and locality for Colombia.

Species	Plant species	Locality	References
Amblyseius anacardii	*Citrus sinensis*	Palmira, Guacari	[14]
Amblyseius aerialis	*Clonorchis sinensis, Sida rhombifolia, Guazuma ulmifolia, Ipomoea batatas, Psidium guajaba, Banisteria* sp., *Corchorus orinocensis, Vigna* sp., *Citrus* sp., *Morchella esculenta Passiflora edulis Gossypium hirsutum*	Palmira Sabana Larga (Atlántico) Arjona (Bolívar)Puerto tejada, Canalete, Cereté, Ciénaga de Oro, Montería, Sahagún, San Pelayo, Tres Palmas, San Juan de Arama (Córdoba), Pivijay (Magdalena), San Juan de Betulia, Sincelejo (Sucre), Caicedonia, Candelaria, Ginebra, Palmira La Unión-Valle Córdoba	[14] [15]
Amblyseius arawak	*Ficus benjamina*	Miranda (Cauca)	[15]
Amblyseius aciculus	*Miconia* sp.	Cali, La Plata	[15]
Amblyseius chiapensis	*Matisia cordata Citrus* sp. *Trichantera giant, Lagerstroemia* sp., *Bougainvillea glabra, Morchella esculenta*	Marseille (Risaralda) Anserma (Caldas), Miranda, Puerto Tejada, Buenos Aires (Cauca), Aguachica (Cesar), Puerto Gaitán (Meta), Andalusia, Caicedonia, Candelaria, Florida, Geneva, Jamundi, La Union, La Victoria, Palmira, Yotoco	[15]
Amblyseius coffeae	*Melicocca bijuga*	Villanueva (Guajira), Cali	
Amblyseius curticervis calis	*Tricanthera* sp., *Plantago* sp.	Cali (Villacarmelor)	
Amblyseius dentilis	*Morchella esculenta*	Sabanalarga (Atlántico), Arjona, Carmen de Bolívar (Bolívar), Canalete, Chinú, Ciénaga de Oro, Montería, Sahagún, San Andrés de Sotavento, Tierra Alta (Córdoba), Pivijay (Magdalena), Morroa, San Juan de Betulia, Sampués, Sincelejo, Tolú Viejo (Sucre)	
Amblyseius dominigos	*Citrus* sp.	Quindío, Risaralda	
Amblyseius farallonicus	*Plantago* sp.	Cali (Villacarmelo)	
Amblyseius fordycei	*Citrus* sp.	Anserma (Caldas)	
Amblyseius herbicolus	*Citrus* sp., *Inga spectabilis, Alsophila* sp., *Baccharis* sp., *Trichanthera*	Turbaco (Bolívar), Anserma, La Plata San Agustín (Huila), Río Negro (Santander), Sincelejo, Argelia, Caicedonia, Sevilla, Yotoco	

	gigantea, Miconia sp., *Mangifera indica, Psidium guajava, Carpotroche pacifica, Saccharum officinarum, Coffea arabica, Morchella esculenta*		
Amblyseius largoensis	*Clonorchissinensis Psidium guajava, Morchella esculenta*	Cali, San Andrés, Providencia	[14] [15]
Amblyseius deleoni	*Clonorchissinensis*	Cali	[14]
Amblyseius gonzalezi	*Morchella esculenta*	San Carlos (Cordoba)	[15]
Amblyseius lynnae	*Andropogon* sp	Carimagua (Meta)	
Amblyseius manihoti	*Morchella esculenta*, *Coffea* sp., *Bixa orellana*, *Citrus* sp., *Mikonia* sp.	Carimagua (Meta)Galapa, Luruaco, Bolívar, Mahates, Santa Catalina, Turbaco, Pacillo (Bolívar), Chinchiná, Palestina (Caldas), Buenos Aires, Puerto Tejada (Cauca), San Martín, Tamalameque (Cesar), Chinú, Ciénaga de Oro, Sahagún (Córdoba), Fonseca, Riohacha, San Agustín, Timana (Huila), Sevilla (Magdalena), Carimagua (Meta), Cahira (N. de Santander), La Tebaida (Quindío), Aratoca, Rionegro (Santander), Sampues, San Juan de Betulia, Sincelejo (Sucre), Alvarado, El Guamo (Tolima), Caicedonia, Florida, Seville, Palmira	
Amblyseius miconiae	*Miconia* sp.	Cali (Villacarmelo)	
Amblyseius neotropicus	*Morchella esculenta,Psidium guajava*, *Ctirus* sp.	Cali, Caicedonia, Providencia Island, Barrancabermenja	
Amblyseius neoperditus	*Miconia* sp., *Caladium macrophytes*, *Citrus* sp., *M. esculenta*	Cali (Felidia, Villacarmelo), Armenia, San Agustín	
Amblyseius pentagonoalis	*Calopogonio muconoides, Coffea* sp.	Carimagua (Meta), Manizales	
Amblyseius sinenses	*Psidium guajava*	Cali	
Amblyseius vasiformis	*Citrus* sp., *Matisia cordata*, *Psidium guajava*, *Mangifera indica, Morchella esculenta*	Cerritos (Risaralda), Jamundi, Quindío, Caicedonia	
Cydnodromella alveolaris	*Morchella esculenta*	Providence Island	
Diadromus regularis	*Citrus lemon*	Cali	[14]

Results

These works reflect that the species of *Ambliseus* are very varied in Colombia and that they have been informed by preying on different crops of economic importance in the country such as citrus fruits (orange and lemon), guava,

mango, cassava, cotton, sugar cane, ornamentals. On the other hand, a wide geographical dispersion is reflected by being represented in the studies many departments of Colombia, even two studies are reported in the department of Santander and one in Norte de Santander.

Crops in Colombia and worldwide in general are strongly affected by the appearance of phytophagous mites that affect the growth and development of the plant and, therefore, the economy of farmers who generate great losses due to the appearance of these arthropods. One of the challenges traditionally faced by farmers is pest control on crops. Indeed, the appearance of chemicals meant an important change in this area, but their use entails serious drawbacks given their acute and chronic toxicity to humans [3].

All these aspects are important in the development of a method of control or integrated pest management and for this reason in recent years there has been increased interest in the application and adaptation of methods of biological control of these phytophagous mites, their biological characteristics and the potential damage that the pest may have, which requires the development of management strategies that control it, taking into account its biology and its times of greatest susceptibility to available control actions or methods [3]. In addition, in order to solve this problem, agriculture has made a great effort to become essential of chemical control methods and use much healthier and environmentally friendly alternatives [16]. For some years now, an evolution of agricultural production systems towards pest control methods has been derived, turning them into much more rational methods, respectful of the environment and the conservation of diversity resources, since the use of chemical substances triggers multiple drawbacks such as: the resurgence of treated populations, destruction of beneficial species, high costs in equipment, labor and material and the resistance of organisms to treated products [17].

On the other hand, predatory mites constitute the third trophic level of the food chain in an agroecosystem, they are important, for their use in the biological control of phytophagous mites of crops [18].

Also, inrecent decades the family Phytoseiidae has received considerable attention due to their great potential as biological control agents; these mites are the most common predators of phytocars in numerous plant species, which makes them the most studied and used group for the control of these pests. Phytoseids are primarily known for their predatory function against tetranychid mites and other families of phytophagous arthropods such as eriophytes, coccids, whiteflies, thrips, tenuipálpidos and tarsonemids, however, the greatest efforts have been devoted to the practical application of these predators for the control of tetranychids in numerous crops around the world [19].

In addition, we must take into accountthe rapid development of agriculture coupled with the intensive use of agricultural inputs such as fertilizers and organic synthetic pesticides to produce food, has caused agricultural fields of very low stability and ecological diversity, quite fragile and susceptible to diseases and pests. Collaterally with this problem, there is the environmental crisis due to the threats in agricultural sites by the irrational management of resources by man. In this scenario, the role of predatory mites of the Phytoseiidae family as biological control agents in agriculture is an indispensable alternative in the sustainable and integral management of these pests. These mites have a wide worldwide distribution and in addition to being predators of other phytophagous or fungal mites, they can feed on leaf juices, pollen grains and other plant materials. Many countries are carrying out integrated control programmes for phytophagous mites in various crops, using natural populations [20].

Reason why, the mite family mentioned above stands out for its abundance in crops and its efficiency as predators of phytophagous mites, it is a family of wide worldwide distribution, has more than 2000 described species which belong to 67 different genera around the planet, these mites have turned out to be excellent agents of biological control and therefore their great importance is highlighted from the point of view agricultural [21].

It is important to note thatin Colombia various predatory mites have been used for the management of agricultural pests, in paprika crops whose limiting pest is thrips have been used predators *Amblydromalus limonicus* Garman & McGregor, for the management of pests in citrus, coffee, papaya and ornamentals have been used *predators Neoseiulus californicus* McGregor and *Phytoseiulus persimilis* Athias-Henriot [22].

Different studies have shown that *P. persimilis* Athias-Henriot and *N. californicus* McGregor, has functional response type II that is, the rate of consumption increases according to the density of the prey until reaching the set or plateau, because there is a satiety of predators. The larvae of these two species do not consume eggs and as they pass from protoninfa to deutoninfa and later adult, they increase their consumption rate [23].

In the results presented the efficacy and effectiveness of predatory mites in various Colombian crops is demonstrated, the most used mites are *Neoseiulus californicus* McGregor and *Phytoseiulus persimilis* Athias-Henriot in various crops where the spider mite *Tetranychus* spp is present. The characteristics that these predatory mites have is their piriform-like shape, that is, they are pear-shaped and active seekers of their prey. The most successful results of phytoseid releases are reported in ornamentals, although naturally favorable results of biological balance have been reported with the presence of predatory mites in several crops.

Despite the biodiversity of species, the existence of reproductive technologies both at the laboratory level and on a commercial scale, the wide geographical distribution, and reports of predatory mites in multiple crops of economic importance, there is no correspondence with the official level of commercialization and the use of predatory mites in crops. The ICA Bioinputs registry only authorizes the commercialization of three products from predatory mites, two based on *Phytoseiulus persimilis and* one from *Neoseiulus californicus*, the three cases in the cultivation of rose [24]

(ICA, 2020), when the wide use of predatory mites in greenhouse crops such as tomato is known, pepper and others in Europe, as well as naturally in vineyards where agroecological methods of management of phytophagous mites are developed [25] and the wide possibilities they have if they are conveniently managed in the fields of crops where they are naturally preying.

IV. CONCLUSIONS

In the last decade, eight publications were obtained in Colombia on predatory mites that collect basic and applied studies that are still being developed in the country on this subject, on the other hand the presence or use at an experimental level of *Phytoseiulus persimilis*, *Neoseiulus anonymus*, *Neoseiulus californicus*, *Iphiseiodes zuluagai*, *Amblyseius herbicolus*, *Amblyseius sp.*, *Gaeolaelaps aculeifer* and *Euseius concordis* in several crops of economic importance such as avocado, papaya, beans, citrus, rose and other ornamentals, which evidences scientific activity in this regard.

An analysis of the species of predatory mites reported for Colombia in different investigations demonstrates the presence of a wide diversity of species of *Ambliseus* and other genera of the family Phytoseidae that have been reported preying on crops of economic importance such as citrus, guava, mango, cassava, cotton, sugar cane, ornamental and others, with a wide geographical dispersion.

The richness of the beneficial acaro-fauna present in Colombia, the existence of reproduction methodologies for predatory mites and the multiple research results that the country holds, do not correspond to the official use of these biological controllers in crops of economic importance by farmers.

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