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Study of the evolution of the pest mite *Tetranychus urticae* (Koch) and the predatory mite *Phytoseiulus persimilis* (Athias-Henriot) according to temperature variation and phenological stages of strawberry plants in the region of Algiers (Algeria)

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Summary

Our study aims to see the influence of temperature and phenological stages of strawberry plants on the development of the pest mite *Tetranychus urticae* and the predatory mite *Phytoseiulus persimilis*. It appears from this study that the yellow mite marked its presence from the early stages of crop development in the form of winter females. The density of this species has evolved as the temperature increases, reaching a maximum plateau in March which coincides with the fruiting stage (T4) where temperatures vary between 21°C and 27°C. The first appearance of *Phytoseiulus persimilis* is marked during this month. This predator reached its maximum in April when the average temperature is 31°C. the yellow mite population fell and the infestation rate was less than 5% in May, which corresponds to the stage of senescence and onset of rest (T5) where temperatures vary between 33°C and 40 °C. The density of the predator then decreased in parallel and was zero during this stage.

Keywords: *Tetranychus urticae*; *Phytoseiulus persimilis*; Temperatures; Strawberries cultivation ; phenological stages.

Introduction

The two-spotted spider mite, *Tetranychus urticae* Koch, is a chelicerate arthropod in the class Arachnida, family Tetranychidae (ZHANG, 2003). *T. urticae*is recognized by the presence of two black spots on the anterior dorsal part of the prosoma (GERSON, 1985). *Tetranychus urticae* is an important agricultural pest, attacking more than 1200 wild and cultivated plant species (HAMLEN and LINDQUIST, 1981). In the region of northern Algeria, the yellow mite is one of the main pests that can cause considerable losses in the qualitative and quantitative yield of strawberry production, which has experienced a remarkable evolution both in terms of yield and in terms of fruit quality.In the

region of northern Algeria, strawberry production has experienced a remarkable evolution both in terms of yield and in terms of fruit quality. The yellow mite is one of the main pests that can cause considerable losses in the qualitative and quantitative yield of this crop. The nutritional bites of this pest cause a change in the color of the leaves, which first take on a speckled appearance. In heavy infestations, webs are visible around the leaves, which eventually dry out. (OATMAN & *al*., 1982; SANCES & *al*., 1982). The development of these mites is all the more rapid when the weather is hot and dry. The massive use of broad-spectrum insecticides practically eliminated the populations of naturally present predators and enabled this pest, hitherto considered as secondary, to become a main pest (JEPPSON &*al*. 1975). The predatory mite, *Phytoseiulus persimilis* Athias-Henriot (Acari, Phytoseiidae), has proven its effectiveness in controlling yellow mite populations (GILLI & *al*., 2005). It is commonly used in biological protection integrated in culture under shelter; but also on strawberries in the open field (BAROFFIO & *al*., 2007). SKIRVEN & FENLON (2003) Showed that the predator *Phytoseiulus persimilis* is very mobile and demonstrates a great capacity for dispersal under the right environmental conditions. Many studies are carried out on dust mites in Algeria. We cite the work of GRANDJEAN, 1934; ATHIAS, 1957-1961; NIEDBALA, 1985; BOULFEKHAR, 1998; FEKKOUN &*al*. 2011, 2014, 2021 and 2022.However the majority of work is devoted to soil mites. Due to the lack of research on the bio-ecology of strawberry mite pests and predators, we conducted this study.

Material and methods

The present study was carried out within the National Institute of Agronomic Research of Algeria (I.N.R.A.A.) KOPIA of El Harrach, Algeria (Figure 1). The samples were collected on a strawberry crop, planted on November 30, 2020, in an above-ground greenhouse on palm fibers, irrigation is done by drip, the varieties planted are Nabila and Splendor, this crop has no was not treated with any phytosanitary treatment. The sampling period extends from January 3, 2021 to May 26, 2021. The mites were monitored one month after planting the strawberry plant by weekly surveys, at each outing the daily temperature in the greenhouse was measured.Field work is based on the monitoring of predatory and pest mites by visual checks and manual captures. To follow their evolution we divided the greenhouse into four homogeneous blocks, from each block we took five samples at random, each sample has a ramification of 3 leaflets. Each sample is placed separately in a tightly closed plastic bag which is previously labelled. In the laboratory, the eggs, larvae and adults of *Tetranychusurticae* as well as the eggs, larvae and adults of *Phytoseiulus persimilis* were counted under a binocular magnifying glass.

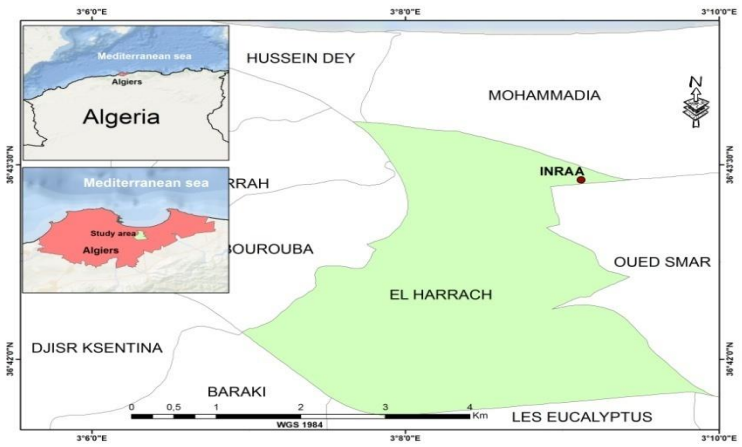

Fig. 1. Location of the INRAA station (Algeria).

Results

In January 2021, from the first observation, no characteristic symptoms of a yellow mite attack were visible on the strawberry plant. 21% of the leaves sampled were infested by *Tetranychus urticae* mainly in the form of winter female with a very low presence. It should be noted that the temperatures during this month vary between 10°C and 18°C. (Figure 2). The density of this species has evolved as the temperature increases. It reaches a maximum level in March when temperatures vary between 21°C and 27°C, with an infestation rate of 100%. During this period, the yellow mite attack was clearly visible on the leaves, which presented grayish spots and were accompanied by webs on the most important foci (fig.3). Then a gradual decline is marked in April, temperatures during this month vary between 26°C and 35°C. In May the yellow mite population dropped and the infestation rate was less than 5%. The presence of this pest mite is almost nil, temperatures during this month vary between 33°C and 40°C.

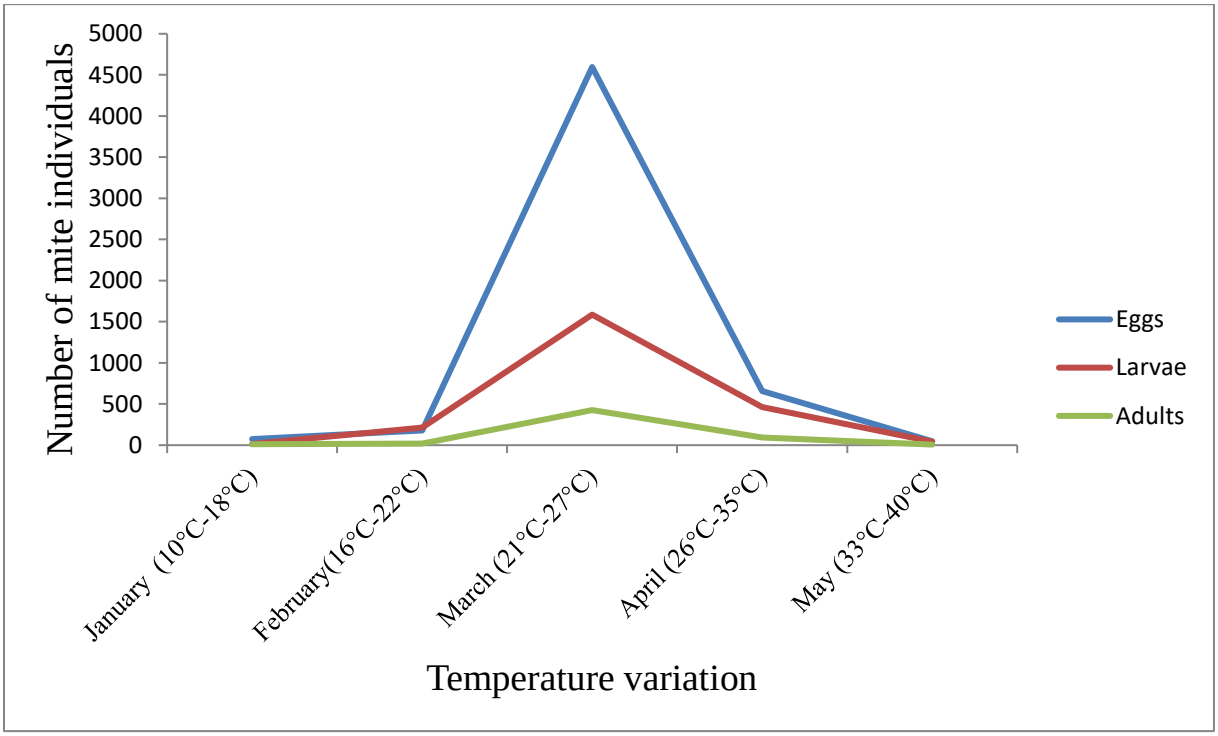

Fig. 2- Evolution of the different stages of the species *Tetranychus urticae* according to temperature variation on strawberry culture

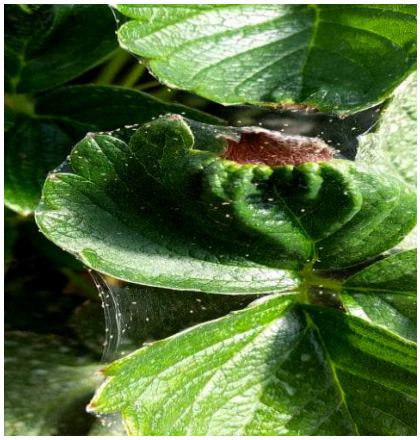

Fig. 3- Plants infested with the webs of the yellow mite *Tetranychus urticae* (original photo)

The monitoring of the species *Phytoseiulus persimilis* shows that this predator is completely absent during the months of January and February, the average temperatures during these months are respectively (16°C and 22°C). The first appearance of this species is marked on March 3 with two (2) adults only. *Phytoseiulus persimilis* continues to evolve and reaches its maximum in April when the average temperature is 31°C. The occupancy rate of this predator was then 92%. After a decline is marked from the end of April. The presence of this predator is almost nil in May (Fig.,4).

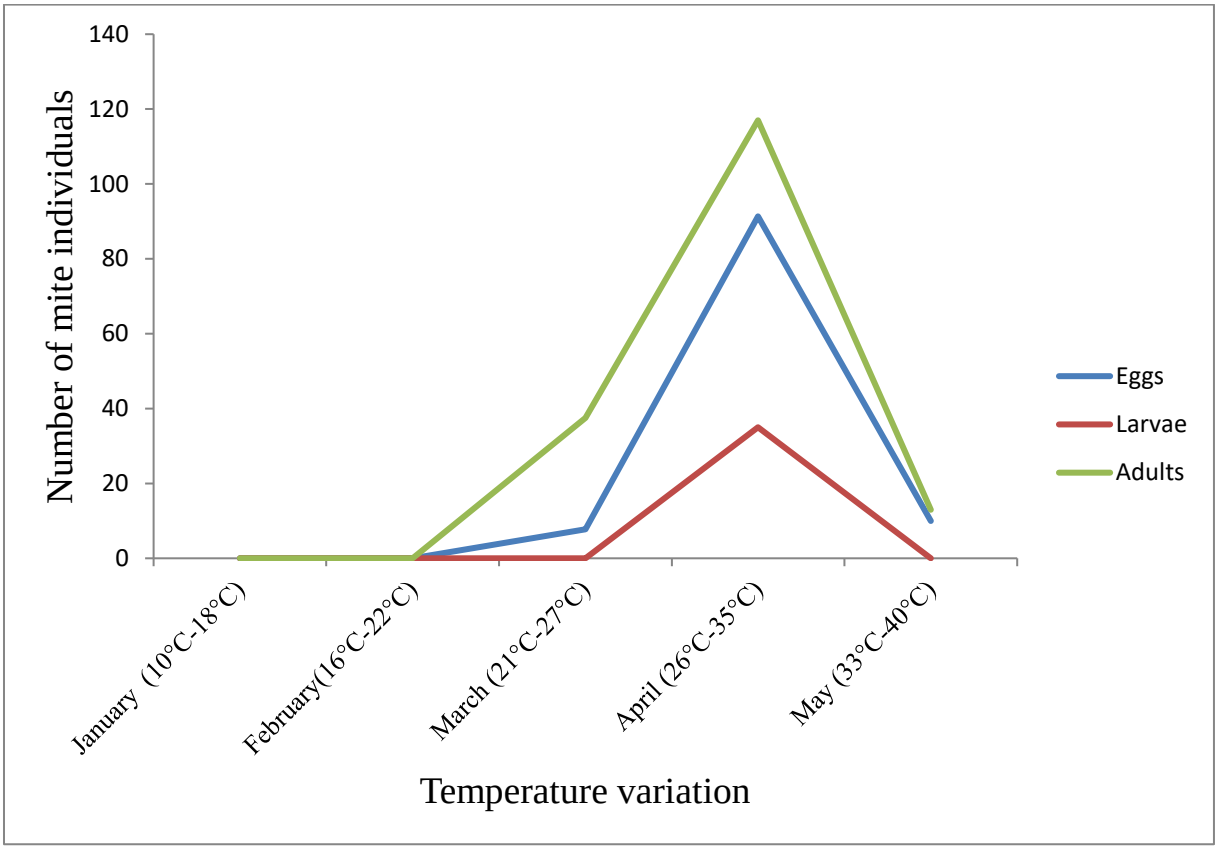

Fig. 4- Evolution of the different stages of the species *Phytoseiulus persimilis* according to the change in monthly temperatures on the strawberry crop

The comparative study of the evolution of the *Tetranychus urticae* species and the predator *Phytoseiulus persimilis* according to the phenological stages of the strawberry culture has shown that the *Tetranychus urticae* species marked its presence from the first stages of strawberry development. . Their numbers are low during the T1 and T2 stages, which correspond respectively to the leaf development stage and to the stolon and young leaf development stage. Its presence evolved gradually, reaching its maximum during the fruiting stage (T4). A rapid decline is noted during the last phenological stage T5 (senescence stage and onset of rest). The predator *Phytoseiulus persimilis* marks a total absence at the leaf development stage and at the stolon and young leaf development stage (T1 and T2) and a timid presence at the T3 flowering stage. Its numbers are relatively large only during the T4 fruiting stage. A decline is immediately started in the stage of senescence and onset of rest.

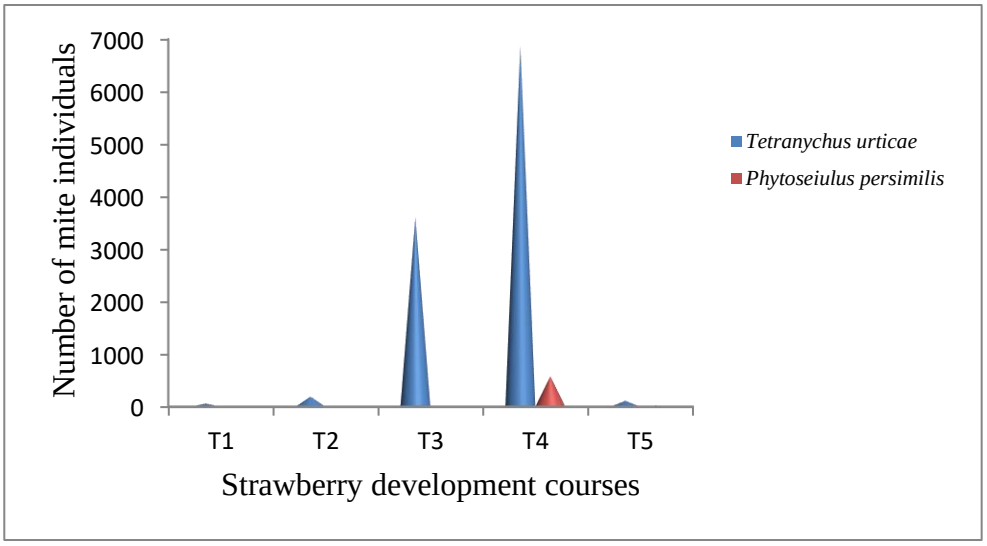

Fig.6 - Comparative study of the evolution of *Tetranychus urticae* and the predator *Phytoseiulus persimilis* according to the phenological stages of strawberry cultivation.

DISCUSSION

Our study showed that the strawberry crop is mainly attacked by the yellow mite *Tetranychus urticae*. These results confirm those of MARQUIER and ALBON in 2011 who worked on the biological control of *Tetranychus urticae* on Reunion Island. In our strawberry greenhouse the arrival of the yellow mite has been announced since January when the temperatures were below 18°C, this shows that this mite can resist low temperatures and remains active and continues to reproduce throughout the year in the greenhouse as winter females. HELLE & SABELIS (1985) noted that female spider mites can withstand very low temperatures and go into diapause when the days get shorter, the temperature drops and their food source decreases or becomes depleted. They proliferate in winter under greenhouse conditions where host plants are available. The monitoring of *Tetranychus urticae* showed that the density of this species evolves as the temperature increases. SAQR & *al.*(2007)mentioned that from the beginning of spring, overwintering females colonize the lower surface of the first leaves and establish the first colonies. In the present study, the maximum pullulement of *Tetranychus urticae* is reached in March when the temperatures varied between 21°C and 27°C. It is noted that the development of these mites is all the more rapid as the weather is hot and dry. JEPPSON & *al*. (1975) reported that the development of spider mites is rapid in hot weather with an optimum at 30-32°C and generations follow one another at a high rate. Similarly in 2001 BOUNFOUR and TANIGOSHI noted that females lay their eggs on the foliage, most often on the underside and can lay up to 100 eggs and they reported that the total life cycle of the yellow mite is 36.3 days at 15°C, 16.6 days at 20°C and 7.3 days at 25°C. ZHANG, in 2003 reported that the lifespan of a spider mite is between two and four weeks. In April we marked a gradual decline where temperatures were above 32°C. In May the temperatures reached 40°C, the population of the yellow mite during this month fell and its presence was almost nil. These results show that the species *Tetranychus urticae* does not resist excessively high temperatures and that the speed of its development decreases when temperatures exceed 32°C. According to the work of CHAIN-ING and*al*. in 1976, female two-spotted spider mites lay more eggs on average at high temperatures than at cool temperatures, but the number of eggs laid nevertheless decreases at 35°C. The monitoring of the appearance of the species *Phytoseiulus persimilis* during our study shows that this predator is totally absent during the months of January and February, the average temperatures during these months are respectively 16 and 22°C. According to SKIRVIN and FENLON (2003) the predator *Phytoseiulus*

persimilis is more effective when temperatures increase from 15 to 25°C. In our study, this predator was completely absent even if the temperatures were favorable for its development. This shows that this species is a monophagous species that feeds only on spider mites, so when the prey is absent or insufficient, this pest will not be able to survive usually in crops during an infestation. This confirms the results of YANAR & *al*.(2019) who used the predatory mite *Phytoseiulus persimilis* to control the two-spotted spider *Tetranychus urticae* in a greenhouse cucumber crop. Indeed in our surveys we noted the first appearance of the predatory mite *P. persimilis* in March during which the species *Tetranychusurticae* reached the maximum pullulement. KREITER in (1991) reported that the predator *Phytoseiulus persimilis* is a very effective scavenging predator attacking all stages of spider mites and occurs when prey density is high. This predator is very mobile and is able to move through the webs of two-spotted spider mites. According to our results after the appearance of the predator, the two populations (pest and predator) increase to a critical point for which the balance between the two populations is reversed in favor of *Phytoseiulus persimilis* which reaches its maximum in April. Where the average temperature is 31°C. The life cycle of the two-spotted spider mite consists of 5 stages of development, between each stage the spider mites form an immobile pupa and molt. As for the predator, it reproduces quickly and its speed of development is twice as fast as that of the spider mite because it does not pass through the immobile forms during its development. These results confirm those of HALLOUM & *al.* (2007) who worked on the effectiveness of *Phytoseiulus persimilis* in controlling *Tetranychus urticae* on greenhouse strawberries. The disappearance of the predator population was reported in May because the pest density during this month was zero. The comparative study of the evolution of the *Tetranychus urticae* species and the predator *Phytoseiulus persimilis* according to the phenological stages of the strawberry culture has enabled us to observe that the *Tetranychus urticae* species marked its presence from the first stages of development. of strawberry, its presence evolved gradually reaching its maximum during the fruiting stage. Then a rapid decline is noted during the Stage of senescence and onset of rest. During the early stages, strawberry leaves provide shelter for female spider mites in diapause, protecting them from sunlight, bad weather and predators. Their numbers during these stages were low because overwintering females did not feed and do not lay eggs. The leaf area of this plant during these stages is small which prevents the proliferation of these pests. During the fruiting stage, the sap flow is important and the leaf area increases, which provides the best conditions for the feeding and reproduction of these predators. This is why during this stage the development of spider mites reaches its maximum. The last phenological stage of the strawberry plant corresponds to the stage of senescence and beginning of rest, this stage is characterized by the formation of new leaves with a smaller blade and a shorter petiole than the old ones, the latter dry up and die. BAILLOD (1986) noted that the predator *Phytoseiulus persimilis* is specific to *Tetranychus urticae* and cannot survive on a purely plant diet (pollen, honeydew, plant juices, plant exudates, etc.) in the absence of its prey, it dies. So the evolution of this predator depends on the density of prey and not on the phenological stages of the plant.

Conclusion

Thanks to the experiments carried out, it was found that the development of spider mites depends on temperature and the phenological stages of the host plant. The growth of the latter is rapidly in hot weather. In the case of strawberries, the evolution of these pests reaches its maximum during the fruiting stage because the sap flow is important during this stage and the leaf area increases, this provides the best conditions for feeding and reproduction of these pests.

The predator *Phytoseiulus persimilis* is specific to *Tetranychus urticae*, its evolution essentially depends on the density of prey and not on the phenological stages of the plant.

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