Bulgarian Journal of Agricultural Science, 31 (No 2) 2025, 334–340

Bioecology of the whitefly *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) on tomato crop in the oases of the arid region El Oued – Algeria

Azzeddine Haddad[1,3*], Ahmed Mehda[1] and Nacer Tarai[2]

[1] *Chahid Hamma Lakhdar University, Faculty of Sciences, Nature and Life, Department of Agronomy, El-Oued, Algeria*
[2] *Mohamed Khider University, Faculty of Exact Sciences and Natural Sciences and Life, Department of Agronomy, Biskra, 07000, Algeria*
[3] *Laboratory of Biodiversity and Biotechnology Applications in Agriculture, Faculty of Natural Sciences and Life, El-Oued University, El-Oued 39000, Algeria*
[*]*Corresponding author:* potp105@gmail.com

Abstract

Haddad, A., Mehda, A. & Tarai, N. (2025). Bioecology of the whitefly *Bemisia tabaci* (Genn.) (Hemiptera: Aleyrodidae) on tomato crop in the oases of the arid region El Oued – Algeria. *Bulg. J. Agric. Sci., 31*(2), 334–340

The El Oued region is known for its large tomato production. However, the whitefly is an intimidating pest of this crop, which causes considerable economic damage. The bioecology of this scourge is the subject of a study carried out in three stations: Hassi Khalifa, Magrane, and Guemar in 2022 and 2023. The number of adults of *Bemisia tabaci* (Gennadius) highest on the tomato variety Sahara (at Magrane station is 15.61 ± 0.12 individuals/plant. It is 11.20 ± 0.21 individuals/plant on the Dawson tomato variety. The lowest number, is 0.31 ± 0.62 per Sahara plant is counted, and 0.02 ± 0.43 individuals/plant on the Dawson variety. A negative correlation with temperatures exceeding 30°C and a weak positive correlation with adults and strong with larvae have been recorded. The Sahara variety presents more sensitivity to attacks by *B. tabaci* while the Dawson variety seems not appreciated by this pest.

Keywords: Bemisia tabaci; Tomato; pests; Bioecology; arid; El-Oued

Introduction

For the last two decades, the El-Oued region has constituted one of the largest production centers for vegetable crops in Algeria, particularly potatoes and tomatoes. Yields have experienced an increasing and remarkable evolution (Khezzani et al., 2016). They went from a production of 58 858 quintals in 2008 on an area of 332 ha to 2163.100 quintals in 2018, on an area of 3130 ha (Khezzani et al., 2016). However, according to Djidji et al. (2010), this culture suffers from sensitivity to excessive heat and humidity. *Bemisia tabaci* Genn. (Hemiptera, Aleyrodidae), it is a very polyphagous insect, it is currently one of the most important pests on vegetable crops, reported on more than 120 species of plants, notably on cotton, beans, sunflowers, eggplant, potato, pepper, tobacco, tomato, citrus fruits and various ornamental plants (Alford, 2013; Didi et al., 2018). The tobacco whitefly was introduced into Algeria a few years ago where it is expanding and it risks causing serious problems for vegetable crops. The presence of the whitefly in farms in the north and south of Algeria causes the infestation of the virus. Virus vector (T.Y.L.C.V.) “Tomato Yellow Leaf Curl Virus”. The pest attacks many vegetable crops and is considered an important vector of viral plant diseases worldwide (Morales and Jones, 2004; Valverde et al., 2004; Ghabeish et al., 2021). According to Delatte et al. (2003) who noted that since 1997, TYLCV has been responsible for heavy infections on tomato crops in Reunion Island. It continues to invade new regions in Africa, mainly in East of Africa (Macfadyen et al., 2018). In Venezuela, tomato production decreased by 50% (Salas and Mendoza, 1995). In Algeria, according to Tarai and Hadad (2014), who indicated that in the sub-littoral region, outbreaks of whiteflies of vegetable crops *Trialeurodes vaporariorum* West. and *Bemisia tabaci* Genn. are increasingly important in all vegetable crops regions.

Whiteflies are exopterygota neoptera insects. They belong to the super order Hemipteroid, whose main characteristic is a piercing-sucking type oral apparatus, particularly adapted to the puncture of liquids of animal or plant origin (Afroje et al., 2016). In greenhouses and southern regions, whiteflies are oviparous, usually having a bisexual mode of reproduction. It can also occur by facultative parthenogenesis (van der Kooi et al., 2017). The objective of this study is focused on the bioecology of *Bemisia tabaci* (Genn.) in greenhouses in the El-Oued region which is a Saharan region located in the southwest of the Algerian territory, knowledge of which is necessary if we want to undertake an effective fight.

Materials and Methods

Choice of stations

The stations chosen are representative of the widely distributed biotopes in the region. They are three locations.

Magrane station

Known for its greenhouse vegetable crops production unit located near the town of Magrane, El Oued region at (33° 35′ 58.39″ N., 6° 55′ 19.67″ E.) on an altitude of 45 m.

Hassi Khalifa station

Located 35 km northeast the town of El Oued at Lambert coordinates (33° 31′ 12.68″ N., 7° 2′ 25.00″ E.). In 57 m of altitude.

Guemar station

The station is part of a rural area, located near Guemar municipality, (33° 29′ 37.27″ N., 6° 40′ 20.69″ E.). At an altitude of 69 m. The three stations produce vegetable crops under greenhouses, notably tomato crops (*Solanum lycopersicum* L.). Tomato cultivation applied at all altitudes (Močević and Šunjka, 2018). Two varieties were grown in our sampling stations, notably Sahara and Dawson variety. Sowing in nurseries was carried out in mid-August. The transplant, in plastic greenhouses, was carried out on September 20, 2022. Each greenhouse measures 50 m in length and 8 m in width. In total of 400 m². Two main doors on each side assure ventilation. The distribution and alignment inside the greenhouse organised in eight lines with 120 plants per line, totally 960 plants. All observations taken out every fortnight and began from October 1, 2022 until April 1, 2023. In every observation, whitefly adults were counted in the field at 6 a.m.; the collected data addressed to an analysis of variance using the generalized linear model of the Xlstat 16 software, followed by Duncan's multiple means comparison test at the 5% threshold.

Sahara variety

A hybrid and late variety, characterized by a giant capacity to generate additional flowers from one bouquet to another. The period from transplant to flowering estimated by 42.13 days. On a daily growth rate of around 2.59 cm/day. Speaking of the number of flowers per floral bouquet, the 3rd and 4th bouquets has the maximum performance with 13.14 and 15.88 flowers, considered resistant to diseases and pests (Haddad et al., 2019). The Sahara F1 development succeeded during the year 2014–15. Its evaluation in a preliminary yield trial progressed at the Vegetable Research Institute, Faisalabad during the year 2015–16 (Nadeem et al., 2024).

Dawson variety

Dawson variety is heart-shaped, light-red-orangey fruits streaked with yellow, with a flame red summit; good flavouring and rich in sugar, fully fleshy and juicy, very fine and particularly seedless, giving a good late productivity (80 to 100 days) and considerable sized fruits with a mass of 300 g to 1 kg depending on growing conditions. initially marketed in 2009; Variety resulting from the crossing of "Russian 117" and Georgia Streak", developed by Jeff Dawson, USA (Chougar, 2020).

Study of white fly population dynamics

The study of the dynamics of whitefly populations in greenhouses requires the counting of adults and larvae of *B. tabaci* on the leaves from a sample of nine plants chosen randomly from each variety (Arx et al., 1984; Abisgold and Fishpool, 1990). While counting the different larval forms of *B. tabaci* requires counting on a single leaf per plant. Sampling was planned systematically with two observation tours per month. Counting adults is carried out on 9 leaves. The capture and collection of adults done according to the diagonal technique established by Bastide in a random manner where only 9 plants have been chosen, the leaves and the floral bouquets likely to be infested (Musuna, 1986; Aslam et al., 2001). The visual inspection includes counting the adults of *B. tabaci* present on the leaves for the collection of specimens and thus having a representative vision. A minimum of promptness is necessary to collect the insects, so a vacuum cleaner can be used (Visser et al., 2017). The samples taken kept in labelled plastic bags with the following information: date, location, variety and greenhouse surveyed, so they can be processed at the laboratory in order to extract, identify the species and count the larvae recovered.

Results and Discussion

The evolution study of the adult population of *Bemisia tabaci* shows that it is reported on the main two greenhouse crops in the study region: tomatoes and peppers. The fluctuation in populations in the study region on the two tomato varieties studied (Sahara and Dawson) are comparable. However, the population size is low on tomatoes, particularly on the Dawson variety compared to Sahara. During two agricultural seasons, both varieties Sahara and Dawson planted in the region were studied. Observing and studying the pest is based on counting adults and larvae of *B. tabaci*. The first sampling period is from the beginning of October 2022 until the end of December 2022 and the second sampling period is from mid-January 2023 until the beginning of April 2023. Adult counting of *B. tabaci* done during two sampling periods, one autumnal and the second on spring, indicates that the number is high from mid-October to mid-November and from mid-February to mid-March (Figure 1). While, according to Nzi et al. (2010), in Ivory Coast, show that the number of adults of *Bemisia tabaci* is 9 individuals per plant at the time of sowing in March.

The results obtained during the sampling period in 2022 and 2023, at the station of Magrane, Hassi Khalifa and Guemar are indicated in the form of means (± standard deviation) of adult *B. tabaci* depending on the tomato varieties, Sahara and Dawson (Figures 1, 2, 3 and 4). These results show that the highest number of adult *B. tabaci* is recorded at Magrane station during the spring period, where the highest adult average is 15.61 ± 0.12 individuals per plant. Counted on March 1, 2023 on Sahara variety (Figure 1). Also, the average number of the lowest population counted is around 0.02 ± 0.43 individuals per plant noted on January 15, 2023 on Dawson variety at Guemar's site (Figure 2). The counting of winged individuals of *B. tabaci*, during the sampling period, at the study stations, shows that the number of the population gradually increases during the months of October, February and March, for the two tomato varieties Sahara and Dawson. Or 14.9 ± 0.21 individuals counted on greenhouse in Sahara variety, on October 15, 2022 at Hassi Khalifa site (Figure 1). When on Dawson variety, the average number of the highest population is 10.98 ± 0.02 individuals per plant, took on the same day at Magrane station in autumnal period (Figure 2).

Indeed, the average number of the lowest adult population for Sahara variety is 0.31± 0.62 individuals/plant, observed on January 1, 2023 at Guemar station (Figure 1). On the other hand, the lowest average population for the Dawson variety is 0.02 ± 0.43 individuals/plant counted in mid-January, 2023, in the same station (Figure 2). The evolution of the populations is comparable on the two varieties (Figure 1) and (Figure 2). In the southern region of El Oued, the first evolution peak in *B. tabaci* in Dawson variety with 10.98 ± 0.02 ind. per plant, recorded on October 15, 2022 (Figure 2). The population stability period is noted on April 1, 2023, which 3.96 ± 0.35 individuals per plant are counted (Figure 1). 3.56 ± 0.20 indi-

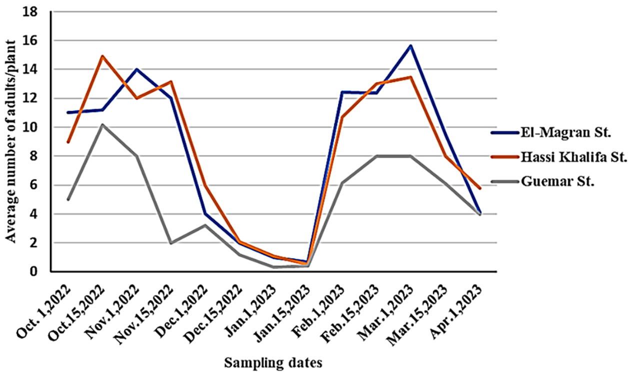

Fig. 1. Average number of individuals of *Bemisia tabaci* Genn. adults per plant on tomato, "Sahara" variety at the three stations during the 2022 and 2023 sampling period

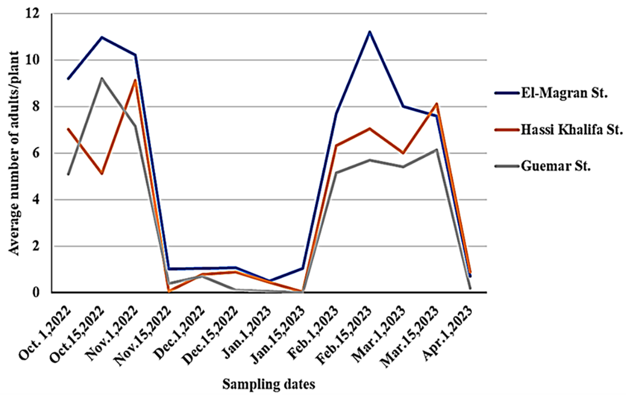

Fig. 2. Average number of individuals of *Bemisia tabaci* Genn. adults per plant on tomato, "Dawson" variety at the three stations during the 2022 and 2023 sampling period

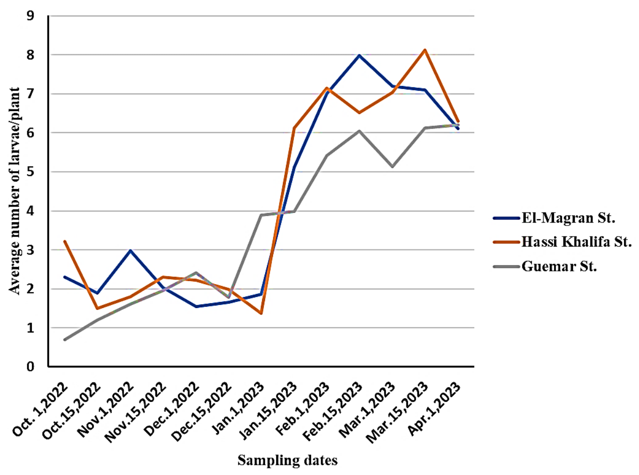

Fig. 3. Average number of individuals of *Bemisia tabaci* Genn. larvae per plant counted on Sahara variety tomato crops at the three stations in the El-Oued region. 2022–2023 campaign

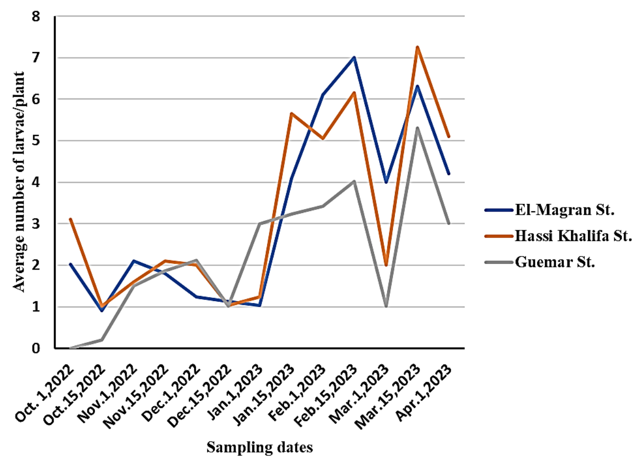

Fig. 4. Average number of individuals of *Bemisia tabaci* Genn. larvae per plant counted on Dawson variety tomato crops at the three stations in the El-Oued region. 2022–2023 campaign

viduals/plant are witnessed in Zahra variety in April. Whereas, in March 5.78 ± 0.31 individuals per plant were noted in Toufan variety and 5.67 ± 0.43 individuals/plant for Zahra variety (Tarai and Hadad, 2014). However, the Sahara tomato variety had recorded the highest average numbers of individuals per plant compared to Dawson variety, particularly during mid-March, 2023, where the average counted at leaf-level is 15.61 ± 0.12 ind./plant at Magrane station (Figure 1). However, Dawson variety recorded the highest number at Magrane station with an average of 11.2 ± 0.21 ind./plant on February 15, 2023 (Figure 2). The evolution of population of *B. tabaci* goes through three distinct periods, exponential growth, stability in size populations and the final decline accompanying plant senescence (Gerling, 1967). Tarai (2012) shows that in the southern region of Aures, the first evolution peak of *B. tabaci* for the variety "Toufan" corresponds to 8.22 ± 0.35 per plant, recorded on March 15, 2011, followed by stability in the population towards the beginning of April. 5.33 ± 0.32 ind/plant is the average for Toufan, recorded on April 1, 2011. According to, Tarai (2012), the variety "Zahra", presents the first evolution peak with an average of 7 ± 0.44 individuals per plant, recorded in mid-March 2011. The period of population stability is noted on April 1, with the highest numbers at Hassi Khalifa station 5.76 ± 0.48 ind./plant; however, for Guemar station Sahara recorded 3.96 ± 0.26 ind./plant (Figure 1). Also, Dawson variety at the end of the cycle recorded in Hassi Khalifa station a number of 0.9 ± 0.17 ind./plant. Meanwhile, Guemar station recorded 0.2 ± 0.26 ind./plant (Figure 2). The period of stability has valued by 4.11 ± 0.35 individuals per plant (Tarai, 2012). The decrease in population seems linked to the high temperature in the greenhouse during the end of March; the average recorded being 34°C. Fishpool et al. (1987) noted that climatic conditions are among the main factors determining the dynamics of *B. tabaci* populations. Indeed, the factors influencing the dynamics of *B. tabaci* populations seem to be growth methods of the plants, linked to cultural practices and climatic conditions (Fishpool et al., 1987). Furthermore, fecundity and longevity of *B. tabaci* decrease linearly with temperature, while the survival rate increases up to 21 to 30°C (Muñiz and Nombela, 2001). Besides, Drost et al. (1998) and Muñiz (2000), show that there is a relationship between evolutionary parameters and temperature, tall plant species and varieties among insects. Tsai and Wang (1996), mention that the optimal temperature necessary for the development of adults of *B. tabaci* is 32.5°C. Which is high compared to that calculated for *B. argentifolii* which is of the order of (21.8–22.7 days) cultivated on eggplant, cucumber and pepper at 25°C (Kakimoto et al., 2007). The longevity of *B. tabaci* is 56 days at a temperature of 17°C, from the egg to the adult stage. While it is 20 days at a warmth of 35°C, this accords with our obtained result which shows that there is a negative correlation with high ambient temperatures (Figure 5) and a strong positive correlation with relative humidity for larvae and low for adults (Figure 6). This agrees with: Huat (2006) who indicated that climatic and edaphic factors lead to interesting parasitic pressure which considerably limits the potential of crop production. It also agrees with the results of Bonato et al. (2006) who highlighted that there's a negative correlation between temperature and population evolution (between 30 and 35°C, at $P > 0.05 \pm 0.05$), and contravene with the results obtained by Chougar and Medjdoub-Bensaad (2014), who affirmed that climatic factors represented by temperatures and humidity levels on the Kabyle sublittoral don't influence the number male adults captured during the sampling of the study. *Bemisia tabaci* in adult stage remains present during all sampling operations, on the two varieties (Figures 1 and 2).

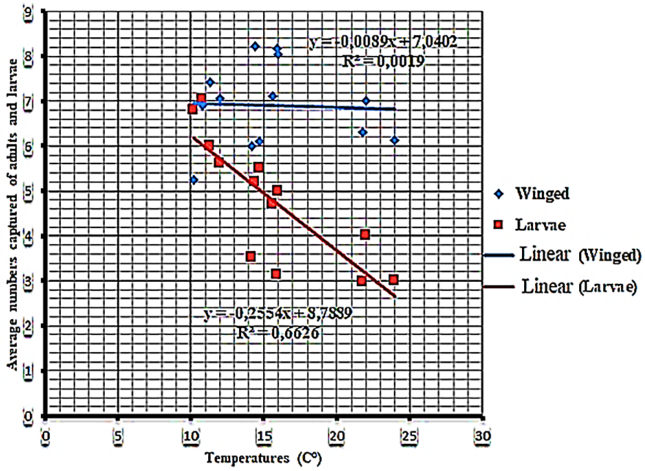

Fig. 5. Correlation of the average numbers of larvae and adults of *Bemisia tabaci* Genn. per plant, with ambient temperatures, counted on Dawson variety tomato cultivation at the three stations in the El-Oued region. 2022–2023 campaign

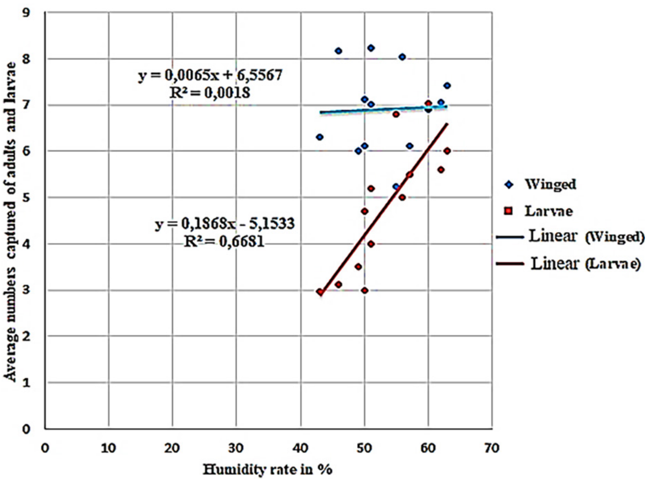

Fig. 6. Correlation of the average numbers of larvae and adults of *Bemisia tabaci* Genn. per plant, with ambient humidity, counted on Dawson variety tomato cultivation at the three stations in the El-Oued region. 2022–2023 campaign

Number of larvae

During the autumn period, a tiny population of larvae recorded on the two varieties studied with an average of 0.7 ± 0.42 ind./plant on Sahara at Guemar station and 0 ind/plant in Dawson at Guemar's station on the same day (Figure 3) and (Figure 4).

Which accords with the number larvae of *Bemisia tabaci* on the two varieties of tomato planted in greenhouses, Zahra and Toufan, which is low during the autumnal sampling, despite the fact that the planting of tomatoes in greenhouse nurseries started at the end of August (Tarai and Hadad, 2014). The totality number of larvae becomes significant from mid-March, for both Zahra and Toufan Varity (Tarai and Hadad, 2014).

However, peak numbers were recorded on Sahara with an average of 8.41 ± 0.45 ind/plant in Hassi Khalifa station (Figure 3) and Dawson recorded 7.25 ± 0.35 ind/plant on March 15, 2023 at the same station (Figure 4). The numbers of larvae at all stages known a negative correlation with temperatures (Figure 5) and a positive correlation with humidity levels (Figure 6).

Conclusions

The Whitefly (*Bemisia tabaci* Genn.) consolidated by three essential factors, firstly the adequate environmental conditions during two seasons (autumn and spring), secondly the phenological cycle of plant, which is very important when, temperatures are most suitable for the development. Thirdly the sensitivity of the cultivated varieties. The evolution of adults of *B. tabaci* recorded on tomato varieties Sahara and Dawson, at Guemar station, Magrane and Hassi Khalifa shows that the highest average number of individuals per plant recorded on 1 March 2023 on Sahara; however, the lowest number recorded on mid-January 2023 on Dawson at Guemar station. Mentioning that the number of adults of *B. tabaci* on the two varieties of tomato is low, during the sampling of autumn and winter. The total number of adults becomes significant from mid-October until beginning of winter and from the beginning of February until mid-March, on both varieties.

The sensitivity of the Sahara and Dawson to the attack of the pest indicates that the population size is low on Dawson compared to Sahara during most of the sampling, which seemed more sensitive to attacks by *B. tabaci*. Note that the correlation in adult numbers with temperatures is weakly negative with adults and strongly negative with larvae; however, the correlation of adult numbers is weakly positive with humidity, while a strong positive correlation is recorded with larvae. Climatic conditions, particularly temperatures exceeding 34°C, do not seem to increase in the numbers of *B. tabaci*. Furthermore, the number of larvae on the two tomato varieties planted in greenhouses, is low during the autumnal sampling despite certain temperature fluctuations recorded during the planting in the nursery and transplantation in greenhouse. Note that the larvae of *B. tabaci* appeared in greenhouses as clusters; this is due to the airflow in the greenhouse. The heat of August was not suitable for the pest-establishment during the nursery planting. An increase in larvae is only recorded from mid-February on both varieties with a slight increase particularly on Sahara variety. The peak samplings are February 15, 2023 at Magrane station; and March 15, 2023 at Hassi Khalifa station for Sahara; and February 15, 2023 and March 15, 2023 for the Dawson. We recorded diminution in numbers of larvae on October 15, 2022, which is 1.5 ± 0.25 individuals/plant for Hassi Khalifa station and 1.2 ± 0.96 individuals/plant for Guemar station for Sahara, and 1.02 ± 0.19 ind./plant and 0.2 ± 0.21 ind./plant for Dawson variety at Hassi Khalifa and Guemar stations, respectively. While at Magrane station 0.9 ± 0.91 ind./plant was recorded. Overall, Guemar station had low numbers throughout all the experiment compared to the two other stations.

References

Abisgold, J. D. & Fishpool, L. D. C. (1990). A method for estimating population sizes of whitefly nymphs (*Bemisia tabaci* Genn.) on Cassava. *Tropical Pest Management, 36*(3), 287-292. doi:10.1080/09670879009371490

Afroje, R., Khan, M. & Rahman, M. (2016). Taxonomic classification, population variation and damage extent of guava whitefly, aleurodicus dispersus russell (hemiptera: Aleyrodidae). *Bangladesh j. entomol, 26*(1), 31-46.

Alford, D. V. (2013). Pests of ornamental plants: trees, shrubs, flowers (Éditions Quæ ed.): Manson Publishing.

Arx, V. R., Baumgärtner, J. & Delucchi, V. (1984). Sampling of *Bemisia tabaci* (Genn.)(Sternorrhyncha: Aleyrodidae) in Sudanese cotton fields. *Journal of Economic Entomology, 77*(5), 1130-1136.

Aslam, M., Khan, A. H., Rasheed, T. & Khan, I. A. (2001). Monitoring whitefly, *Bemisia tabaci* (Genn.) on cotton. *Pakistan journal of zoology, 33*(4), 261-264.

Bonato, O., Couton, L. & Fargues, J. (2006). Feeding preference of *Macrolophus caliginosus* (Heteroptera: Miridae) on *Bemisia tabaci* and *Trialeurodes vaporariorum* (Homoptera: Aleyrodidae). *Journal of Economic Entomology, 99*(4), 1143-1151. doi:10.1603/0022-0493-99.4.1143

Chougar, S. (2020). Bioecology of the tomato leafminer *Tuta absoluta* (Meyrick, 1917) in the Tizi Ouzou region. Control trials. (Doctorat), Universite de Tizi-Ouzou, Tizi ouzou; Algérie. Retrieved from https://dspace.ummto.dz/items/032d76c5-a86c-4f54-8a70-38a4b2c824dd

Chougar, S. & Medjdoub-Bensaad, F. (2014). Biology and dynamics of *Tuta absoluta* populations (Meyrick, 1917) on two tomato varieties (Dawson and Zahra) on the coast of the Tizi-ouzou region. Paper presented *at the AFPP Dixième Conférence Internationale sur les Ravageurs en Agriculture. – 22 et 23 Octobre; Montpellier, France*.

Delatte, H., Dalmon, A., Rist, D., Soustrade, I., Wuster, G., Lett, J.-M., ... & Reynaud, B. J. P. D. (2003). Tomato yellow leaf curl virus can be acquired and transmitted by *Bemisia tabaci* (Gennadius) from tomato fruit. *87*(11), 1297-1300. doi:10.1094/PDIS.2003.87.11.1297.

Didi, G. J. R., Kone, P. W. E., Ochou, G. E. C., Dekoula, S. C., Kouakou, M., Bini, K. K. N., ... & Ochou, O. G. (2018). Spatio-temporal evolution of infestations of the whitefly *Bemisia tabaci* (Gennadius, 1889) associated with cotton cultivation in Côte d'Ivoire. *Journal of Applied Biosciences, 121*, 12202-12210. doi:10.4314/jab.v121i1.10.

Djidji, A. H., Zohouri, G. P., Fondio, L., Nzi, J. C. & Kouame, C. N. G. (2010). Effect of shelter on tomato cultivation during the rainy season in southern Côte d'Ivoire. *Journal of Applied Biosciences, 25*, 1557 – 1564. doi:10.5829/idosi.aje.2016.9.1.10253.

Drost, Y., Van Lenteren, J. & Van Roermund, H. (1998). Life-history parameters of different biotypes of *Bemisia tabaci* (Hemiptera: Aleyrodidae) in relation to temperature and host plant: a selective review. *Bulletin of Entomological Research, 88*(3), 219-230. doi:10.1017/S0007485300025840.

Fishpool, L., Van Helden, M., Van Halder, I., Fauquet, C. & Fargette, D. (1987). Monitoring *Bemisia tabaci* populations in cassava: field counts and trap catches. Paper presented *at the Proceedings of the International Seminar on African Cassava Mosaic Disease*.

Gerling, D. (1967). Bionomics of the whitefly-parasite complex associated with cotton in southern California (Homoptera: Aleurodidae; Hymenoptera: Aphelinidae). *Annals of the Entomological Society of America, 60*(6), 1306-1321. doi:10.1093/aesa/60.6.1306.

Ghabeish, I., Sweiss, M. & Anfoka, G. (2021). Updated status of whiteflies (Hemiptera: Aleyrodidae) in Jordan with emphasis on the *Bemisia tabaci* species complex. *Revista Colombiana de Entomología, 47*(1), 1-9. doi:10.25100/socolen.v47i1.8944.

Haddad, A., Zaater, A., Ladjali, A. & Djerah, A. (2019). Bio-ecological study of *Myzus persicae* (homoptera, aphididae) at El-oued region, Algeria. *Journal of Fundamental and Applied Sciences, 11*(3), 1408-1417. doi:10.4314/jfas.v11i3.25.

Huat, J. (2006). Limitative factors of yields in factory-growing tomato fields in Northern Senegal. *Cahiers Agricultures, 15*(3), 293–300.

Kakimoto, K., Inoue, H., Yamaguchi, T., Ueda, S., Honda, K.-i. & Yano, E. (2007). Host plant effect on development and reproduction of *Bemisia argentifolii* Bellows et Perring (*B. tabaci* [Gennadius] B-biotype) (Homoptera: Aleyrodidae). *Applied Entomology and Zoology, 42*(1), 63-70. doi:10.1303/aez.2007.63.

Khezzani, B., Bouchemal, S. & Halis, Y. (2016). Some agricultural techniques to cope with the fluctuation of the groundwater level in arid environments: Case of the Souf Oasis (Algerian Sahara). *Journal of Aridland Agriculture, 2*, 26-30. doi:10.19071/jaa.2016.v2.3060.

Macfadyen, S., Paull, C., Boykin, L. M., De Barro, P., Maruthi, M., Otim, M., ... & Tay, W. T. (2018). Cassava whitefly, *Bemisia tabaci* (Gennadius)(Hemiptera: Aleyrodidae) in East African farming landscapes: a review of the factors determining abundance. *Bulletin of Entomological Research, 108*(5), 565-582. doi:10.1017/S0007485318000032.

Močević, N. & Šunjka, D. (2018). Organic agriculture at high altitudes: Experimental organic garden in ilovice, bosnia and herzegovina. *AGROFOR, 3*(2). doi:10.7251/AGRENG1802032M.

Morales, F. J. & Jones, P. G. (2004). The ecology and epidemiology of whitefly-transmitted viruses in Latin America. *Virus Research, 100*(1), 57-65. doi:10.1016/j.virusres.2003.12.014.

Muñiz, M. (2000). Host suitability of two biotypes of *Bemisia tabaci* on some common weeds. *Entomologia Experimentalis et Applicata, 95*(1), 63-70. doi:10.1046/j.1570-7458.2000.00642.x.

Muñiz, M. & Nombela, G. (2001). Differential variation in development of the B-and Q-biotypes of *Bemisia tabaci* (Homoptera: Aleyrodidae) on sweet pepper at constant temperatures. *Environmental Entomology, 30*(4), 720-727.

Musuna, A. (1986). A method for monitoring whitefly, *Bemisia tabaci* (Genn.), in cotton in Zimbabwe. *Agriculture, Ecosystems & Environment, 17*(1-2), 29-35. doi:10.1016/0167-8809(86)90024-1.

Nadeem, K., Sardar, S., Iqbal, M., Hammad, G., Chishti, S., Iqbal, M., ... & Cheema, K. L. (2024). Sahara F 1, an indeterminate tomato hybrid suitable for cultivation in virus conducive environment. *SABRAO Journal of Breeding, 56*(6). doi:10.54910/sabrao2024.56.6.18.

Nzi, J. C., Kouamé, C., N'Guetta, A. S. P., Fondio, L., Djidji, A. H. & Sangare, A. (2010). Populations' evolution of whitefly *Bemisia tabaci* Genn. according to tomato (Solanum lycopersicum L.) varieties in Central Côte d'Ivoire. *Sciences & Nature, 7*(1), 31-40. doi:10.4314/scinat.v7i1.59918.

Salas, J. & Mendoza, O. (1995). Report from Venezuela. *Ceiba, 36*(1), 49-50.

Tarai, N. (2012). Study of the entomological fauna of the southern Aures region. Institut National d'Agronomie, El-Harrach; Alger. Retrieved from http://catalogue.ensa.dz/bib/25200

Tarai, N. & Hadad, A. (2014). Study of insect pests in the southern region of Aures, southern Algeria. Paper presented *at the Actes du 4ème Meeting International ''Aridoculture et Cultures Oasisennes : Gestion des Ressources et Applications Biotechnologiques en Aridoculture et Cultures Sahariennes : perspectives pour un développement durable des zones arides, 17-19/12/2013*.

Tsai, J. H. & Wang, K. (1996). Development and reproduction of *Bemisia argentifolii* (Homoptera: Aleyrodidae) on five host plants. *Environmental Entomology, 25*(4), 810-816. doi:10.1093/ee/25.4.810.

Valverde, R. A., Sim, J. & Lotrakul, P. (2004). Whitefly transmission of sweet potato viruses. *Virus Research, 100*(1), 123-128. doi:10.1016/j.virusres.2003.12.020.

van der Kooi, C. J., Matthey-Doret, C. & Schwander, T. (2017). Evolution and comparative ecology of parthenogenesis in haplodiploid arthropods. *Evolution letters, 1*(6), 304-316. doi:10.1002/evl3.30.

Visser, D., Uys, V. M., Nieuwenhuis, R. J. & Pieterse, W. (2017). First record of tomato leaf miner *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in Tanzania. *Agriculture & Food Security, 6*(4), 301-305. doi:10.1186/s40066-016-0066-4.

Received: **November, 09, 2023**; *Approved*: **January, 22, 2024;** *Published:* **April, 2025**