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# **Boufaroua (*Oligonychus afrasiaticus*) in Tolga palm groves in 2021**.

Boufaroua (*Oligonychus afrasiaticus*) nos pomares de palmeiras de Tolga em 2021.

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**Abstract**

Global warming, which has affected the entire globe, has increased the activity of crop pests. The Boufaroua (*Oligonychus afrasiaticus*) is among the serious threats to date production in Algeria. Through regular monitoring, field surveys and recording of temperature and relative humidity data within the Tolga palm grove (known for the famous 'Deglet Nour' date), it was found that the spider of this date palm in 2021 has expanded in the study area. This spider, in addition to half-soft cultivars, has exceptionally attacked soft and dry cultivars during this year. The multiplication of this tiny spider increases when the average air temperatures follow an upward trend (above 30 °C) and the relative air humidity registers a perpetual decrease (below 35 %); two important waves of Boufaroua propagation were recorded, the first one during the second dekad of June and the second one at the beginning of August. Farmers in the study area did not apply preventive control of *Oligonychus afrasiaticus* and resorted to curative control, when the pest appeared; where chemical treatments were most frequent. Nevertheless, a part of the farmers uses inherited (traditional) practices, while a minority uses household detergents.

**Keywords**: Algeria. Date palm. Sahara. Threatens. Struggle.

**Resumo**

O aquecimento global, que afetou todo o globo, aumentou a atividade das pragas das culturas. O Boufaroua (*Oligonychus afrasiaticus*) está entre as sérias ameaças à produção até hoje na Argélia. Através de monitoramento regular, pesquisas de campo e registro de dados de temperatura e umidade relativa dentro da palmeira Tolga (conhecida pela famosa tâmara 'Deglet Nour'), descobriu-se que a aranha desta palmeira em 2021 se expandiu na área de estudo. Esta aranha, além de cultivares semi-mole, atacou excepcionalmente cultivares macias e secas durante este ano. A multiplicação desta pequena aranha aumenta quando a temperatura média do ar segue uma tendência ascendente (acima de 30 °C) e a umidade relativa do ar registra uma diminuição perpétua (abaixo de 35 %); duas importantes ondas de propagação de Boufaroua foram registradas, a primeira durante a segunda década de junho e a segunda no início de agosto. Os agricultores da área de estudo não aplicaram o controle preventivo de *Oligonychus afrasiaticus* e recorreram ao controle curativo, quando a praga apareceu; onde os tratamentos químicos foram mais frequentes. Entretanto, uma parte dos agricultores usa práticas herdadas (tradicionais), enquanto uma minoria usa detergentes domésticos.

**Palavras-chave**: Argélia. Palmeira tâmara. Saara. Ameaça. luta.

## Introduction

Agriculture involves natural processes that often require fixed proportions of nutrients, temperatures, rainfall and other conditions (KERVENO, 2019). Global warming, which has induced climate change, has prompted changes in pest and disease activity, changes in atmospheric carbon dioxide, changes in the nutritional quality of certain foods, changes in the growing season and changes in sea level (YOHANNES, 2016; LESCARMONTIER et al., 2019).

Palm date culture is one of the strategic sectors on which Algeria relies as part of the national economic recovery, especially since it has about 20 million productive date palms, producing nearly 11 million quintals of dates; pointing out that the value of national date production has been estimated at more than 487 billion Algerian dinars (equivalent to 3.33 billion dollars) in 2021, or 14 % of the value of national agricultural production (RA, 2022).

*Phoenix dactylifera* L. is the scientific name of the date palm; the word "Phoenix" derives from the name of the date palm among the Greeks, who considered it to be the tree of the Phoenicians, and "dactylifera" comes from the Latin "dactylus" derived from the Greek dactylis, meaning finger, because of the shape of the fruit (MUNIER, 1973; ZAID and ARIAS-JIMÉNEZ, 2002; FACI, 2016). This species belongs to the Arecaceae family and the genus Phoenix contains 12 species. Dactylifera is the most important species in terms of commercial value and human food use. Being a dioecious plant, male and female flowers are born on two different palms, and many male and female cultivars have been identified and successfully cultivated; the number of cultivars recorded is about 3500 (ZAID and ARIAS-JIMENEZ, 2002; FACI, 2021).

The date palm is a monocotyledonous tree with a monopodial trunk (an unbranched tree with a single cotyledon in the seed). It is a dioecious monocot, has obligatory cross-fertilization and individuals from the same population often do not flower at the same time. *Phoenix dactylifera*, an unfixed cross with high heterozygosity, has the property of forming shoots (called Djebbar) generally at the base of the stipe and each planted shoot gives a date palm with the same characteristics as the mother palm, which cannot be obtained by sowing (TOUTAIN, 1967).

The economic importance of the date palm has not ceased to grow, where it generated 71 million dollars in exports in 2020; while the Algerian government is aiming for 500 million dollars in the coming years (APS, 2020a; APS, 2021).

*Oligonychus afrasiaticus* (McGregor 1939), called Boufaroua in Algeria (often this term refers to dust), is one of the pests that have spread remarkably in oasis agrosystems; it has become widespread in the Biskra region over the last twenty years (FACI, 2021). This spider of date palm which lays its eggs on dates where they are strongly stuck and protected by a rather dense white or greyish silky web secreted by the adult; these eggs hatch after 2 to 3 days into light green oval larvae about 0.15 millimeters long. The total duration of the development cycle from egg to imago stage is 12-18 days; generally the life cycle of *Oligonychus afrasiaticus* lasts between two and three weeks. A population of Boufaroua on date palms takes 2 to 3 days to double in size. With six possible generations, the number of individuals per population becomes incredibly fierce for farmers who see their crops depleted (GUESSOUM, 1986; OUDA IBRAHIM and ZAID, 2019; CHAKER et al., 2020).

The skin of infested fruit becomes hard, then cracks and wrinkles, reducing the quality of the fruit, making it unfit for consumption; the sand and dust thus retained make the dates inedible. This mite has become increasingly important every year, especially in recent years, the cumulative effect of drought in the various palm groves; the combination of lack of water, lack of maintenance and

severe drought can contribute to the appearance of this pest on more than 80 % of the palms (GUESSOUM, 1986; BABAZ et al., 2020; CHAKER et al., 2020).

Boufaroua, which belongs to the family Tetranychidae, is present in all the palm groves of North Africa and the Middle East; it was described and reported in Algeria by Marc André in 1932 (there was a confusion between *Oligonychus afrasiaticus* and *Paratetranychus simplex*). This mite is practically invisible to the naked eye, it is about 0.22-0.44 mm long and 0.17-0.20 mm wide; the female is larger than the male (GUESSOUM, 1986; OUDA IBRAHIM and ZAID, 2019; NIPP, 2022a).

According to Guessoum (1986), during its activity the mite feeds on dates and rarely on leaves. Feeding through its stiliform mouthparts that penetrate the epidermis. These innumerable punctures cause small red spots to appear and spread over the entire fruit. This gives the fruit a rough appearance. In addition to this, there is a whitish silken network containing a multitude of larval dexuviae. Dust and sand carried by the wind stick to this silky network and sometimes give it a sandy colour. These fruits are unfit for marketing and are sometimes even rejected by animals. The damage is caused mainly on the Deglet Nour variety.

Algeria has reserved, in 2020, 91.56 million Algerian dinars (equivalent to 627 thousand dollars) to fight against this mite and against the Myelois (APS, 2020b).

According to Faci (2021), Biskra is a potentially agricultural region, characterized by date palm culture, where the number of date palms reached, in the year 2020, 4.44 million planted on an area of 44.05 thousand ha; the Deglet Nour variety holds 2.78 million trees, or 62.49 %. The number of producing palms is 4.36 million, including 2.70 million Deglet Nour; this heritage generates a production of 4.77 million quintals of dates, 3.08 million quintals are dates of the famous Deglet Nour. The average yield of dates per palm is 109.4 kg, while it is 113.9 kg for the variety Deglet Nour.

The Deglet Nour date from the Tolga region is the only variety with the Geographical Indexation (GI) label, out of the 1100 varieties listed in Algeria. This label may be withdrawn due to the deterioration of the quality of the fruit, caused by pests and climate change.

This contribution aims to present an overview of the dates of appearance of Boufaroua in the Tolga region, the influence of temperature (air and surface) and humidity (air and soil) on the spread of this tiny spider and, finally, an inventory of control practices against this date pest.

## Materials and methods

### 1. Study area

The municipality of Tolga is located about 380 km south-east of the capital Algiers and about 35 km south-west of the capital of the wilaya (province) of Biskra (Fig. 1). This municipality, with an area of 121430 hectares, is known for its agricultural products; on an area of 94421 hectares, cereals, fruits and vegetables are produced, as well as extensive sheep farming (more than 55,000 sheep) (DPBMB, 2019).

The Tolga palm grove, located on a full area of 3134 hectares, is composed of 315258 palm trees, of which 309080 are in production phase; producing 443080 quintals of dates, that is to say an average of 143,35 kg/tree (DASB, 2021).

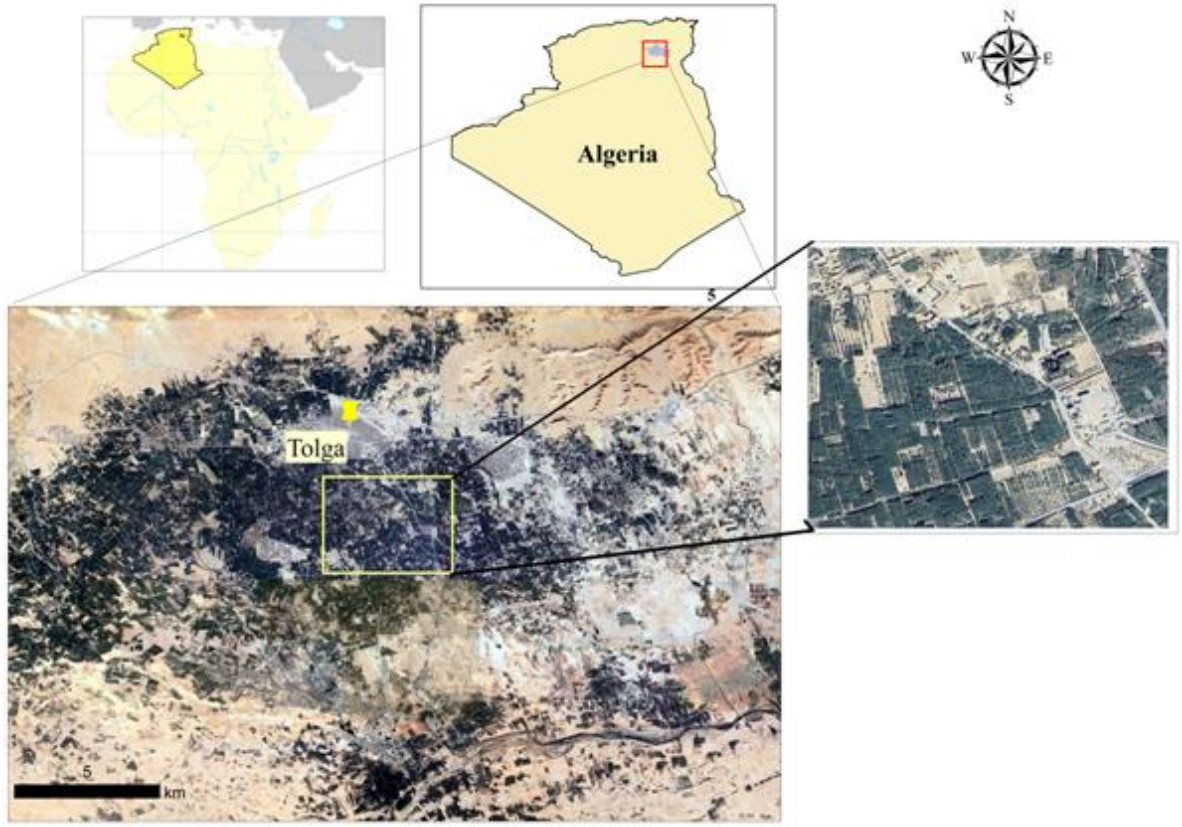


Figure 1 - Location of the study area. Source: AUTHORS OF THIS ARTICLE, 2022.

## 2. Recording of climatic data

Data recording of temperature and relative humidity was carried out by the 'Testo 175 H1' data logger; the ComSoft Basic software, which can be downloaded free of charge, allows quick programming of the logger and easy data analysis. The measuring range for temperature is between -20 and +55 °C, while for humidity it is between 0 and 100 % (TESTO, 2021). The measuring instrument was installed in a palm grove in Tolga (Fig. 1), at a height of about 2.10 m from the ground; to avoid the effects of soil reflectivity and water evaporation.

## 3. Field surveys

According to Angers (1997), the researcher has a range of methods at his or her disposal to conduct research; there are three typical methods:

1- The historical method, has as its object the phenomena of the past which it seeks to reconstruct in order to study and understand them; its means of evaluation are internal and external criticism.

2- The experimental, method takes measurable phenomena as its object and aims to establish a causal relationship; it must be said that "it is the natural sciences that are at the origin of this method".

3- The survey method, which is carried out by means of several investigative techniques designed according to rigorous plans. This procedure is mainly concerned with population phenomena and makes it possible to study the behavior, attitudes and opinions of this population.

Through various techniques, the field survey makes it possible to collect useful information that should help the investigator to answer his or her questions and verify his or her hypotheses (GASPARD, 2019).

Constructing a sample for qualitative surveys must combine both rigour, based on principles to be respected in order to define the audiences to be surveyed, and pragmatism in order to obtain the names of people from sources that are rarely exhaustive and up-to-date (FACI, 2021). The semi-directive interview, which is based on the individual interview between the investigator and the respondent, was applied; thus, a specific part was devoted to group interviews, called collective interviews.

In order to inventory the practices of control of Boufaroua, applied in Tolga, farmers aged over 60 years were contacted; the choice of this age category is to identify ancestral practices. The field survey was carried out during the period from 21 February to 28 September 2021; where 25 farmers were contacted, representing 35.71 % of the sample targeted by this study. In the year 2021, the structure of the farmers' affiliation (Chamber of Agriculture of the Wilaya of Biskra) counted 70 registered farmers aged over 60 years and, at the same time, specialized in date production.

## 4. Satellite image processing

In recent years, remote sensing techniques have been advanced and varied their estimation to make it a more effective tool for monitoring soil moisture index (SMI) and other related variables such as land surface temperature (LST) and normalized difference vegetation index (NDVI) (TAJUDIN et al., 2021).

Landsat 8 images (Path 136, Row: 94) were selected based on the climatology of rainfall and the availability of cloud free satellite images; the selected images are those of 19 May, 22 July and 23 August 2021.

### 4.1. Radiometric and atmospheric calibration

The radiometric is a necessary step before satellite images processing, normalization unifies spectral information into the same metric system (BIDAY and BHOSLE, 2010). According to Fraser et al. (2005), there are many approaches to obtain radiometric correction, a set of methods for calibrating images to standard reflectance units using atmospheric radiation, calibration attempts to compensate for radiometric errors against sensor faults, scan angle variations and system noise to produce an image that represents true spectral radiation at the sensor.

For atmospheric calibration, Fast Line-of-sight Atmospheric Analysis of Hypercubes (FLAASH) is a first-principle atmospheric correction tool that corrects wavelengths in the visible infrared to near-infrared and shortwave regions, up to 3. FLAASH works with most hyperspectral and multispectral sensors. Water vapor and aerosol recovery is only possible when the image contains bands in appropriate wavelength positions. This tool can correct collected images in vertical or tilted viewing geometries; FLAASH-IDL is commercially available as an add-on to the popular Environment for Image Visualization (ENVI) software sold by ITT Exelis Visual Information Solutions (PERKINS et al., 2012).

### 4.2. Land surface temperature estimation

The extraction of the land surface temperature by remote sensing often uses thermal bands; thermal infrared remote sensing consists of measuring the radiative energy emitted by the earth's surface, which makes it possible to deduce the surface temperature, the sensors measure a spectral luminance linked to the surface temperature by Planck's law.

The method used is based on normalized and standardized vegetation index (NDVI) thresholds by converting digital numbers of thermal bands into radiance and then converting spectral radiance into brightness temperature using the thermal constants provided in the metadata file (BALEW & KORME, 2020):

$$BT = K2 \,/\, \ln\left(\frac{K1}{l} + 1\right) \quad (1)$$

Where:
BT : is brightness temperature,
ln : is the Log number,
$l$ : is the spectral radiance (Watts / $m^2$ * srad * µm),
K1 and K2 are given constants according to the satellite captor:
K1 = 1321.08 (band10), 1201.14 (band11),
K2 = 777.89 (band 10), 480.980 (band11).
The land surface temperature is calculated using the equation:

$$ST = BT \,/\, 1 + w * (BT \,/\, P) * ln\,(e) \quad (2)$$

Where:
*BT* = satellite temperature,
*w* = the wavelength of the emitted radiance 11.5 µm,
*P* = h*c/s
*h* : is plank constant h (6.626*$10^{-34}$ $m^2$ kg/s),
*s* : Boltzmann constant (1.38*$10^{-23}$ $m^2$ kg $s^{-2}$ $K^{-1}$),
*c* : the speed velocity (2.998*$10^8$ m/s),
P = 14380,
*e* : the emissivity of the earth's surface, e = 0.004 PV + 0.986,
PV : proportion of vegetation; PV = (NDVI – NDVImin / NDVImax – NDVImin)

$$NDVI = (NIR - R) / (NIR + R) \quad (3)$$

NIR : near infrared band,
R : red band,
NDVImax and NDVImin are the maximal and the minimal values of NDVI.

### 4.3. Soil moisture estimation

Remote sensing techniques provide a continuous estimate of soil moisture for a large area. For this case study, the soil moisture index was obtained after processing of Landsat 8 images, the scenes were downloaded using USGS Earth Explorer website. Soil moisture estimates refer to near-surface soil moisture (NSSM), which characterizes the top 5 cm or less of the topsoil profile.

According to Tajudin et al. (2021), soil moisture index (SMI) is calculated:

$$SMI = (LSTmax - LST) / (LSTmax - LSTmin) \quad (4)$$

Where: LST is the land surface temperature.

LSTmax and LSTmin are the maximum and the minimum values of the land surface temperature.

## Results

### 1. Period of appearance of the Boufaroua

The fortnightly outings between February and October 2021 allowed us to determine the approximate dates of the increasing prevalence of Boufaroua. The two major outbreaks of this pest were observed from the second dekad of June and the first dekad of August (Fig. 2). However, a small proliferation was recorded at the end of September, but it did not cause much damage.

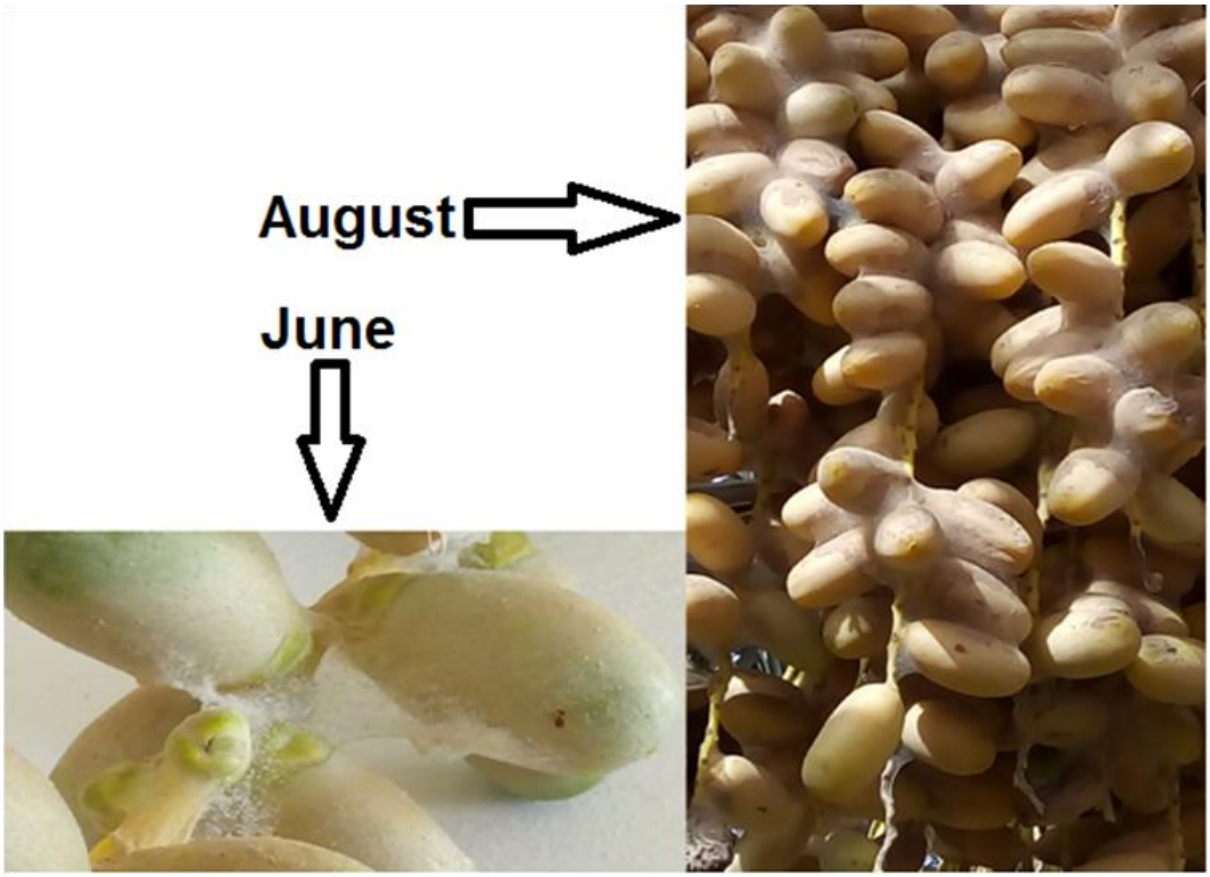


Figure 2 - Installation of webs of Boufaroua on dates (photo credit: Mohammed FACI, 2021).

### 2. Installation of the Boufaroua

Generally, *Oligonychus afrasiaticus* settles on bordering palms, exposed to wind and dust, and on halophytic plants. In winter, it settles on the horns of the upper Lif and on the apical bud; while in summer, it is on date bunches. It prefers green (unripe) bunches and parthenocarpic and/or desiccated fruits from the previous year.

Often, this mite attacks semi-soft cultivars; but in 2021, it attacked even soft (Tantbouchet, Lahloua, Tinicine, etc.) and dry cultivars (like Degla Beidha).

### 3. Changes in air temperature and relative humidity

According to the data recorded inside the Tolga palm grove, a potential date production center, during the period from March 2021 to February 2022, the average monthly air temperature varies between 10.5 °C, in the month of January 2022, and 36.4 °C during the months of July and August 2021 (Fig. 3); while the relative air humidity varies between 24.1 % (July 2021) and 60.9 % (November 2021).

Thermo-hygrometric records show that during the fruiting stage of the date palm in Tolga, from April to October, the average monthly air temperature fluctuates between 22.5 and 36.4 °C; this is the period when the highest temperatures of the year are recorded (the daily data varies between 19 and 36 °C for minimums and between 23 and 46.3 °C for maximums). On the other hand, during this same period, the lowest humidity levels are recorded; from 24.1 % in July to 45.4 % in October (6.2 % as the minimum daily value and 80.2 %, the highest daily value).

Generally, during the period of ripening of dates, the average temperature is above 30 °C (over 36 °C during July and August) and the air humidity is below 35 %. This air temperature threshold has been recorded in other areas of this study region (FACI, 2022).

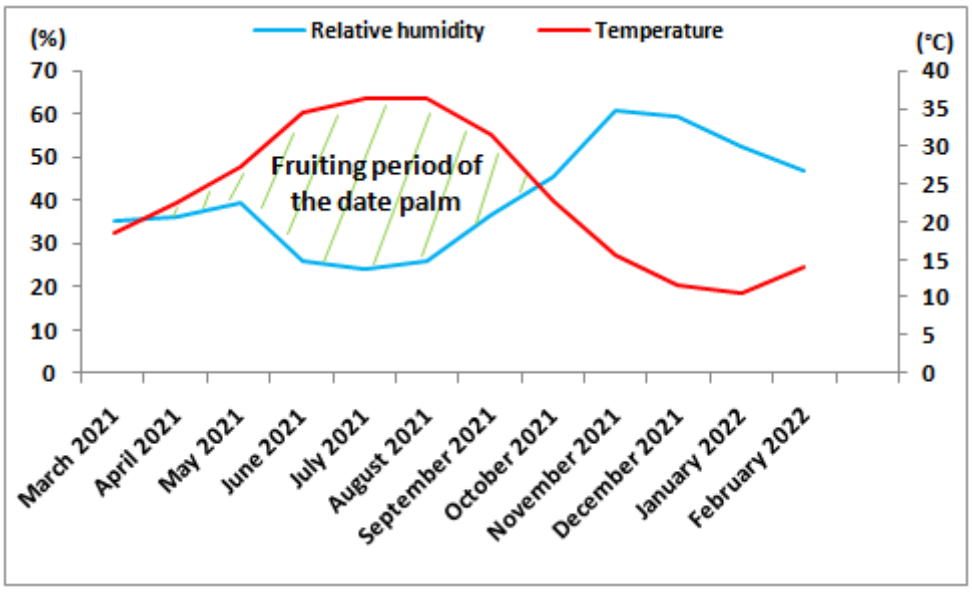


Figure 3 - Monthly evolution of temperature and relative air humidity in the Tolga palm grove (March 2021 – February 2022).

Several authors (GUESSOUM, 1986; OUDA IBRAHIM and ZAID, 2019; CHAKER et al., 2020) agree that the Boufaroua mite needs about two weeks to reach the adult stage; therefore, the averages of the 15 days preceding the start of the two waves of the mite's spread are (Fig. 4):

- first wave (from 15 June 2021); minimum temperature 26.97 °C, maximum temperature 35.73 °C and relative humidity 34.63 %.
- second wave (from 05 August 2021); minimum temperatures were 31.76 °C, maximum 41.38 °C, while humidity was 24.58 %.

The thermal amplitude (the difference between maximum and minimum temperatures) was 8.76 °C for the 02 weeks prior to the first wave of this tiny spider's spread, and 9.73 °C for the August 2021 wave (Table 1).

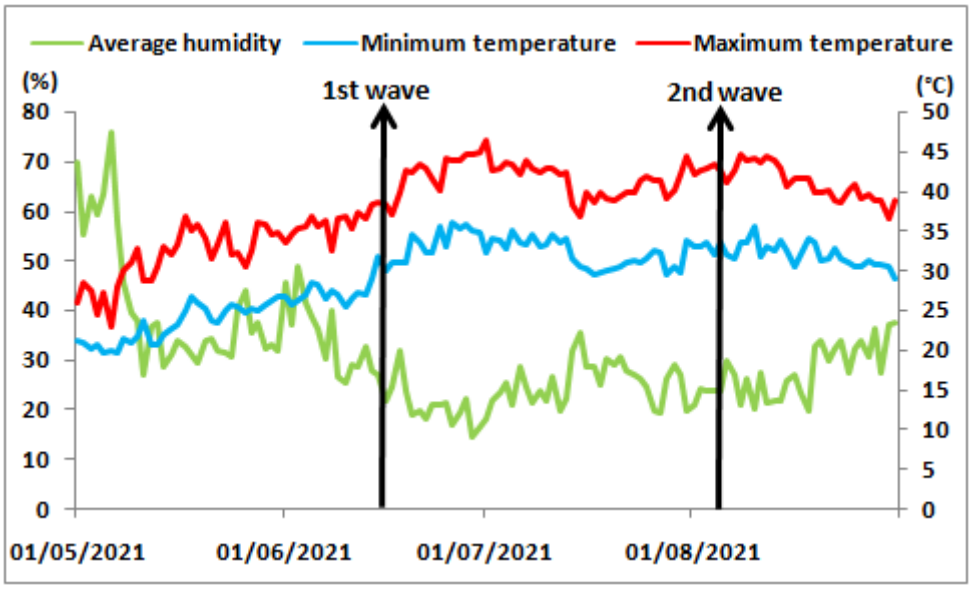


Figure 4 - Daily evolution of temperature and relative air humidity during the period of the Boufaroua propagation in Tolga (May 2021 – August 2021).

Table 1 - Thermal amplitude during the two weeks prior to the spread of the Boufaroua in Tolga, in the year 2021 (in °C).

| Dates | Diference | Dates | Diference |
|---|---|---|---|
| 31/05/2021 | 8.2 | 22/07/2021 | 8.9 |
| 01/06/2021 | 6.9 | 23/07/2021 | 8.6 |
| 02/06/2021 | 9 | 24/07/2021 | 10.2 |
| 03/06/2021 | 9 | 25/07/2021 | 10.3 |
| 04/06/2021 | 8.6 | 26/07/2021 | 8.8 |
| 05/06/2021 | 8.3 | 27/07/2021 | 9 |
| 06/06/2021 | 7.4 | 28/07/2021 | 9.6 |
| 07/06/2021 | 10 | 29/07/2021 | 9.6 |
| 08/06/2021 | 5.2 | 30/07/2021 | 12.2 |
| 09/06/2021 | 9.6 | 31/07/2021 | 10.7 |
| 10/06/2021 | 11.4 | 01/08/2021 | 9 |
| 11/06/2021 | 9 | 02/08/2021 | 9.4 |
| 12/06/2021 | 10 | 03/08/2021 | 9.3 |
| 13/06/2021 | 9.6 | 04/08/2021 | 11.3 |
| 14/06/2021 | 9.2 | 05/08/2021 | 9.1 |

## 4. Estimation of surface temperature and soil moisture

In May 2021, the low surface temperature class ranged between 28.9 to 33.8 °C and occupied 5717.5 hectars, mainly in areas covered by date palm and agricultural lands, medium temperatures class ranged between 33 °C and 39 °C and occupied nearly 22597 hectares. On the peripheral area of agricultural lands, high temperatures ranged between 39.3 °C and 44.8 °C, on bare ground, where vegetation is sparse, and on rocky outcrops. During the same period, low soil moisture values varied between 0.11 and 0.16 , on bare soils outside the agricultural lands, and occupied 9379.5 ha (nearly 22 % of the study area), medium values ranged between 0.27 and 0.41,

on rangelands and peripheral agricultural lands. High values are between 0.42 to 0.55 and occupy 17.62 % of the study area, these values represent palm trees and irrigated agricultural lands.

In July 2021, the low-temperature class values raised to range between 32.8 °C and 35 °C and occupied 5712 ha of palm trees and vegetation cover, the medium temperature class ranged between 35 to 40.1 °C and occupied nearly 22584 ha, and high temperatures ranged between 40.1 °C and 42.6 °C on bare soils and also on the peripheral areas of agricultural lands. The moisture values raised vary between 0.25 to 0.44 for low values, while medium values increased to vary between 0.45 and 0.61, these classes occupied 23578.25 ha, and high values increased up to 0.62 and 0.78 and occupied 14.38 % of the study area.

In August 2021, The low-temperature class values raised significantly to range between 37 °C and 40.3 °C and occupied 6584.3, the medium temperature class raised to range between 40.3 to 42.1 °C and occupied nearly 22514 ha, and high temperatures ranged between 43.6 °C and 47.4 °C on bare soils and also on the peripheral areas of agricultural lands. The soil humidity raised significantly and clearly, value classes raised to 0.62 to 0.99 for the highest values and occupied 8419 hectares.

Generally, the processing of freely available satellite images, prior to the appearance of Boufaroua in the Tolga region, revealed (Fig. 5):

- the surface temperature is higher outside the palm grove than inside it, reaching up to 47.45 °C on 23 August 2021.
- the difference between the temperatures recorded inside and outside the palm grove varies between 9.79 and 15.90 °C.
- temperatures inside the palm grove were higher than 28.89 °C during the day of 19 May, 32.85 °C on 22 July and 37.03 °C on 23 August.
- the soil was wetter on 23 August 2021 compared to the 19 May; however, on 22 July the soil was drier.

## 5. Results of the survey

### 5.1. Evolution of the Boufaroua in Tolga

Farmers interviewed during the field survey stated that the occurrence of this date pest was very limited in the past. From the beginning of this millennium, the spread of Boufaroua became more noticeable, but without the recording of significant damage. In contrast, in the year 2021, the spread of this pest was very noticeable and the damage was more severe.

According to our interlocutors, the expansion of this pest is the consequence of:

- lack of maintenance inside the palm groves and invasion of weeds,
- absence of the palm toilet,
- recording of high air temperatures,
- lack of rainfall,
- recording of long-duration drought sequences,
- low-rate relative air humidity inside palm groves,
- installation of agricultural greenhouses (plasticulture) throughout the year,
- dust, accentuated especially by the development of the road network.

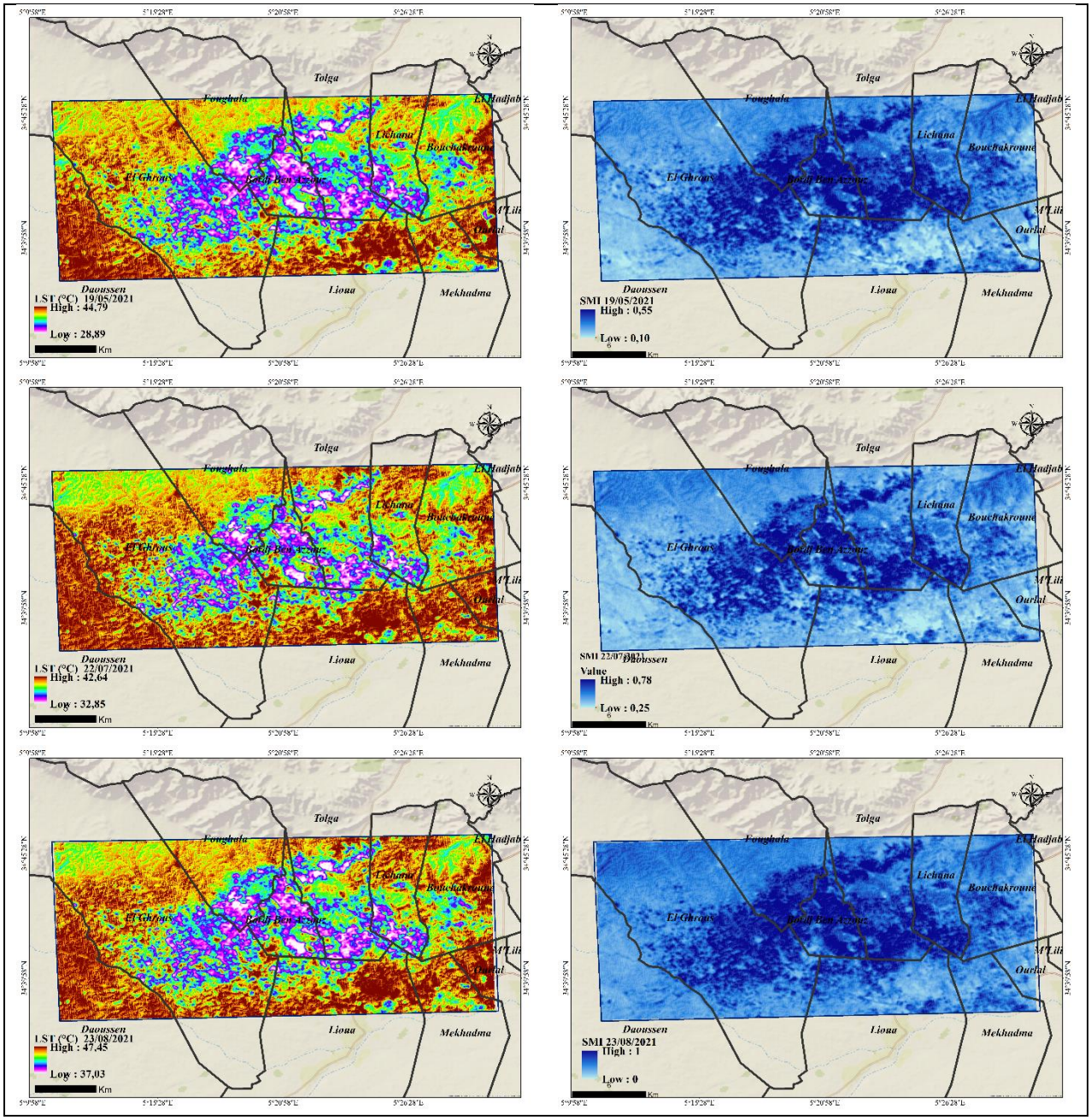


Figure 5 - Estimation of surface temperature and soil moisture before the multiplication of Boufaroua in the Tolga region in 2021.

### 5.2. Fight against Boufaroua

According to the results of the field survey, two types of control of Boufaroua are applied in the Tolga palm grove:

*a- Preventive fight*

The National Institute for Plant Protection (NIPP) is the government agency responsible for preventive control of Boufaroua and uses a mixture of lime and sulphur. Unfortunately, farmers reported that the spraying was applied after the web of this mite had settled on the date bunches. However, it should be noted that farmers in the Tolga region did not carry out preventive control; they were waiting for state intervention.

*b- Curative fight*

This control is applied after the installation of the Boufaroua cloth on the first date bunches; farmers resort either to the:

- *Chemical fight*

If the spread of the pest is important on the bunches, farmers resort to the use of anti-mite plant protection products. During the study, some farmers were using non-mite control products such as insecticides; the main thing for them is to use a plant protection product.

- *Traditional or ancestral wrestling*

These methods are still used today by some farmers:

- smoke, farmers light fires using weeds and date palm waste; while others add sulphur or DDT (dichlorodiphenyltrichloroethane) to the above components.
- washing of attacked diets with water.
- cutting off infected branches and/or date bunches.
- the use of ash powder, scattered directly on the bunches attacked by Boufaroua, while other farmers add lime to the ash.
- a mixture of lime and sulphur (2/3 lime + 1/3 sulphur); the majority use the mixture in powder form, while a minority use it in liquid form.
- the rainfall, they waited for the heavy rains of August and September to wash out the diets.

- *Local struggle*

These practices are recently applied by a limited number of farmers:

- FLY-TOX (household insecticide), used when pest attacks are very limited.
- bleach (an oxidizing liquid solution used as a household disinfectant) diluted in a quantity of water, while some farmers add household detergents (liquid or powder) to the above mixture.
- powdery mixture of ash and sulphur.

**Discussion**

During the date palm fruiting period in Tolga, from the end of March to the end of October 2021, the highest air temperatures of the year (up to 46.3 °C, on 1 July 2021) and the lowest air humidity levels (6.2 %, on 12 August 2021) were recorded. During this date-growing period, two major waves of spread of *Oligonychus afrasiaticus* were recorded; the first from the second dekad of June and the second from the first dekad of August.

Generally, in spring Boufaroua activity increases rapidly; it is found on several weeds surrounding the palms with egg clusters, as well as on various market garden crops grown. Sometimes it poses a danger to these underlying crops where it multiplies and subsequently migrates to the date palm to settle on the fruit; from May onwards, attacks can occur as early as the fruit set stage and continue throughout the fruit enlargement stage. The mites feed by sucking sap from the plant tissue of dates (GUESSOUM, 1986; NIPP, 2022a).

About twenty generations can occur during the year, but the strongest outbreaks are observed from May to July. During June, Boufaroua is very abundant and can cause the destruction of entire bunches, especially during the sirocco period. The outbreak of this mite is linked to the climatic characteristics of the year, particularly high temperatures, low humidity percentages, wind direction and speed. If at the beginning of the summer (date growth stage), the temperature is high, the date production will fall prey to these mites which will strongly depreciate the quality of dates. The receptive stage of the date to the attacks of the Boufaroua (fattening of the fruit) lasts from 06 to 07 weeks approximately, according to the climatic conditions (mainly the temperature); as of the

beginning of the maturity of the dates, the mite migrates towards other sites and reappears only the next year (GUESSOUM, 1986; NIPP, 2022b).

The average air temperature recorded during the two weeks preceding the first wave of the pest's spread in Tolga, in the year 2021, was 31.35 °C; while during the second wave, it was 36.56 °C. The relative humidity was 34.63 % for the first wave and 24.58 % for the second wave. Sedra (2003), reported that the climatic conditions favorable to the development of this mite are an average air temperature of 20-25 °C and a very low relative air humidity (65-75 %); in contrast, in the region of the present study, average temperatures above 31 °C and humidity levels below 35 % allowed rapid multiplication of Boufaroua. A harmonization was noted before the expansion of this pest, between temperature and humidity; where a successive upward trend was recorded for air temperatures and a continuous decrease for relative air humidity.

In the Tolga region, farmers did not apply preventive control of Boufaroua, although the danger of this mite requires intensified efforts to contain its negative effects. The farmers in the study area relied on the interventions of public institutions. In Algeria, the intervention units of the National Institute for Plant Protection (NIPP) will contribute to the treatment of 800,000 date palms, young investors' companies will treat (on behalf of the NIPP) 1.4 million palms, while farmers will treat nearly two (02) million palm trees (RA, 2022). These interventions consist of applying powdered sulphur mixed with lime in order to facilitate the spreading of the product at a rate of 1/3 sulphur and 2/3 lime. Treatments should be carried out whenever outbreaks occur. The powdering should be done on the bunches and the heart of the palm tree (GUESSOUM, 1986).

In case of Boufaroua outbreaks inside the gardens, farmers use Abamectin-based acaricides; whereas a minority of the farmers contacted declared the use of insecticides. According to Guessoum (1986), the use of the latter phytosanitary products can aggravate the situation, especially as mites are in a group that is very prone to habituation and resistance to chemical products. They may even have toxic effects on predators. The different control methods, especially chemical, applied in palm groves to fight against this pest have not given the expected results, on the contrary the abusive use of pesticides (acaricides) has caused disturbances at different levels, several inconveniences have been noted after the use of these synthetic phytosanitary products (BABAZ et al., 2020).

Traditional control of Boufaroua, originating from the ancestors, is still applied in the Tolga palm groves, but on a limited scale; in small farms or gardens where attacks are limited. The effectiveness of these practices is not well studied.

Although the new control practices, called in this manuscript (local struggle), are rarely used, they risk deteriorating the quality of dates and even causing consequences for consumers, because the products used are, generally, detergents. Therefore, it is essential to stop using these methods.

In order to minimize the outbreak of this tiny spider, palms and palm groves should be well maintained, host plants and unfertilized dates should be removed, and acaricide treatments should be applied regularly to underlying crops that may harbour this mite. Thus, make a preventive treatment after the fruit set to avoid the installation of the mite on the young fruits, improve the daily surveillance at the level of the palm groves during the strong heats and intervene quickly to avoid the generalization of the attack. In addition, irrigation and balanced nutrition should be applied (GUESSOUM, 1986; NIPP, 2022a).

## Conclusions

This study, which aimed at monitoring the evolution of *Oligonychus afrasiaticus* in the region of Tolga in the South-East of Algeria, in the year 2021, through regular observation and prospection field trips, allowed to record the periods of pullulation of Boufaroua. Two large waves of propagation of this mite were noted; the first, from the second dekad of June and the second during the first dekad of August, causing considerable damage. A third wave of expansion was recorded towards the end of September and the beginning of October, but without damaging date production. In addition to semi-soft cultivars, this mite attacked, during the year of this study, soft and dry cultivars.

The rapid multiplication of Boufaroua begins after the recording of a continuous upward trend in air temperatures, accompanied by a downward trend in relative air humidity. During the first wave of the mite's spread, the average temperature varied between 30 and 33.6 °C, while humidity was between 35.2 and 48.9 %; during the August wave, the temperature was higher (36.8 to 40.1 °C) and humidity lower (14.4 to 25.4 %).

During the 2-4 weeks prior to the spread of this tiny mite, soil moisture was low and surface temperatures were high in the Tolga area. The difference between the surface temperatures recorded outside the palm grove and those inside could exceed 15 °C.

Field surveys conducted with farmers over 60 years old (25 farmers), revealed that farmers did not apply preventive treatments against Boufaroua; they relied on the control carried out by the government agency (National Institute for Plant Protection). According to the respondents, the NIPP applies this control after the first outbreaks of this tiny spider.

Farmers in the Tolga region apply curative controls, just after the first webs of Boufaroua appear on the date bunches; generally, these are chemical treatments (based on Abamectin), in a number of 3 to 5 treatments. Nevertheless, some farmers use non-specific plant protection products, such as insecticides.

A part of the farmers apply traditional methods to fight this date mite, while a minority of them use detergents to fight this date pest; but, the latter products can degrade the quality of dates and present a serious threat to the health of consumers.

Thus, we recommend that *i)* the NIPP apply preventive pest control during the appropriate periods, starting in month of May, *ii)* that farmers apply preventive pest control without waiting for state intervention, *iii)* the maintenance of plant gardens and date palms, and *iv)* the use of appropriate phytosanitary products in case of curative pest control.

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## Conflicts of interest

There were no conflicts of interest for the authors.

## Authors' contribution

Mohammed Faci – data collection, monitoring and field surveys, paper writing; Meriem Boultif – mapping, writing and interpretation of map results; Mohamed Elhadi Matallah – data collection; Billal Nia – discussion; Mohammed Mesnoua – discussion.

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