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# Effects of host plants on distribution, abundance, developmental time and life table parameters of *Oligonychus afrasiaticus* (McGregor) (Acari: Tetranychidae)

Sameh Ben Chaaban[1,3]
Brahim Chermiti[1,4]
Serge Kreiter[2,5]

## ABSTRACT

*The biology and ecology of the date palm mite* O. afrasiaticus *have been studied through regular inspection in Tunisian oases and laboratory observations. Results indicate that the start date of fruit infestation varied between years and by date palm variety. Start dates ranged from the first week to the third week of July. The period spent by the mite on fruits varied from one variety to another; lasting 8 weeks on the Deglet Noor variety, 2 to 5 weeks on Alig, 2 to 4 weeks on Kentichi dates, and 2 to 4 weeks on Bessr fruits. The Deglet Noor variety was the most susceptible to* O. afrasiaticus. *Mite populations on the pinnae remained low from May through December. During autumn and spring,* O. afrasiaticus *was found on sorghum leaves in the orchard ground-cover. A life table study in the laboratory at 27°C on six host plants (fruits of date palms varieties Deglet Noor, Alig, Kentichi, Bessr, and Deglet Noor pinnae and sorghum leaves) showed that the life cycle of* O. afrasiaticus *differed among host plants with average values ranging between 13 on Alig fruits and 10.9 days on sorghum leaves. Relatively high fecundity was found on sorghum leaves (2 eggs/female/day) during 5.2 oviposition days, while low fecundity values occurred on Deglet Noor pinnae and Alig fruits with 0.7 eggs/female/day during 5.4 days. Average longevity of* O. afrasiaticus *females ranged from 13.4 to 7.5 days on Deglet Noor fruits and sorghum leaves, respectively. Intrinsic rate of increase* ($r_m$) *was highest on sorghum leaves (0.171) and Deglet Noor fruits (0.166), and lowest on Alig fruits (0.103). Greater knowledge of life history traits and seasonal abundance of this species is needed in order to design appropriate control strategies.*

Key-Words: Intrinsic rate of increase *($r_m$);* Date palm; Southern Tunisia; Deglet Noor; Seasonal abundance.

1. Institut Supérieur des Sciences Agronomiques de Chott-Mariam, Département de Protection des Plantes, Laboratoire de Zoologie Agricole, 4042 Sousse, Tunisie.
2. Montpellier SupAgro, UMR CBGP, bâtiment 16, 2 Place Pierre Viala, 34060 Montpellier cedex 01, France.
3. Corresponding author and e-mail: samah_bchaaban@yahoo.fr
4. E-mail: chermiti.ibrahim@iresa.agrinet.tn
5. E-mail: kreiter@supagro.inra.fr

## INTRODUCTION

The date palm mite *Oligonychus afrasiaticus* (McGregor) (Acari: Tetranychidae), is a serious pest of date palm fruits. It is present in all date-growing areas in the Middle East: Mauritania (Caudin & Galvez, 1976), Algeria (Guessoum, 1986), Libya (Edongali *et al.,* 1988), Egypt (Saleh & Hosny, 1979), Tunisia (Dhouibi, 1991), Saudi Arabia (Talhouk, 1991), Oman (Elwan, 2000), Iraq (Hussain, 1969), Jordan (Palevsky *et al.,* 2004), Israel (Palevsky *et al.,* 2003), Iran (Kadjbaf Vala & Kamali, 1993) and Yemen (Baankoud & Basahih, 2000).

Immediately after fruit set, mite start its oviposition activity, laid eggs hatch into larvae, which feed on the fruits that are later covered with a web retaining fine particles (Hussain, 1974). Feeding on the immature green dates causes severe fruit scarring, sometimes so badly that the dates turn brown and have a scabbed appearance. The skin of infested fruit becomes hard, then cracks, and shrivels, reducing the grade of the fruit resulting in subsequent economic yield. In Algeria in 1981, 30 to 70% of dates were discarded (Guessoum, 1986). In Mauritania, annually production was reported as unmarketable on 70% of infested trees (De Montaigne & Mouloud, 1986).

In Tunisia, *O. afrasiaticus* is classified as one of the four major pests of date palm trees. When present, it can cause very serious damage to fruits (Dhouibi, 1991; Khoualdia *et al.,* 1997).

Dates mature through four stages during which color, flavor and texture change. The first stage, Kimri, is an inedible green fruit which then develops into a yellow glossy stage called Khalal, and then to a soft brown stage early ripe named Rutab. The final stage is dark brown and fully ripe known as Tamar (Dowson & Aten, 1962).

The infestation of *O. afrasiaticus* begins and increases in summer, during the Kimri stage. Mite populations begin to decline at the Khalal stage. Intensity of infestation changes depending on the variety and climatic conditions (Hussain, 1974; Guessoum, 1986; Dhouibi, 1991; Palevsky *et al.,* 2005).

Published information on *O. afrasiaticus* is limited and more information is needed to control effectively this mite. Therefore, bioecological studies of *O. afrasiaticus* were undertaken to document the population dynamics. Data relating to the biological and life table parameters will help to compare susceptibility of different host plants to *O. afrasiaticus* mite.

## MATERIAL AND METHODS

### Study fields

#### Study Area

This study was carried out between 2004 and 2007 in an orchard of 2 ha planted with mixed varieties of date palm trees. This area is located in Segdoud, from the region of Tozeur (Djerid), in southwest Tunisia. Tozeur belongs to the superior bioclimatic Saharan upstairs with a temperate winter. The annual mean temperature is about 21.6°C, while 44°C in August and 2.5°C in January are the absolute maximum and minimum temperatures, respectively. The annual average rainfall is about 96 mm/year.

During the first year of study, four sprays of Sulfur were applied to palm trees of this orchard and as follows on June 22$^{th}$, July 18$^{th}$, July 25$^{th}$ and August 1$^{st}$. In 2005, palm trees received 2 sprays of Sulfur on July 3$^{rd}$ and August 15$^{th}$ however, in 2006 it received 3 sprays of wettable Sulfur respectively, on July 2$^{nd}$, July 24$^{th}$ and August 1$^{st}$. Every year, a quantity 100 to 150 g of Sulfur was used in treatments per palm tree.

### Dynamics and distribution of *O. afrasiaticus* from 2004 to 2006

Fruits and pinnae of Deglet Noor variety and sorghum leaves of plants cultivated under date palms were used to assess seasonal abundance of *O. afrasiaticus.* Samples were weekly collected from 23 May to 10 October in 2004; from 30 April to 25 October in 2005 and from 15 April to 4 November in 2006. Hibernating populations of *O. afrasiaticus* were monitored twice a month during the rest of the years of this study.

In 2007, a detailed and specific census was realized from 1$^{st}$ May to 17$^{th}$ November on the existing field population living on Deglet Noor variety. In fact, to insure the homogeneity of samples inside the orchard palm trees were chosen randomly per 2 trees from each side (North, South, West, and East) and 2 trees from the middle.

The sampling technique consists on taking 10 date fruits and 10 pinnae per palm tree. For pinnae, five young (less than 1 year old) were chosen from the central crown and five old from the base (the oldest fronds). Samples of extracted spider mites, from all habitats (ground cover, fruits and pinnae) were mounted in Hoyer's medium on microscopic slides

and identified using a phase and interferential contrast microscope. The strains were identified and morphologically characterized at Montpellier SupAgro (France).

### Variety susceptibility to *O. afrasiaticus*

In addition to Deglet Noor variety, the susceptibility of Alig, Kentichi and Bessr varieties to *O. afrasiaticus* was assessed, by counting motile stages on dates collected weekly from 15th April to 4th November 2006 and from 1st May to 17th November 2007. Hibernating *O. afrasiaticus* populations were monitored twice a month during the rest of the year. Samples of 10 date fruits were collected from each of ten trees for each cultivar.

Date fruits, sorghum leaves and pinnae were individually placed in plastic bags, kept in an insulated cooler with ice, brought to the laboratory and stored at a temperature of 4°C. On removal samples, motile forms of *O. afrasiaticus* were counted under a stereomicroscope.

### Mite development and life table construction

### Mite cultures

Date palm fruits (var. Deglet Noor) that was well-infested with spider mites *(O. afrasiaticus),* were collected from the Segdoud oases located near Tozeur, Southern Tunisia, in July 2006. With several hundred spider mites of all stages from these dates a stock colony was started on sorghum plants (*Sorghum* sp.).

One month later hundreds of females and males were randomly selected from the laboratory culture and placed together on each of rearing units containing dates of Alig, Bessr, Kentichi and Deglet Noor and on pinnae of Deglet Noor, to lay eggs. The obtained eggs were conserved until they reached maturity and will be used for experiments.

This was done to ensure that mites with which we started the experiments were produced from food that was ingested from the date or leaf type on which we determined the intrinsic rate of increase $(r_m)$. The spider mite populations in the colonies were never below several hundred individuals.

All colonies, were kept in a room at 25 ± 1°C, 62.5 ± 12.5% relative humidity (R.H.) and a 16:8 h (L:D) photoperiod.

### Estimation of *O. afrasiaticus* developmental time

*Oligonychus afrasiaticus* juvenile survival and developmental time of males and females were determined when feeding on fruits of Deglet Noor, Alig, Kentichi, Bessr, and Deglet Noor date palm varieties and on sorghum leaves and Deglet Noor pinnae. Dates and pinnae were collected during the period of Kimri stage.

All experiments were conducted in a climate-controlled room at 27 ± 1°C, 60 ± 10% R.H., and a photoperiod of 16:8 h (L:D). Date Fruits and leaf disks (4 cm) were placed on water saturated foam mat in a plastic tray. Water saturated cotton wool was used to prevent mite escape and maintained leaf freshness. The cotton wool was maintained wet by adding distillate water when necessary.

A few days prior to the starting of the test, for each host plant, fifty Deutonymphal (2nd nymph stage) females were randomly selected from the corresponding colony and were held separately on each date or leaf disc, after that 2 males were added and allowed to mate. After two days, ten mated females were placed together on each of five of date or leaf disc, to lay eggs. An hour later, all females are eliminated and eggs laid during this space of time are counted. This operation was repeated until the getting of 100 eggs. All these eggs have an age known at almost one hour near. After hatching, larvae were reared on fresh experimental units. Before hatching, eggs were observed at 6-h intervals. After the hatching of larvae, continuous daily observations were made at 6:00 AM and 6:00 PM until they reached maturity.

### Estimation of *O. afrasiaticus* reproductive parameters and longevity

Pre-oviposition, oviposition and post-oviposition periods, total fecundity, daily oviposition rate and female longevity were determined on each of the six host plants. For each host plant, 50 deutonymphal (2nd nymph stage) females were randomly selected from the corresponding colony. To ensure mating, two adult males were placed with each newly emerged adult female. Females were confined individually per leaf disk or date fruit and observed daily. The number of eggs deposited by each female was recorded daily until all the females died. The eggs obtained from each female were cultured to determine their hatchability. Pre-oviposition period was recorded at 6-h intervals, while other reproductive parameters and longevity were recorded every 12 h. Dates and leaf disks were removed and replaced by new ones at 2-day intervals.

### Sex ratio

Sex ratio is described as the proportion of females in the progeny. We evaluated sex ratio of twenty *O. afrasiaticus* females, for each host plant. The method was the same as that used for oviposition, except that females were placed on a new leaf disc every day and discs with eggs were maintained under the same experimental conditions as for females. The sex ratio was determined on the basis of a count of adults originating from those eggs. Unmated females, i.e. producing only males, were not taken into account.

### Life tables

The life table was constructed considering the females cohort studied. The net reproductive rate (Ro), the mean generation time *(T),* the intrinsic rate of natural increase *($r_m$),* the doubling time *($D_t$),* and the finite rate of increase (λ) were calculated using the method recommended by Birch (1948):

$$1 = \sum_{X=0}^{K} e^{-r_m x}(l_x m_x)$$

With x pivotal age, lx number surviving to age x, $m_x$ age-specific fecundity

- Ro = Σ lx.mx
- $r_m$ = ln(Ro)/T
- $D_t$ = ln 2/$r_m$
- $T$ = ln Ro/$r_m$
- λ = $e^{-rm}$

### Statistical analysis

Data on developmental time, duration of female reproductive periods and fecundity were analyzed using one-way ANOVA followed by the Sheffe test ($P$ = 0.01) to compare data means. Differences in sex ratio were analyzed by a Khi square ($\lambda^2$) test. The statistical analysis was done by the statistical software SPSS 10 (Statistical Package for the Social Sciences version 10).

## RESULTS AND DISCUSSION

### Field study

### Dynamics and distribution of *O. afrasiaticus* from 2004 to 2006

During the years 2004-2006 (Fig. 1), *O. afrasiaticus* on Deglet Noor fruits were first observed between

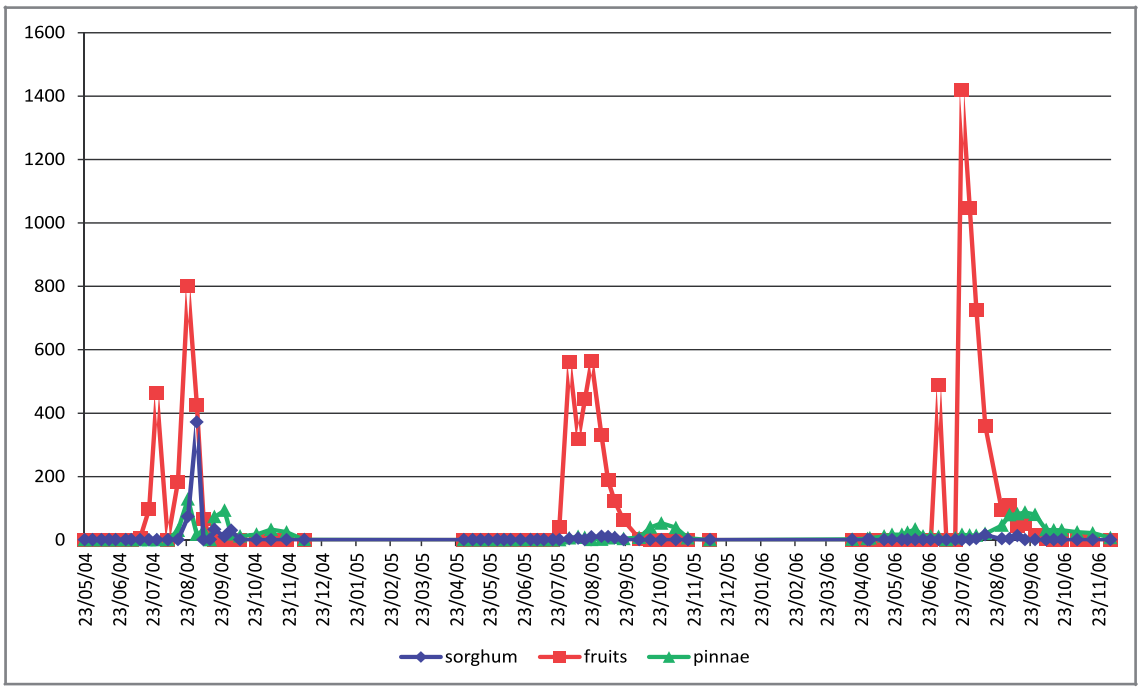


**FIGURE 1:** Seasonal fluctuations of *O. afrasiaticus* densities on Deglet Noor pinnae and fruits and on sorghum leave, at Segdoud, South of Tunisia in 2004-2006.

the beginning and the mid-July. It is important to mention that spider mite density increased rapidly in July and August, their levels exceeding 1400 mites per 100 fruit in 2006. This period coincided to the Kimri stage, characterized by the green color of fruit, rapid increase in size, weight, and reducing sugars. At this stage, moisture content and acid activity are at the highest (Barreveld, 1993; Palevsky *et al.,* 2005; Aldosari & Ali, 2007; Ben Chaaban & Chermiti, 2009). Registered results showed that the presence of *O. afrasiaticus* population's on pinnae in the summer months, was with a low densities (< 20 motile forms/100 pinnae). On the ground cover, *O. afrasiaticus* was found at detectable densities on Sorghum leaves from mid August, (Fig. 1). In Tozeur, the monthly mean temperatures in July and August are 32°C.

At the end of August, field experiments indicated that the *O. afrasiaticus* population levels began to decline with color change of fruit to yellow at the Khalal stage, when the weight gain is slow but sucrose content increases, moisture content goes down, and tannins start to precipitate and lose their astringency (Barreveld, 1993). Recent studies, demonstrated that decreased in water content with elevated sugar contents at Khalal stage, render the date extremely resistant to *O. afrasiaticus* (Palevsky *et al.,* 2005; Aldosari & Ali, 2007; Ben Chaaban & Chermiti, 2009).

In September and October, the monthly mean temperature is about 27°C. Over this time period, the absence of mites in the fruit dates coincided with its apparition on fronds. Individuals of *O. afrasiaticus* were also founded on the ground-cover essentially on sorghum plants; in 2004 its levels reached 370 motile forms per 100 leaves. In winter season, extremely low populations of *O. afrasiaticus* were detected on the fronds and on sorghum leaves.

In April-May of spring 2005 and 2006, mite populations were detected in the ground-cover, before being seen on the fruits. The monthly mean temperature during this period is about 27°. A previous study of the effect of fruit maturity on susceptibility to infestation by *O. afrasiaticus* (Ben Chaaban & Chermiti, 2009) showed that mite establishment on the Deglet Noor began only when the water content of the fruit increased to 86%. The mite appearance on Deglet Noor coincides with the decrease of fruit acidity from 2.2 mEq/100 g at the third week of June to 0.4 mEq/100 g in the beginning of July. The restricted sugar level during the week of June on fruits prevented *O. afrasiaticus* establishment.

It was clear from those results that excessive dry and greater heat seasons in July and August favor *O. afrasiaticus* populations on Deglet Noor fruits, though sulfur use. Spider mite populations often reach higher densities under hot and dry conditions (Van de Vrie *et al.,* 1972). The results of our research offer strong confirmation to a previous laboratory study done to compare demographic parameters of *O. afrasiaticus* on different host plants at 32°C. Deglet Noor dates were found to be very suitable for mite population development, nevertheless sorghum leaves were less susceptible and pinnae were resistant to *O. afrasiaticus* invasion (Ben Chaaban *et al.,* 2008).

Our data indicate that *O. afrasiaticus* responds to the variation of fruits phenology and to the decrease of temperature, by leaving dates bunches and migrating to the palm crown and ground cover on sorghum leaves. Literature demonstrated that the dust mite migrates to rejections, fibers, palms, inflorescence, male date palms and infertile date palms, on grasses as *Cynodon dactylon* L. and *Lolium* sp (Lepesme, 1947; Hussain, 1969; Dhouibi, 1991; Guessoum, 1986; Palevsky *et al.,* 2003). Met also on cucumber, watermelon, fig, grapevine (Guessoum, 1986). The initiation of dispersal phase of tetranychid mites appears to be a response to food shortage (Helle & Sabelis, 1985). In effect seasonal declining of *O. afrasiaticus* populations on date palm fruits seems to be a phenomenon occurring everywhere independent of climatical or geographical zones. It has been noted from USA (Mauk *et al.,* 2005), Middle East (Palevsky *et al.,* 2005; Hussain, 1974; Talhouk, 1991) and North Africa (Khoualdia *et al.,* 2001; Guessoum, 1986). It is often related to changes in chemical composition of dates (Palevsky *et al.,* 2005; Ben Chaaban & Chermiti, 2009).

**Variety susceptibility to *O. afrasiaticus***

Comparison of seasonal fluctuation of selected date palm varieties showed significant and quantifiable differences in susceptibility to *O. afrasiaticus* feeding activity (Fig. 2). In fact, Deglet Noor variety appeared to be the most sensitive to *O. afrasiaticus* attacks; on this variety mite populations were detected on field between early July and September. However, for the other present varieties colonization by this mite may occur late on the second week of July and the stress caused to the plant by this infestation can be judged as intermediate on Alig, Bessr and Kentichi varieties which were qualified as more resistant.

Maximum of *O. afrasiaticus* motile forms on Deglet Noor dates were approximately 1.7 and 7.5 times more abundant than on Bessr and Kentichi, respectively. The period spent by the mite on fruit dates varied from a variety to another in fact it was

of 8 weeks on Deglet Noor variety, 2 to 5 weeks on Alig, 2 to 4 weeks on Kentichi dates for and 2 to 4 weeks on Bessr dates. Previously findings revealed that performance of *O. afrasiaticus* varied greatly depending on chemical composition of date variety (Ben Chaaban & Chermiti, 2009).

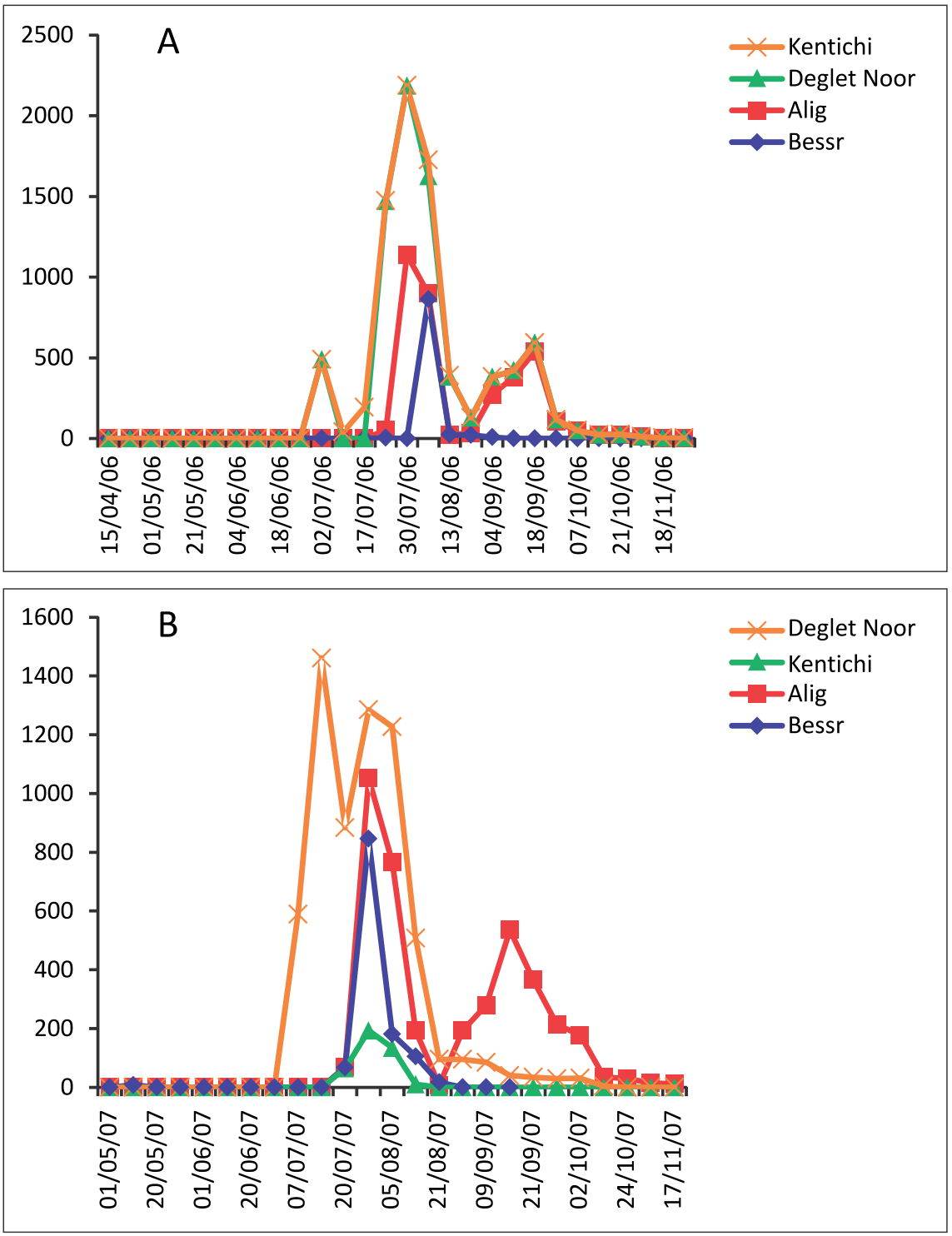


**FIGURE 2:** Densities of *O. afrasiaticus* motile stages, at Segdoud, South of Tunisia, (A) 2006 (B) 2007, on date varieties 'Deglet Noor', 'Alig', 'Bessr', and 'Kentichi'.

Different degrees in susceptibility of date palm varieties to *O. afrasiaticus,* have been reported from several areas. In Gulf area, Hussain (1974) indicated that the Iraqi variety 'Sayer' was relatively resistant to mite attacks. In the Kingdom of Saudi Arabia, date fruit cultivars 'Sokary' and 'Rothan' appeared as highly susceptible to *O. afrasiaticus* contrary to 'Cebiky' cultivar that seems to be resistant, and to the 'Khodary' cultivar that appeared to be moderately resistant to attacks by this mite's specie (Aldosari & Ali, 2007). In Oman the cultivars 'Hilali', 'Gibri' and 'Khanazani' were infested by *O. afrasiaticus* during the month of April, whereas other cultivars were attacked later in the season (Elwan, 2000). In the Middle East (Israel), Palevsky *et al.* (2005) reported that the 'Deglet Noor' cultivar was more targeted than 'Medjool' and 'Barhi' cultivars. In north Africa and specifically in Libya, the varieties 'Asabir', 'Aurig', 'Bestian', 'Apel' and 'Talise' were found to be more attractant and susceptible to this mite than 'Tafsirt' which was found to be less susceptible (Edongali *et al.,* 1988).

## Mite development and life table construction

### Immature development

The total developmental time (egg-adult) of *O. afrasiaticus* females showed significant differences between host plants (Sheffe test, $P < 0.01$; Table 1), indeed on sorghum leaves and Deglet Noor fruits, mites spent respectively 10.9 and 11.1 days to reach adulthood, while on Alig fruits development was approximately two days slower. For males developmental duration, statistical analysis showed significant differences among host plants (Sheffe test, $P < 0.01$; Table 1), the highest means on the development period were registered on Deglet Noor pinnae (11.1), Kentichi (11.1) and Alig (11) against the lowest one registered on sorghum leaves (9.6). The total development duration was significantly longer for females than for males on all host plants (Sheffe test, $P < 0.01$; Table 1). Van de Vrie *et al.* (1972) emphasised the occurrence of the differences between males and females as to development rate. Previous studies had demonstrated cultivar effects on life cycle and population increase of a variety of tetranychid species. For example, the life cycle of *O. punicae* differed among grape cultivars with an average values ranging between 8.2 days on Tucupita leaves and 9.1 days on Sirah (Vásquez *et al.,* 2008). Another example is the developmental time of Amphitetranychus viennensis (Zacher), which was found to be lower when reared on apple cultivars 'Starkrimson Delicious' and 'Golden Delicious' (10.7 days) than on 'Amasya' and 'Starking Delicious' (11.7 days) (Kasap, 2003).

In this study, the rate of immature survival (Table 1) ranged from 81to 94% with the highest registered rate on Deglet Noor fruits (94%). However, for other species like *Oligonychus perseae* survival was significantly different across three avocado cultivars (Kerguelen & Hoddle, 2000).

### Adult female longevity

Periods of pre-oviposition, oviposition and post-oviposition for *O. afrasiaticus* females varied in accordance with alimentary supports. In this study, the longest pre-oviposition and post-oviposition periods were registered respectively, for the Kentichi fruits (2.8 days) and Alig dates (3.2 days); while on others fruits pre and post-oviposition periods ranged from 0.9 to 2 and 1.4 to 2.6 days, respectively (Table 2). The oviposition period was longer on Deglet Noor fruits than on other supports (Sheffe test, $P < 0.01$; Table 2). Add to these results, this study showed that the longevity of female of *O. afrasiaticus* was highly affected by the nature of the host plant, in fact the longest period was registered on Deglet Noor fruits (13.4 days) and the shortest period on sorghum leaves (7.5 days) (Table 2).

Vásquez *et al.* (2008) founded that mean longevity of *O. punicae* was affected by grape cultivar: females lived longest on 'Sauvignon' (17.5 days) and shortest on 'Villanueva' (8.1 days). The mean female *O. perseae* longevity increased by 100% from 12 days in May to 24 days in July in the susceptible avocado cultivar 'Hass', while in more resistant cultivars, 'Pinkerton' and 'Lamb Hass', longevity dropped by 30% over the same period (Kerguelen & Hoddle, 2000).

### Fecundity and hatchability

The total number of eggs laid per female was highest on Deglet Noor fruits and lowest on Bessr fruits (Sheffe test, $P < 0.01$; Table 3). Daily egg production obtained on Alig, Kentichi, and Bessr fruits also on Deglet Noor pinnae were less than one egg per female, while it reached 2 eggs/female on sorghum leaves. The peak of this parameter is reached on day 18 (1.36 eggs/female/day), 16 (1.66 eggs/female/day), 18 (2.4 eggs/female/day), 20 (1.7 eggs/female/day), 16 (1.8 eggs/female/day) and 17 (3.2 eggs/female/day) respectively, on Alig, Bessr, Deglet Noor,

**TABLE 1:** Means (± SD) in days of the development duration of females and males and immature survival of *O. afrasiaticus* at 27°C on several host plants.

| Host plants | *N* | Development duration | | Immature survival (%) |
|---|---|---|---|---|
| | | Female | Male | |
| Deglet Noor | 100 | 11.1 ± 0.9 (64) a | 9.9 ± 0.7 (30) a | 94 |
| Alig | 100 | 13 ± 1 (58) c | 11 ± 0.7 (28) b | 86 |
| Kentichi | 100 | 11.9 ± 1.2 (62) b | 11.1 ± 1.1 (19) b | 81 |
| Bessr | 100 | 11.9 ± 0.7 (65) b | 9.7 ± 0.8 (18) a | 83 |
| Deglet Noor pinnae | 100 | 12.1 ± 0.6 (59) b | 11.1 ± 0.7 (22) b | 81 |
| Sorghum leaves | 100 | 10.9 ± 0.8 (67) a | 9.6 ± 0.7 (19) a | 86 |

*N* eggs tested for development duration, sample size of other parameters is in the parenthesis.
Means followed by different letters within each column are significantly different according to the Sheffe test ($P < 0.01$).
(Development duration: male $F = 18$; female $F = 47.6$)

**TABLE 2:** Adult longevity, pre-oviposition, oviposition and post-oviposition times (± SD) (days) of *O. afrasiaticus* at 27°C on several host plants, number of replicates *(N).*

| Host plants | *N* | Longevity | Pre-oviposition | Oviposition | Post-oviposition |
|---|---|---|---|---|---|
| Deglet Noor | 50 | 13.4 ± 4.7 a | 1.9 ± 0.8 a | 10.1 ± 4.7 a | 1.4 ± 0.6 a |
| Alig | 50 | 10.6 ± 2.8 b | 2 ± 1.4 a | 5.4 ± 3.2 bc | 3.2 ± 2.5 bc |
| Kentichi | 50 | 12.6 ± 4.2 ab | 2.8 ± 1.3 c | 7.7 ± 4.4 ab | 2.1 ± 1.1 ac |
| Bessr | 50 | 7.6 ± 2.9 c | 1.4 ± 0.9 ab | 4.7 ± 3 c | 1.5 ± 0.9 ac |
| Deglet Noor pinnae | 50 | 10.8 ± 3 ab | 1.6 ± 0.9 ab | 6.6 ± 3.3 bc | 2.6 ± 2 c |
| Sorghum leaves | 50 | 7.5 ± 1.9 c | 0.9 ± 0.3 b | 5.2 ± 2.1 bc | 1.4 ± 1.3 a |

Means followed by different letters within each column are significantly different according to the Sheffe test ($P < 0.01$).
(Longevity: $F = 26.5$, pre-oviposition: $F = 19.9$; oviposition: $F = 15.9$ and post-oviposition: $F = 11.3$)

**TABLE 3:** Number of eggs per female, daily fecundity (eggs/female/day), egg hatchability, and sex ratio of *Oligonychus afrasiaticus* at 27°C on several host plants.

| Host plants | *N* | Total eggs per female | Daily fecundity | Egg hatchability (%) | Sex ratio (% female) |
|---|---|---|---|---|---|
| Deglet Noor | 50 | 21.4 ± 8.1 a | 1.5 ± 0.4 | 94.4 | 0.76 $a^1$ |
| Alig | 50 | 8.3 ± 3.6 b | 0.7 ± 0.3 | 96 | 0.75 $a^1$ |
| Kentichi | 50 | 12.9 ± 6.8 bc | 0.9 ± 0.5 | 92.8 | 0.74 $a^1$ |
| Bessr | 50 | 8 ± 4.7 b | 0.9 ± 0.4 | 96 | 0.75 $a^1$ |
| Deglet Noor pinnae | 50 | 8.7 ± 3 b | 0.7 ± 0.2 | 97.7 | 0.73 $a^1$ |
| Sorghum leaves | 50 | 17.4 ± 13.5 a c | 2 ± 1.3 | 93 | 0.73 $a^1$ |

Means followed by different letters within each column are significantly different according to the Sheffe test ($P < 0.01$)
(Total eggs per female: $F = 27.5$)
Values in a row followed by $a^1$ are not statistically different ($\lambda^2$, $P > 0.05$)

Kentichi, Deglet Noor pinnae and sorghum leaves, and thereafter decreased gradually (Fig. 3).

In general, there was no distinct mx peak, egg production on all tested varieties was distributed over a relatively long time period, and survival declined gradually after an extended oviposition period. No significant difference in hatchability was observed between the different plant-based food resources. The lowest hatchability was observed with Kentichi dates (92.8%) (Table 3). In fact of host plant on reproduction has been established for several Tetranychid species (*e.g.,* Ribeiro *et al.,* 1988; Krisp *et al.,* 1998; Kerguelen & Hoddle, 2000; Hilker & Meiner, 2002; Vásquez *et al.,* 2008; Razmjou *et al.,* 2009).

## Sex ratio

There were no significant effects of plant-based foods on sex ratio of the descendant of *O. afrasiaticus* ($\lambda^2$, $P > 0.05$; Table 3). The sex ratio is always female biased.

## Table life

Calculated life table parameters are given in the Table 4. The longest mean generation time *(T)* occurred on Kentichi (19.2 days), followed by Alig. Whereas the shortest mean generation time was determined on sorghum leaves (15.8 days). Net

**TABLE 4:** Demographic parameters of *Oligonychus afrasiaticus* at 27°C on different Host plants collected at Segdoud oasis, South of Tunisia: net reproductive rate (Ro), mean generation time *(T),* intrinsic rate of increase *($r_m$),* doubling time *($D_t$)* and finite rate of increase (λ)

| Alimentary support | Demographic parameter | | | | |
|---|---|---|---|---|---|
| | Ro | *T* | λ | $D_t$ | $r_m$ |
| Deglet Noor | 20.1 | 18.1 | 1.18 | 4.2 | 0.166 |
| Alig | 6.8 | 18.6 | 1.11 | 6.7 | 0.103 |
| Kentichi | 10.4 | 19.2 | 1.13 | 5.7 | 0.122 |
| Bessr | 6.6 | 16.9 | 1.12 | 6.2 | 0.112 |
| Deglet Noor pinnae | 7 | 17.1 | 1.12 | 6.1 | 0.114 |
| Sorghum leaves | 15 | 15.8 | 1.19 | 4.1 | 0.171 |

reproductive rate (Ro) was highest on Deglet Noor fruits (20.1 female/female). Concurrently with the tendency observed for lowest duration of development and with the observed higher rates of oviposition, the mites reared on the Deglet Noor fruits and sorghum leaves present the highest values of the intrinsic rate of natural increase successively $r_m$ = 0.166 day$^{-1}$ and $r_m$ = 0.171 day$^{-1}$, while mites on Alig had the lowest intrinsic rate of increase *($r_m$)* (0.103). Consequently, feeding on sorghum leaves engenders the shortest doubling time ($D_t$ = 4.1 days) of mites.

The intrinsic rate of natural increase *($r_m$)* is an important parameter to describe population growth potential under specific climatic and food conditions because it reflects the overall effects of temperature and food on development, reproduction and survival (Southwood, 1978). The $r_m$-values of *Oligonychus* mites range from 0.178 to 0.290 day$^{-1}$ at near 25°C (Perring *et al.,* 1984;

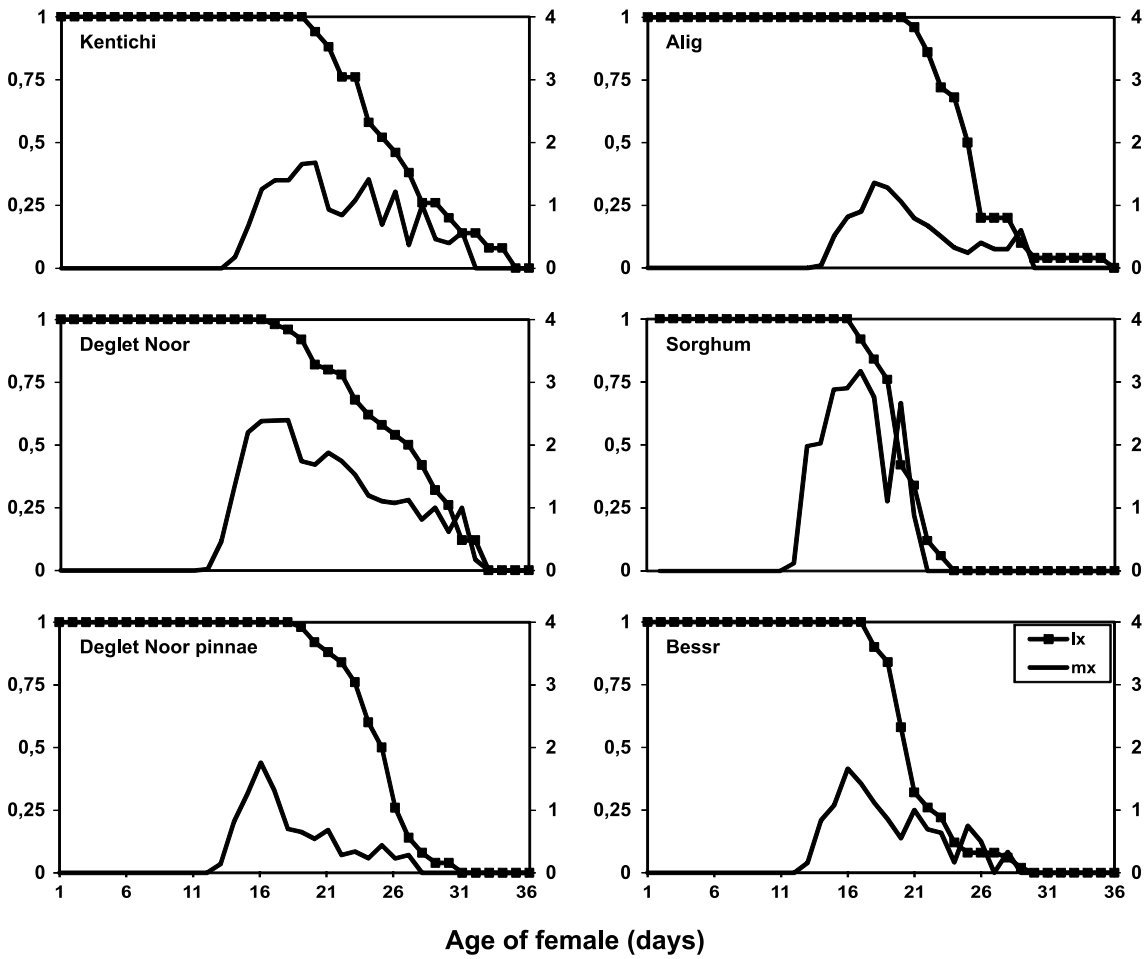


**FIGURE 3:** Survivorship curve ($l_X$) and age-specific fecundity ($m_x$) of *O. afrasiaticus* on six alimentary supports at 27°C.

Saito, 1979). Oligonychus punicae (Hirst) Biology, were studied on six grapevine cultivars at 27 ± 2°C, demonstrated that Intrinsic rate of increase ($r_m$) varied between 0.292 and 0.135 (Vásquez *et al.,* 2008).

These differences may be associated with impediments to feeding such as host plant texture, nutritional value of the host plant, host physiology (Bengston, 1970; Archer *et al.,* 1986; Kielkiewicz & Van de Vrie, 1990; Kerguelen & Hoddle, 2000; Kasap, 2003; Ragusa & Ferragut, 2005; Kafil *et al.,* 2007; Vásquez *et al.,* 2008). Tetranychids pierce the parenchyma tissue of leaves with their stylets and siphon out the cells' contents (Jeppson *et al.,* 1975; Van der Geest, 1985). Consequently, mite nutrition is directly affected by the chemical composition of ingested fluids.

### Population dynamics

The finite rate of increase (λ), ranged from 1.11 to 1.19 mites/day. The multiplication of population per unit of time is represented by the equation: Nt = λ N0 (Nt: population density at the time t, λ: the finite rate of increase, N0: population density at initial time). The logarithmic transformation of this equation permits to illustrate the variation of population in time (Fig. 4). So, an important difference between the six plant based food resources is observed. After two generations (19, 19, 18, 17, 17 and 16 days successively for Kentichi, Alig, Deglet Noor, Bessr, Deglet Noor pinnae, and sorghum leaves), populations of *O. afrasiaticus* reared on Deglet Noor fruits and sorghum leaves would be in theory more abundant than on other food sources.

## CONCLUSION

Field observations and laboratory studies predicted the distribution and the seasonal abundance of *O. afrasiaticus* well. The mite was active on fruits from July until September. Populations of *O. afrasiaticus*

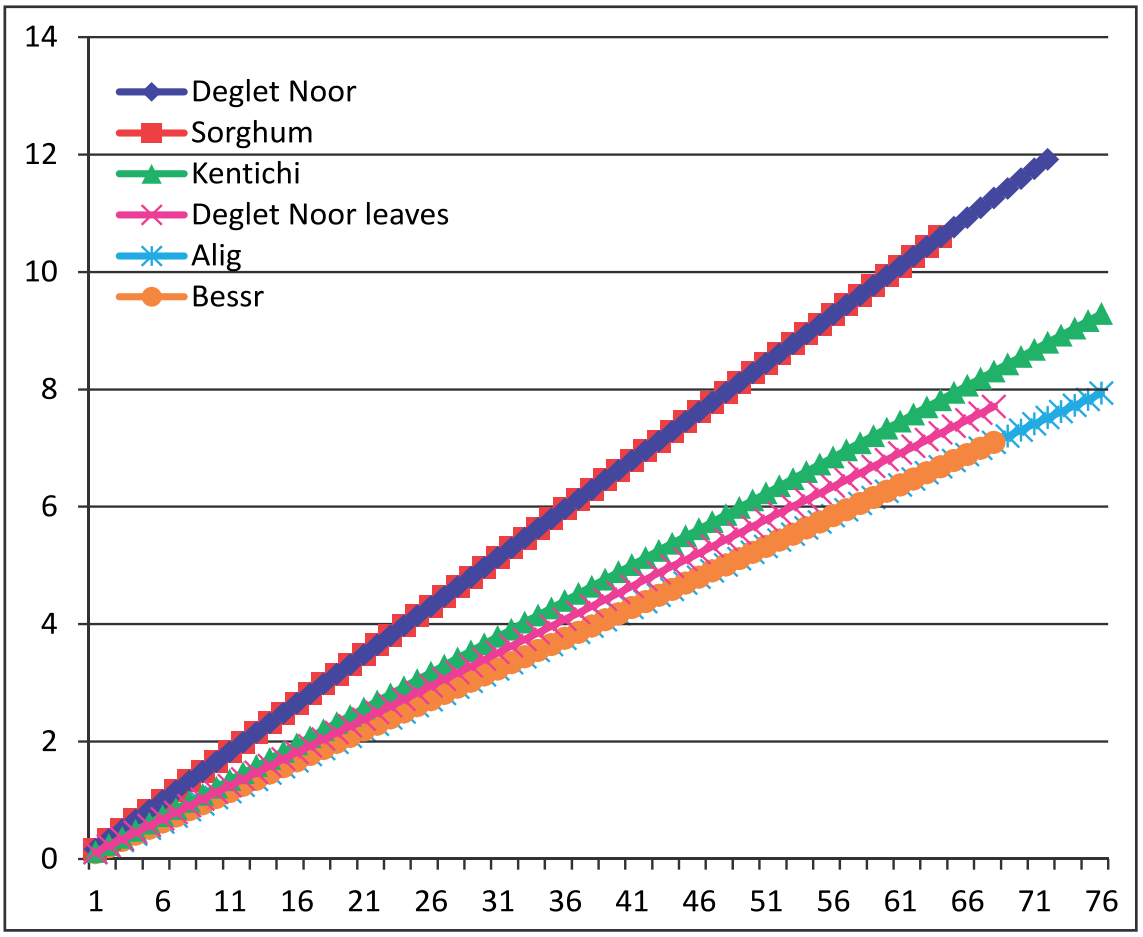


**FIGURE 4:** Population dynamics of *O. afrasiaticus* at 27°C on different supports collected at Segdoud oasis, South of Tunisia.

started leaving fruits in autumn affected by the variation of the fruit chemistry and it's a response to the climatic conditions. Based on our laboratory study, the sorghum leaves proved to be the most suitable host for this pest mite. The temperature of 27°C corresponds to the monthly mean temperature of September and October, when motile forms migrate to the pinnae and to the ground cover essentially, on *Sorghum* sp. One of the most outstanding characteristics of the population dynamics of spider mites is their ability to colonize and develop on host plants before dispersal to new plants when nutritional resources have been exhausted. Obviously, wider the range of possible host plants is, greater will be the chance of survival of individuals in the process of dispersal. Identifying differences in date palm variety susceptibility to *O. afrasiaticus* is crucial for developing efficient pest control programs. Varieties that are less susceptible can be left unsprayed or sprayed at a very low threshold. Identifying characteristics that enhance resistance to spider damage will enable plant breeders to produce resistant varieties. At last, increasing variety diversity in orchards should be considered as a strategy to reduce damage and associated yield reductions caused by *O. afrasiaticus.*

## RESUMO

*A biologia e ecologia do ácaro da tamareira* O. afrasiaticus *foram estudadas através de inspeções regulares em oásis Tunisianos e observações em laboratório. Os resultados indicam que a data inicial da infestação dos frutos variou entre os anos e pelo tipo de variedade das tamareiras. Datas iniciais variaram entre a primeira e a terceira semana de julho. O período passado pelo ácaro nos frutos variou de acordo com o tipo de tamareira, sendo de 8 semanas na variedade "Deglet Noor", de 2 a 5 semanas na "Alig", 2 a 4 semanas nas* tâmaras *"Kentichi", e 2 a 4 semanas nos frutos "Bessr". A variedade "Deglet Noor" foi a mais sensível ao* O. afrasiaticus. *As Populações de ácaros nas pinhas permaneceram baixas de maio a dezembro. Durante o outono e na primavera,* O. afrasiaticus *foi encontrado em folhas de sorgo no solo dos pomares. Um estudo tabelado com o ciclo de vida em laboratório,* a 27°C*, em seis plantas hospedeiras (tâmaras das variedades "Deglet Noor", "Alig", "Kentichi", "Bessr", as pinhas de "Deglet Noor" e folhas de sorgo) mostrou que o ciclo de vida de* O. afrasiaticus *variou entre as diferentes plantas hospedeiras com valores médios de 13 dias nos frutos Alig e 10,9 dias em folhas de sorgo. Uma fecundidade relativamente alta foi observada em folhas de sorgo (2 ovos/fêmea/dia) durante 5,2 dias de ovipostura, enquanto valores mais baixos de fecundidade foram observados nas pinhas "Deglet Noor" e frutos "Alig" com 0,7 ovos/fêmea/dia durante 5,4 dias. A longevidade média das fêmeas de* O. afrasiaticus *variou entre 13,4 a 7,5 dias nos frutos "Deglet Noor" e folhas de sorgo, respectivamente. A taxa intrínseca de aumento ($r_m$) foi mais alta em folhas de sorgo (0,171) e frutos "Deglet Noor" (0,166), e mais baixos nos frutos "Alig" (0,103). Um maior conhecimento da história de vida e abundância sazonal desta espécie é necessário para que estratégias apropriadas de controle possam ser elaboradas.*

Palavras-Chave: Taxa de aumento intrínseco ($r_m$); Tamareiras; Tunísia Meridional; "Deglet Noor"; Seasonal abundance.

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