



Persian J. Acarol., 2021, Vol. 10, No. 4, pp. 451–466.
<https://doi.org/10.22073/pja.v10i4.69587>
Journal homepage: <http://www.biotaxa.org/pja>



Article

Economic injury level of date spider mite, *Oligonychus afrasiaticus* (Acari: Tetranychidae) on six commercial date cultivars

Masoud Latifian^{1*} , Mohammad-Javad Assari² , Seyed-Saeed Modarresi-Najafabadi³ , Majid Amani¹ , Farzaneh Basavand⁴ , Mohammad-Taghi Fasihi⁵ , Hadi Zohdi²  and Abdoolnabi Bagheri³ 

1. Agricultural Research, Education and Extension Organization (AREEO), Horticulture Science Research Institute, Date Palm and Tropical Fruits Research Center, Ahwaz, Iran; E-mails: Masoud_latifian@yahoo.com, majidamani2008@yahoo.com
2. Plant Protection Research Department, Kerman Agricultural and Natural Resources Research and Education Center, Agricultural Research Education and Extension Organization (AREEO), Kerman, Iran; E-mails: m.assari@areeo.ac.ir, h.zohdi@areeo.ac.ir
3. Plant Protection Research Department, Hormozgan Agricultural and Natural Resources Research and Education Center, Agricultural Research Education and Extension Organization (AREEO), Bandar Abbas, Iran; E-mails: s_modarres_705@yahoo.com, abibagheri53@gmail.com
4. Plant Protection Research Department, Iranshahr Agricultural and Natural Resources Research and Education Center, Agricultural Research Education and Extension Organization (AREEO), Iranshahr, Iran; E-mail: basavand@hotmail.com
5. Plant Protection Research Department, Bushehr Agricultural and Natural Resources Research and Education Center, Agricultural Research Education and Extension Organization (AREEO), Bushehr, Iran; E-mail: fassihi47@yahoo.com

* Corresponding author

ABSTRACT

The date spider mite, *Oligonychus afrasiaticus* (McGregor) (Acari: Tetranychidae) is a destructive pest on date palm trees, causing high economic losses. Here, we investigated the relationship between population density of *O. afrasiaticus* and the extent of its injury level as well as the relation between rate of damage and date yield losses indices on six commercial date cultivars in five date palm growing provinces including Khuzestan (Sayer and Berhee), Hormozgan (Pyarum), Kerman (Mazafati), Bushehr (Kabkab), and Sistan and Baluchestan (Rabi) of Iran. The experiment was conducted in a complete randomized block design with five treatments and three replications. To this end, in each replication, four date clusters were selected from four different geographical directions, in each of them, 25 fruits were checked randomly to unveil the number of healthy and infested fruits. The sampling was repeated at seven-day intervals from late May to early September. Finally, the Norton model was used to estimate the economic injury level (EIL) under both biological and chemical control conditions. The highest value of EIL in 2019 was estimated for Sayer in the chemical control method (1827 Mite-day) and the lowest one was estimated for Pyarum in the biological control method (25.5 mite-day). Our results also revealed that the cost of biological control was significantly lower than chemical control. The highest and lowest rate of date injury (symptoms of the pest feeding) were observed on Berhee and Mazafati cultivars, respectively. Also, the highest and lowest rate of date loss were observed on Kabkab and Sayer cultivars, respectively. On the other hand, the cost of chemical control in both years was higher than that of biological control.

KEY WORDS: Biological control; chemical control; date palm; EIL; pest management.

PAPER INFO.: Received: 21 June 2021, Accepted: 22 August 2021, Published: 15 October 2021

How to cite: Latifian, M., Assari, M.-J., Modarresi-Najafabadi, S.-S., Amani, M., Basavand, F., Fasihi, M.-T., Zohdi, H. & Bagheri, A. (2021) Economic injury level of date spider mite, *Oligonychus afrasiaticus* (Acari: Tetranychidae) on six commercial date cultivars. *Persian Journal of Acarology*, 10(4): 451–466.

INTRODUCTION

The date spider mite, *Oligonychus afrasiaticus* (McGregor) (Acari: Tetranychidae) is one of the most important pests of date palm in Iran, causing economic loss of date yield. This mite is the dominant spider mite pest of date palm fruit in the Southern Arava Valley of Palestine (Palevsky *et al.* 2003). The optimum temperature for *O. afrasiaticus* development ranges between 30.5 and 32.7 °C (Al-Haidari *et al.* 1982). Kadjbaf Vala and Kamali (1993) in Iran reported that the old-world mite, *O. afrasiaticus* was a serious pest of dates in Khuzestan. The fruits become inedible by feeding of immature and adult individuals (Ba-Angood and Bass'haih 2000). The infested fruits turn to white gray or pale yellow and they are cracked and lose sugar content. The fruit skin is also becoming hard and dry (Al-Deeb 2012). In high infestations, up to 70% of date fruits are destroyed. Chaaban *et al.* (2011) reported a diverse array of *O. afrasiaticus* damage (6 to 53%) on different date palm cultivars in Sudan. This shows that this pest does not always have to be controlled by chemicals. It also indicates the necessity for an estimate of the pest population and the amount of damage before any chemical application.

Recently, much attention has been paid to the economic injury level (EIL) of pests because it can answer the question that at what density of pests the control should be initiated? The answer to this question is the same decision-making principles in implementing pest control programs (Stern *et al.* 1959; Southwood and Norton 1973; Norgaard 1976). The important issue regarding this question is whether the damage levels determined by such a formula are reasonable and reliable? The decision-making methods have been defined and developed based on the basic principles of the economic threshold (EC) and EIL (Damos 2014). The main advantage of these rules is their simplicity and practicality. Some researchers have suggested that these indices can affect other factors in the crop-pest systems including seasonal pest's population dynamics, biological relationships between pests and predators, environmental pollution caused by pesticide residues, resistance to pesticides, effects of the controlling programs in adjacent fields, and pesticide health problems (Ordish and Dufour 1969; Southwood and Norton 1973; Stern 1975; Pedigo *et al.* 1977; Hall and Teetes 1982; Stefanou 1984).

To estimate the relationship between injury and population of each pest, it is usually assumed that this relation is linear (El-Wakeil 2010). However, in some pests, due to the population interference or decreased nutrients at higher densities, sometimes a decrease in pest injury level occurs by increasing density (Jaques 1962; Bardner and Fletcher 1974; Shelton *et al.* 1982; Machlitt 1998). Estimating the relationship between injury and yield is the essential component of the EIL. It removes the practical limitations on the way of EC and EIL application (Pedigo and Higley 1992). The yield loss due to plant's reaction is also included in the formula to estimate these indices through the relationship between injuries and yield (Bardner and Fletcher 1974; Regev *et al.* 1976). A general description of plant responses to crop loss in the result of pest injury was presented by Tammes (1961). This is a well-known method and many researchers have used it to estimate EIL (Bardner and Fletcher 1974) in which four major parameters have been recognized that influence the relation between crop yield and pest injury severity including the time of injury based on plant growth stage, the part of plant damaged, the injury severity and the effects of environment (Tammes 1961; Southwood and Norton 1973; Higgins *et al.* 1984).

Although more information is available on the different biological aspects of *O. afrasiaticus* (Latifian 2012, 2014; Latifian *et al.* 2014), there is no study on the economic injury level of this pest on different date cultivars. This study aimed to answer the following questions. What is the relationship between the *O. afrasiaticus* density and its injury severity? What is the relationship between *O. afrasiaticus* injury and date palm yield indices? And is it possible to determine the economic injury level of *O. afrasiaticus* using the Norton general model?

MATERIALS AND METHODS

This study was conducted on six commercial date cultivars in five provinces of Iran as follows: Sayer, and Berhee from Khuzestan Province, Pyarum from Hormozgan Province, Mazafati from Kerman Province, Kabkab from Bushehr Province, and Rabi from Sistan and Baluchestan Province. The most important commercial cultivar was tested for each province. The selected trees were about 12 ± 2 years old and their number was 160 ± 10 trees per hectare. The experiment was conducted with five treatments (different densities of *O. afrasiaticus*) replicated three times. The six experiments were carried out on individual varieties of the date palm. The aim was to achieve different mite densities to evaluate their effects on injury severity after acaricide treatments. The different densities of *O. afrasiaticus* were created artificially using four concentrations (0.5, 1, 1.5, and 2 ml/L) of an acaricide (Hexythiazox). According to other studies, this acaricide has the most effect on the studied mite and the least side effects such as phytotoxicity and negative effects on natural enemies (Arbabi *et al.* 2017). To this end, each tree was sprayed with five liters of a solution prepared from this acaricide. No acaricide was used in the control. Also, a pesticide (Zolone 35% EC) was used with a concentration of 1 ml/L to control other date pests, especially date palm lesser moth *Batrachedra amydraula* Meyrick (Lepidoptera: Batrachedridae). Sampling started one week after the treatments. One date palm tree of particular date cultivars was taken into account for each of five treatments. Twenty fruits were selected from each bunch and checked to determine *O. afrasiaticus* density. The samples were transferred to the laboratory, and the number of mites was counted and recorded separately. Sampling was repeated every seven days from late May to early September. The Norton model was used to calculate EIL as follows:

$$EIL = \frac{C}{KVID}$$

which C is the cost of management/yield unit (Dollars/ha); V is the marketing value of yield unit (cost/kg) (Dollars/kg); I is the injury/unit pest population (I) (fruit injury/Cumulative Mite Days) and D is the damage/injury unit (kg/ha/fruit injury). K is the proportion of injury prevented by management, which in many instances is assumed to be near 1 and can be omitted.

Management control cost (C)

Management costs were calculated in both chemical and biological control (by Augmentation release of *Stethorus gilvifrons* approaches). Although other natural enemies have been identified for this mite, the evaluation was based on this predatory ladybug, which previous studies have proven effective in terms of field release (Latifian and Kajbafevala 2016). Management costs included control agent costs, machinery costs and labor costs that were estimated based on the customary conditions of each region. Data were obtained through interviews with experts in the Jihad Agricultural Organization of the relevant province.

Market value of yield unit (V)

The market value of each date cultivar depends on the market supply and demand. Some variables including the relative price of date exports, real exchange rate, date of production in other countries and date of export are influencing the demand function of date products. The price for each cultivar was determined based on a six-month average prediction in each region. Data were obtained through interviews with experts in the Jihad Agricultural Organization of the relevant province.

Injury per unit pest population (I)

In each replication four fruit bunches were selected randomly from four main geographical directions. Then 25 fruits were studied from each bunch in terms of being healthy and infested. The

existence of at least one active mite on the fruit was considered as infestation. Then, the fruits were transferred to the laboratory and the number of active mites on the fruits was recorded separately.

To determine the date spider mite's density at the sampling intervals in the field conditions, indicating the relationship of their population densities with date fruit injury, the parameter Mite-day (Md) was calculated to estimate this index as follows (Machlitt 1998).

$$\text{Mite-day (Md)} = (7) \times (M_1 + M_2) / 2$$

In this equation M_1 and M_2 were the mite densities in the current and previous sampling period, respectively. The percentage of injury was calculated by estimating the ratio of infested to non-infested fruits which the index was mite activity. The regression between mite-day as independent variable and fruits injury as dependent variable was used to estimate the economic threshold of *O. afrasiaticus*. The slope of the regression line was equal to the amount of injury per Mite-day.

Damage per injury unit (D)

The regression between injury and quantitative attributes was used to estimate the damage-injury curve. To do so, some quantitative attributes including fruit weight were calculated in each treatment. Injury rate was estimated according to the above-mentioned method. Then, the regression between injury as independent variable and different quantitative traits as dependent variable were fitted and the amount of damage per injury unit was estimated using Norton model (Shiberu and Getu 2018a, b).

Statistical analyses

Quantitative Pearson correlation was used to investigate the relationship between variables including mite-day as independent variable and fruits injury as dependent variable and sum of percent injury as independent variable and fruit weight as dependent. These variables with strong correlation in all studied cultivars were fitted to investigate the regression relationship between these variables. The purpose of analysis was calculation the slopes.

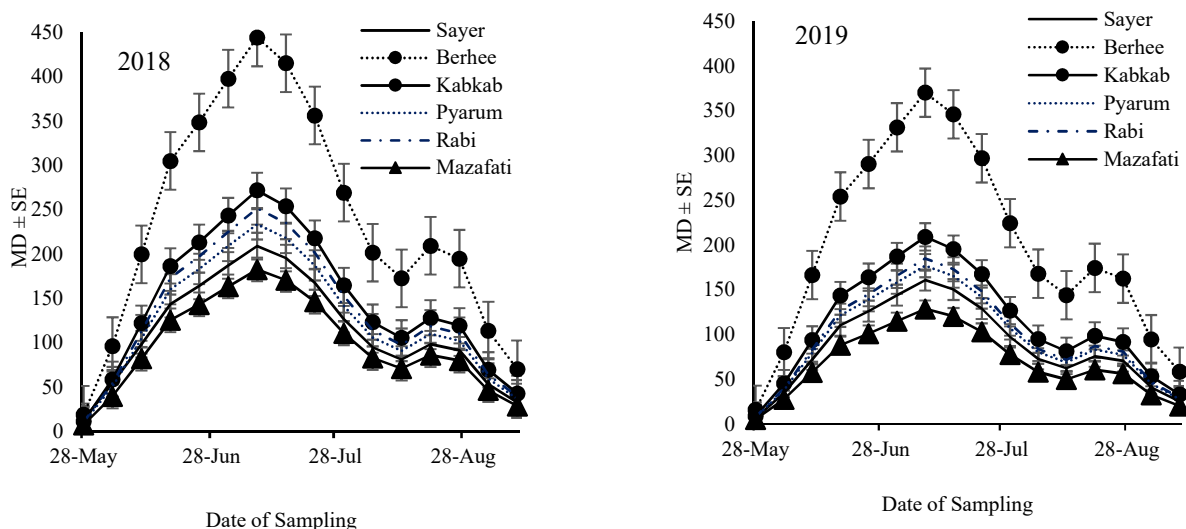
Ordinary least squares (OLS) for correct calculation the linear relations were described by equation $y = bX + a$. R^2 is a statistical measurement of data close to the fitted regression line. This statistic indicates the percentage of the variance in the dependent variable that the independent variables explain collectively. R^2 is also called the coefficient of determination or coefficient of detection. The coefficient of determination indicates "how much of the dependent variable changes are affected by the relevant independent variable and the rest of the dependent variable changes are related to other factors".

RESULTS

Temporal distribution of O. afrasiaticus population and its injury rate

Seasonal fluctuations of *O. afrasiaticus* population and its injury rate on Khuzestan (Sayer, and Berhee), Hormozgan (Pyarum), Kerman (Mazafati), Bushehr (Kabkab), and Sistan and Baluchestan (Rabi) are shown in Figure 1. The results showed that *O. afrasiaticus* activity and its injury began in June and gradually increased by increasing temperature. The pest had two periods of activity during late spring and summer months. So that it showed the highest density and infestation in July and August and then gradually decreased. The pest injury stopped from September as the mites began to overwinter.

A) Mite-Day



B) Injury rate

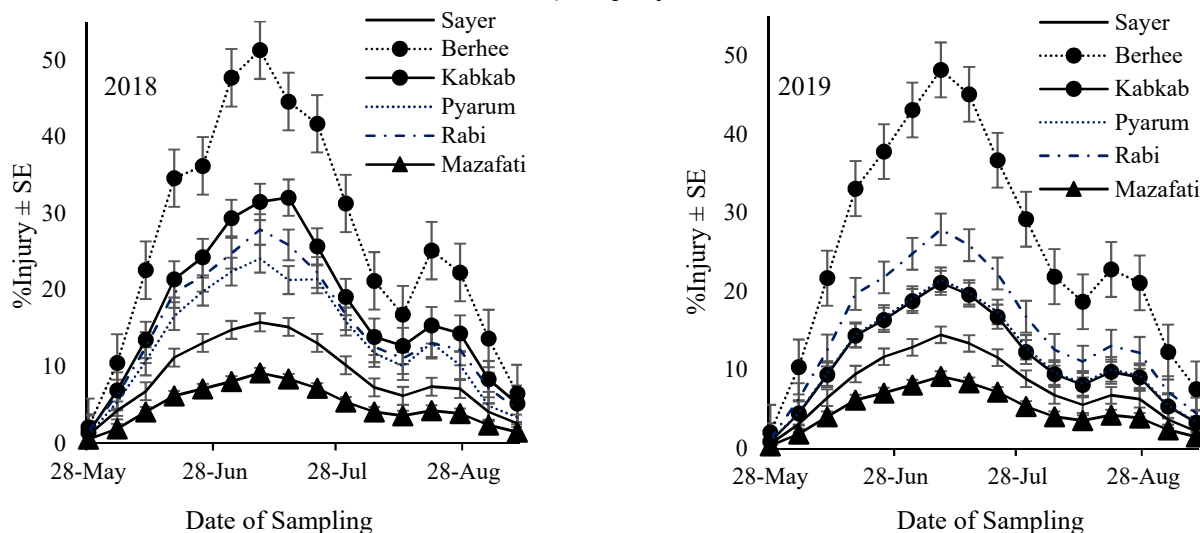


Figure 1. Seasonal fluctuation of *Oligonychus afrasiaticus* (A) and their injury rate (B) on six commercial date cultivars in 2018 and 2019.

Management control cost (C)

Management control costs were calculated in both chemical and biological control approaches (Table 1).

According to the results, management control costs of both chemical and biological control increased 31.25% and 36.1%, respectively, in 2019 than 2018. On the other hand, in both years, the cost of biological control was lower than chemical control. According to other studies, both chemical and biological control had acceptable performance based on the integrated management control (Latifian and Kajbafaveala 2016). The highest cost in both biological and chemical methods was the purchase of the controlling materials.

The marketing value of yield unit (V)

The results of the marketing value of yield units in the studied date cultivars are presented in

(Table 2).

Table 1. Estimation of *Oligonychus afrasiaticus* management cost inferred from day-price and customary conditions in each region (in Dollars).

Year	Control method	Cost (\$)			
		Materials	Machinery	Worker	Total
2018	Chemical	1.8	12	10	23.8
	Biological	10	6	16	32
2019	Chemical	2.4	16	14	32.4
	Biological	14	8	20	42

Table 2. Price of each date cultivar in all five regions of the study based on a six months average prediction.

Cultivar	Price/kg (Dollars)	
	2018	2019
Sayer	0.51	0.62
Berhee	5	6
Kabkab	1.5	3.6
Pyarum	3.84	7.6
Rabi	1.52	3.2
Mazafati	1.7	2.4

The results showed that the marketing value of yield unit of the studied date cultivars increased in 2019 than 2018. The increase in price was 26.7, 16.6, 58.3, 49.4, 52.5 and 29.2%, for the Sayer, Berhee, Kabkab, Pyarum, Rabi and Mazafati, respectively.

Injury per unit pest population (I)

The results of the injury per unit pest population (I) in 2018 and 2019 are depicted in Figures 2 and 3, respectively.

The slope of the mite-day relation to regression injury rate line shows the injury per unit pest population (I), the results are depicted in (Table 4).

The highest and lowest injury per unit pest population were observed in Berhi and Mazafati cultivars, respectively. Although, changes in the injury per unit pest population was negligible for all cultivars during two years of the study, Pyarum, Mazafati and Rabi showed the higher injury rate in 2019 than 2018.

Table 3. The injury created by unit of *Oligonychus afrasiaticus* population (I) on the six studied date cultivars

Cultivar	Injury produced by unit of pest population (I)	
	2018	2019
Sayer	0.077	0.089
Berhee	0.113	0.131
Kabkab	0.102	0.1
Pyarum	0.103	0.122
Rabi	0.011	0.151
Mazafati	0.046	0.071

Damage per injury unit (D)

The regression between injury and fruit weight during 2018 and 2019 are shown in Figures 4 and 5, respectively.

The amount of damage per injury unit (D) is equivalent to the slope of the regression line. These results are presented in Table 4.

The highest and lowest damage per injury unit (D) were estimated for Kabkab and Sayer cultivars, respectively. The difference of damage per injury unit (D) during two-studied years was negligible.

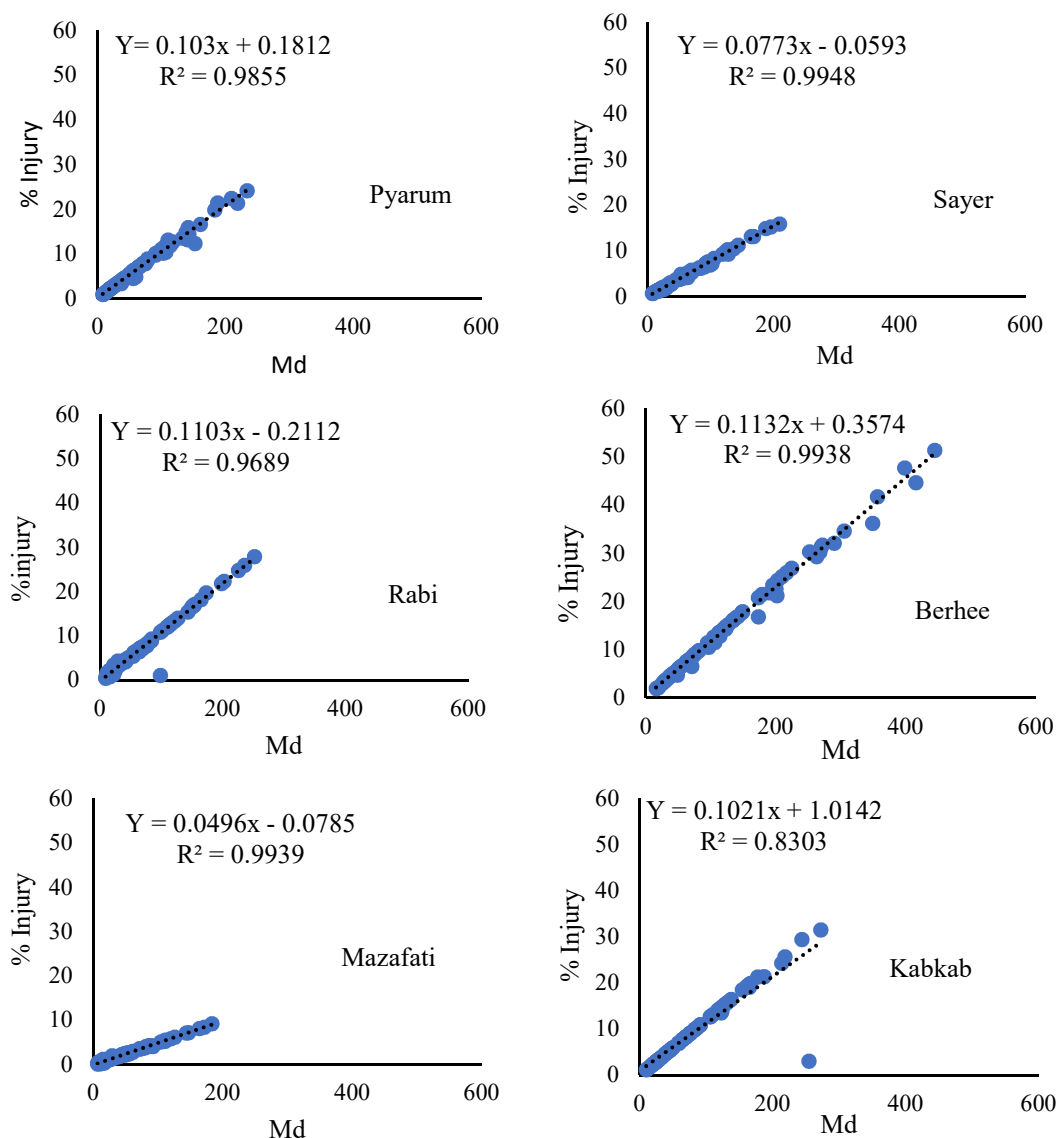


Figure 2. Regression between mite-day as an independent variable and fruits injury rate as a dependent variable in the different date cultivars studied in 2018.

Economic injury level

The EILs for both biological and chemical control were estimated using the Norton model. Figure 6 shows the estimated EIL values for different date cultivars in 2018 and 2019. The economic injury level of *O. afrasiaticus* varied either in different years or on different date

cultivars. Except Rabi, the values of EIL values on all cultivars (Fig. 6). On the other hand, the EIL in chemical control was higher than biological control in both two years on all studied cultivars. The highest EIL was estimated for Sayer cultivar in 2019 and in chemical control (1827 mites-day) and the lowest was for Pyarum cultivar in 2018 and in biological control (25.5 mite-day).

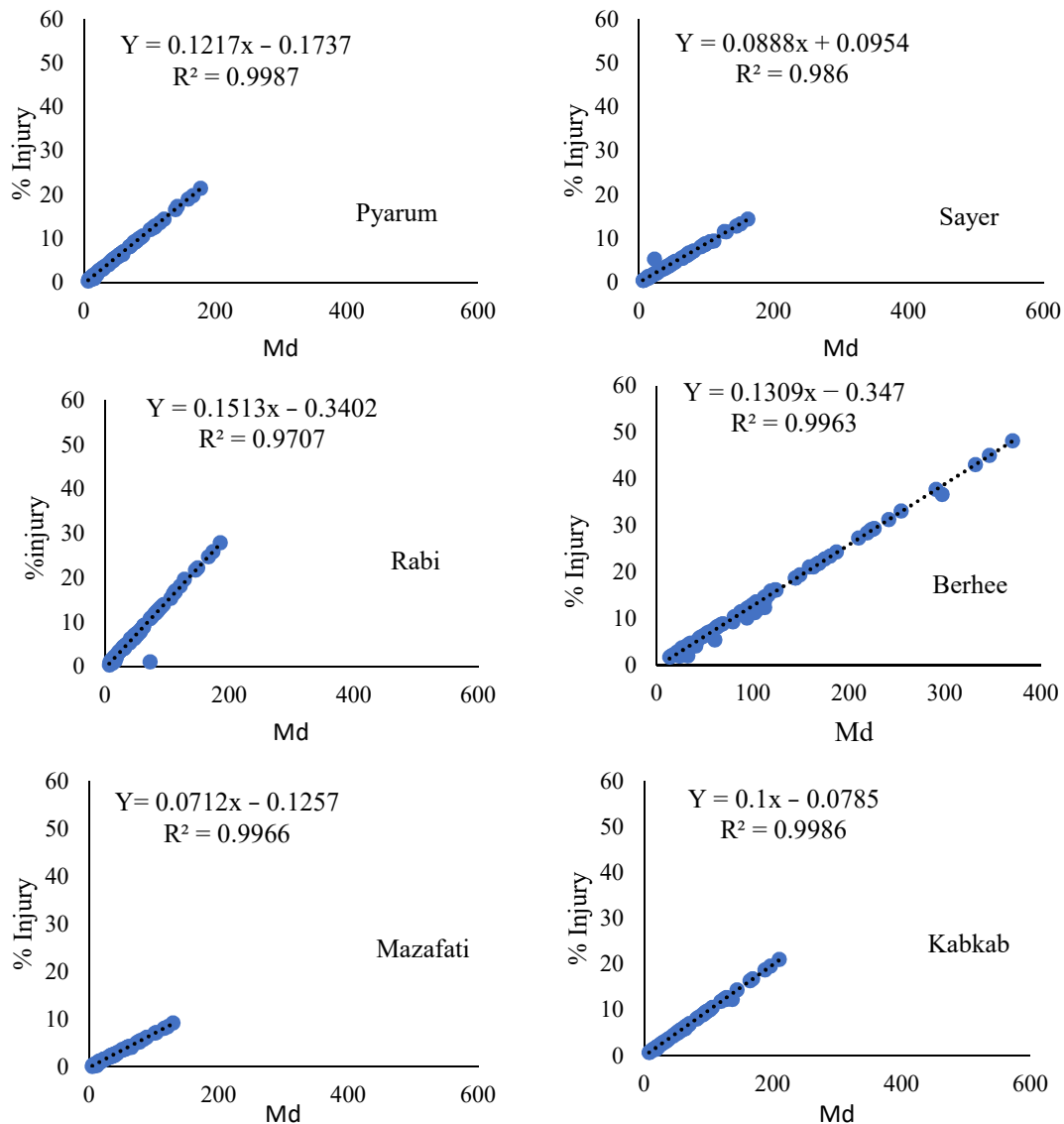


Figure 3. Regression between mite-day as an independent variable and fruits injury rate as a dependent variable in the different date cultivars studied in 2019.

Table 4. Damage per unit injury (D) in the different date palm cultivars based on linear regression model.

Cultivar	Damage per unit injury (D)	
	2018	2019
Sayer	0.006	0.006
Berhee	0.011	0.011
Kabkab	0.06	0.016
Pyarum	0.015	0.016
Rabi	0.024	0.025
Mazafati	0.026	0.26

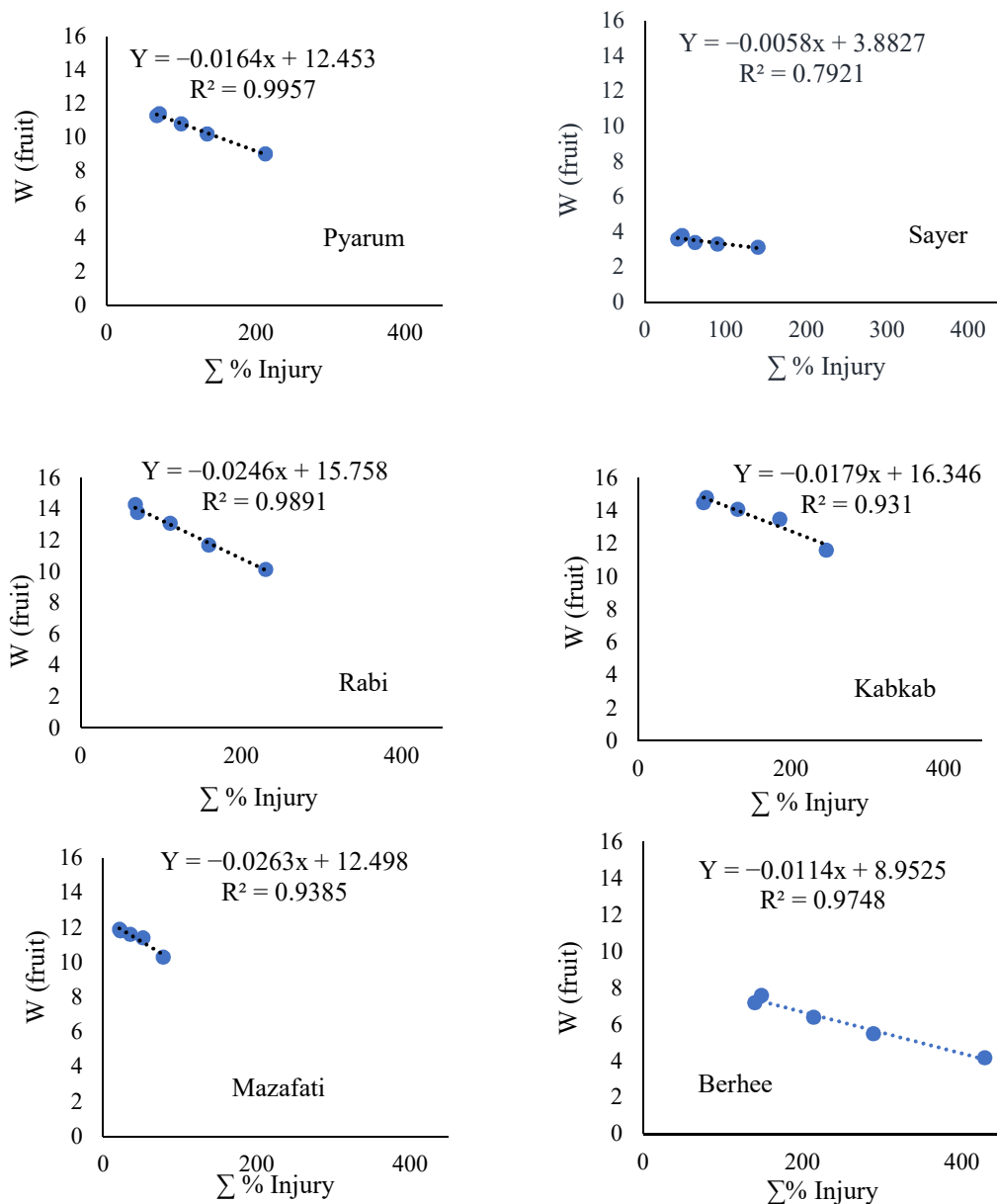


Figure 4. The regression between injury as an independent variable and fruit weight as a dependent variable in the different date palm cultivars in 2018.

DISCUSSION

The EIL has a key role in the integrated pest management programs (Maoz *et al.* 2010). It is better for a farmer to accept a small amount of a pest damage than to experience frequent pest outbreaks or to face the emergence of new destructive pests (Al-Jboory 2007). The cost of pest control and the risk of pest outbreaks in the future are two important issues that may encourage a farmer to focus on non-chemical control strategies (Blumberg 2008). This is despite the important role of insecticides in the control of insect pests and their benefit to have a pest-free product for the marketing (Pimentel 2009). Therefore, it necessitates to explore approaches to restrict this hazardous method to conditions that are inevitable. In this situation, the EIL can help to have not only a rational and sound chemical application but also the most income for farmers (AL-Ahmadi 2019).

The cost of control practice has a positive correlation with the economic injury level. In other words, the EIL rises by increasing cost of the control practice, that's why sometimes we may have to accept some damage of a pest. The cost of control operation depends directly on the cost of

chosen tactics and the economic status of regions where date palm is cultivated (Riley 2008). Our results showed that the cost of biological control was lower than chemical control in the integrated management of *O. afrasiaticus*. However, the cost of biological and chemical control both increased in 2019 than 2018 because of fluctuation in the price of dates in these two years. Furthermore, in both these two approaches, the cost of the chosen tactic was higher in 2019 (the price fluctuations rate in chemical control was higher than biological control). Our results also revealed that the EIL increased by increasing the cost of operation especially in date cultivars with the lower economic value (Chung 2001; Riley 2008).

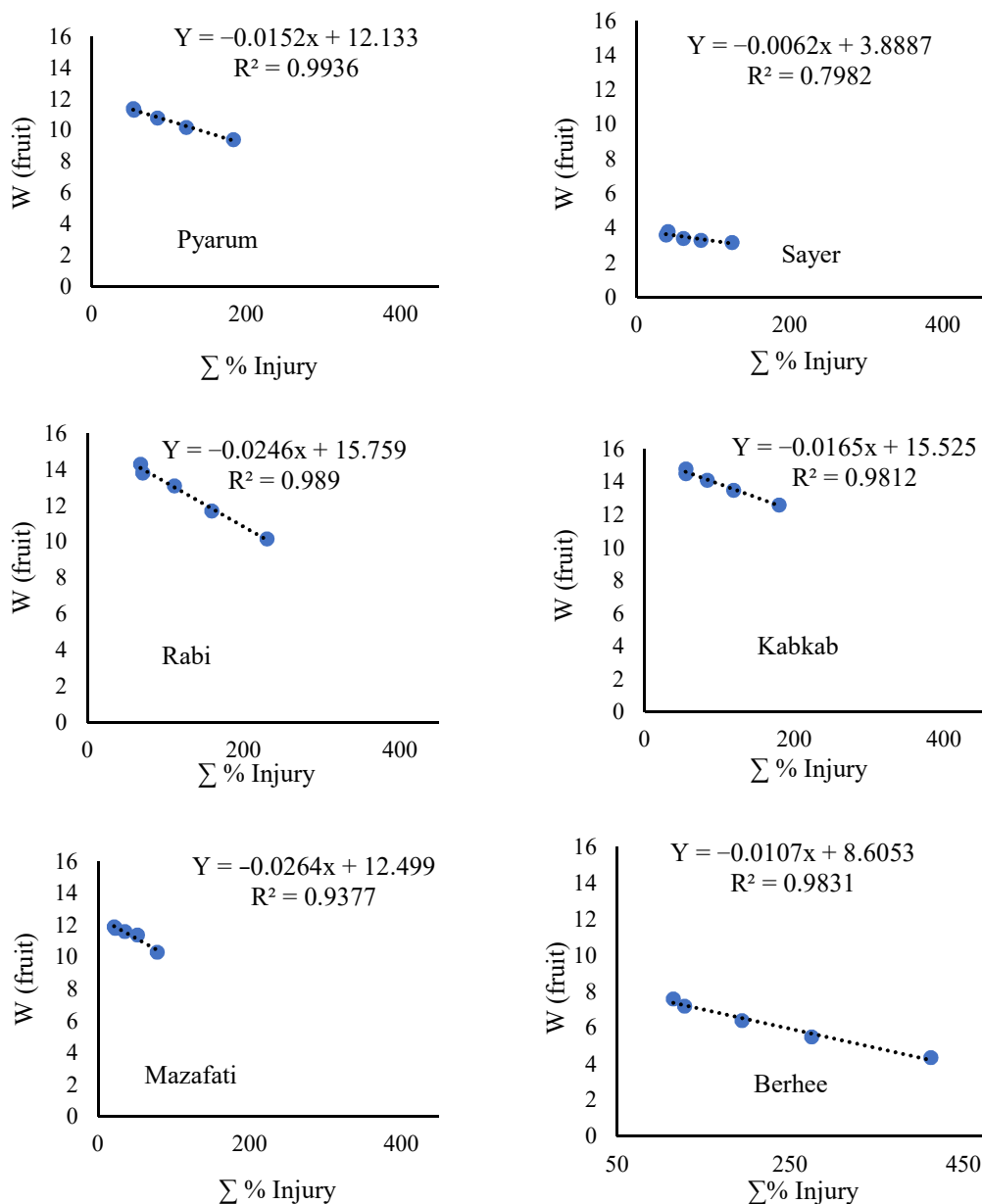


Figure 5. The regression between injury as an independent variable and fruit weight as a dependent variable in the different date palm cultivars in 2019.

The commercial yield value has an inverse correlation with EIL (Shipp *et al.* 2000). As the EIL decreases the commercial yield value increases, and as a result, less injury of *O. afrasiaticus* would be expected to be tolerated. The commercial yield value depends on the production amount and the price of the unit product (Riley 2008). In the present study, Pyarum, Rabi and Mazafati with the

highest yield value and sale price had the lowest EIL. In contrast, Sayer with the lower sale price and yield in comparison with the other cultivars, had the highest EIL. As price of an agricultural product is related to the marketing conditions and annual economic fluctuations, it is reasonable to expect more fluctuations in EIL for date cultivars with lower prices.

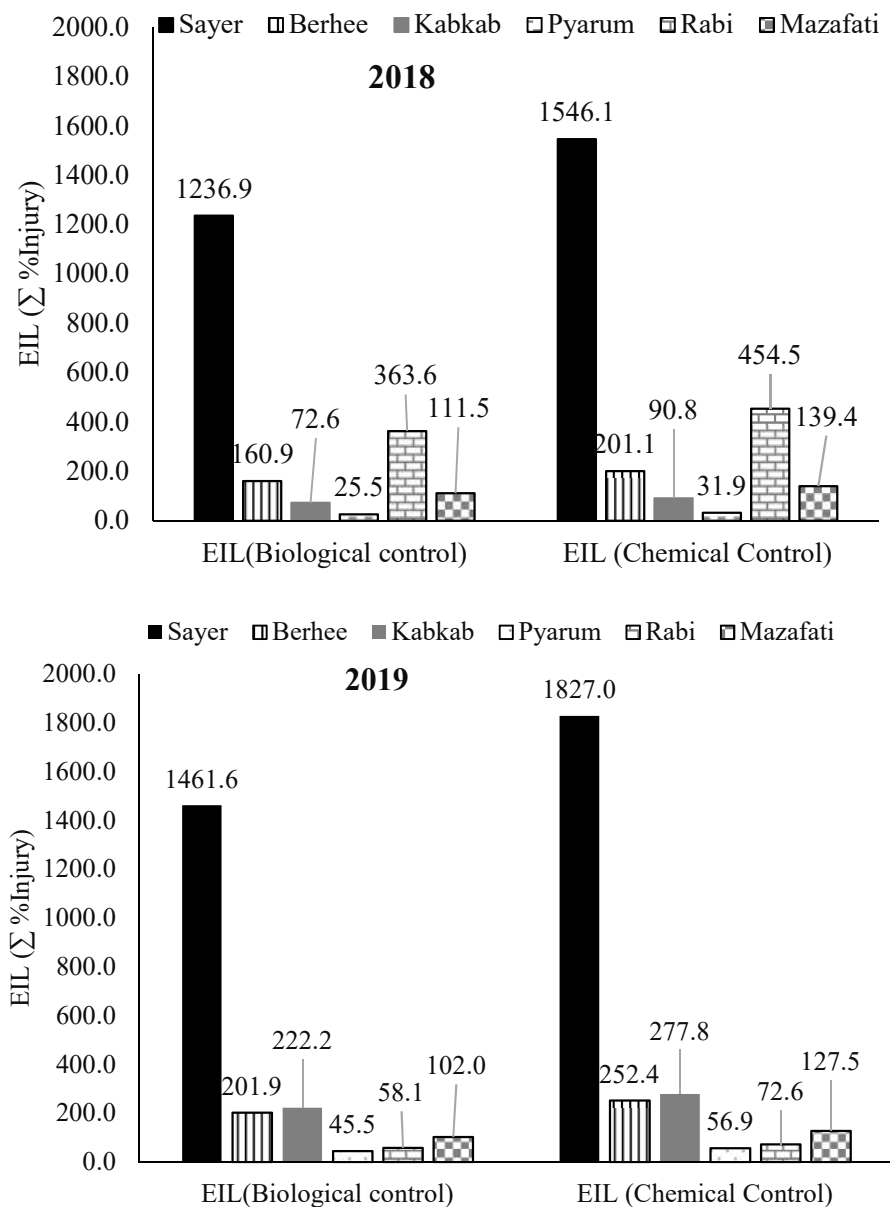


Figure 6. Economic injury levels of *Oligonychus afrasiaticus* under chemical and biological control conditions on the studied date palm cultivars during 2018 and 2019.

Increased pest density is another important factor that increases pest injury and crop loss (Cocco *et al.* 2015; Martins *et al.* 2017). This factor has an inverse correlation with EIL (Surendra 2019). That's why the date palm cultivars with the higher susceptibility to *O. afrasiaticus* e.g. Berhee and Pyarum allocated more injury per pest population unit and had lower EIL. There is high difference in the resistance to *O. afrasiaticus* among various date cultivars. For instance, Sibeki and Sayer cultivars are more susceptible than Shukri and Rutan. Also, it has been revealed that Khodari and Khunizi have moderate resistance to *O. afrasiaticus* (Aldosari 2009). Elwan (2000) showed the susceptibility of Hilly, Gibri and Chennai to date palm spider mite. In Yemen, except Hamra and

Al-Hajri with moderate resistance, all other date palm cultivars are susceptible (Bass'haih 1999). In another study, local date palm cultivars of date palm were divided into four groups including high susceptible cultivars e.g., Liloie, Berhee, Zahedi, Deri, Ashkar and Beraim; susceptible cultivars e.g., Halawi, Belyani, Haddak, Shakar, Bint Elsab, Dagal Zard, Khazravi and Sayer; moderate resistance cultivars e.g., Bubaki, Chabchab, Mashtoom, Jahromi, Amo Bahari, Dagle sorkh, Fersi and Hadel and quantitatively infected cultivars e.g., Khasab, Homeravi, Hasawi, Isahagh and Gantar (Latifian *et al.* 2007).

There were no differences between years and the interaction between the population and injury factors was not significant. Simple regressions show yield loss (expressed as percentage relative to yield in control trees). Our results show that a longer presence of mite populations in the trees (from early summer to harvest) had a stronger impact on production. To decide whether yield and cumulative mite-day had to be taken into account when establishing the new threshold, some studies explored the relationship between both yield loss and other population parameters but they had reached similar accuracy results (Martínez-Ferrer *et al.* 2006).

It should be noted that the general level of a pest population not only is not dangerous but also beneficial because it helps reaching a biological balance (Surendra 2019). This can be also true for *O. afrasiaticus*; in normal densities, it can supply some prevalent predators feeding on this pest. Therefore, the EIL revealed here for different date cultivars provided insights to what extent of *O. afrasiaticus* density, application of chemicals can be avoided. The fact that a certain level of pest density is needed to keep natural enemies alive is a common issue observed for other pests (Surendra 2019).

Product loss per injury unit is also inversely correlated with the EIL. In other words, by increasing the yield loss as a result of the unit of damage, the level of EIL decreases. The higher the yield loss as a result of the damage unit, the lower EIL; farmers have to initiate pest control in the lower densities of the date spider mite. When the population of *O. afrasiaticus* exceeds the date palm tolerance, net income declines rapidly. In contrast, when the pest density is higher and requires less control, the expenditures are expected to decline rapidly, resulting in a reduction in total date production costs. At point of economic damage, some of the gross income will be lost. Beyond the economic threshold, the farmers would not be able to increase their income in the same proportion they spend for controlling *O. afrasiaticus* (the cost of control would be higher than the income). If the control starts successfully at the tolerance point or threshold, the amount of damage will be zero.

Even though the damage of date palm mite can be prevented by prophylactic acaricide applications (Arbabi *et al.* 2017), it is expected that the excessive use of pesticides will eventually lead to the resistance development and subsequent pest outbreaks (Humeres and Morse 2005; Morse 2007; Arbabi *et al.* 2010). Adopting the EIL established in the present study could help to reduce pesticide applications against *O. afrasiaticus* in date palm orchards and delay pest resistance development. It also helps to diminish the adverse effects of chemicals on the environment and human health through providing the dutiable conditions for the activities of natural enemies (Latifian 2017).

REFERENCES

- AL-Ahmadi, M.S. (2019) Pesticides, anthropogenic activities, and the health of our environment safety, pesticides - use and misuse and their impact in the environment. *In*: Larramendy, M.L. & Soloneski, S. (Eds.) *Pesticides, use and misuse and their impact in the environment*. IntechOpen, London, United Kingdom. DOI: [10.5772/intechopen.84161](https://doi.org/10.5772/intechopen.84161)
- Al-Deeb, M. A. (2012) Date palm insect and mite pests and their management. *In*: Manickavasagan, A., Mohamed Essa, M. & Sukumar, E. (Eds.), *Date: Production, processing, food, and medicinal values*. Boca Raton, CRC Press, Taylor and Francis Group, pp. 113–128

- Aldosari, S.A. (2009) Occurrence of dust mite, *Oligonychus afrasiaticus* McG. on fruits, leaflets of some date palm tree and evaluation the efficiency of botanical compound, (biaco) as compared with some acaricides. *Assiut University Bulletin Environmental Research*, 12: 69–77.
- Al-Jboory, I.J. (2007) Survey and identification of the biotic factors in the date palm environment and its application for designing IPM-program of date palm pests in Iraq. *Aden Journal of Natural and Applied Sciences*, 11: 1–28.
- Al-Haidari, H.S., Al-Safi, G., Mechael, N. & Sallam, N. (1982) Effect of temperature on the development of *Oligonychus afrasiaticus* (McGregor). *Plant protection Research Year Book*, 2: 165–167 (In Arabic).
- Arbabi, M., Asgari, M., Fasihi, M.T., Golmohammadzadeh-Khiaban, N., Damghani, M.R., Latifian, M. & Babai, M. (2010) Evaluation of water spray application for organic control of date palm spider mite *Oligonychus afrasiaticus* (McGregor) (Acari: Tetranychidae) of date palm orchards in southern parts of Iran. *Journal of Entomological Research*, 1: 269–277.
- Arbabi, M., Latifian, M., Askari, M., Fasihi, M.T., Damghani, M.R., Golmohammadzadeh-Khiaban, N. & Rezai, H. (2017) Evaluation of different treatments in control of *Oligonychus afrasiaticus* in date palm orchards of Iran. *Persian Journal of Acarology*, 6: 125–135.
- Ba-Angood, A.S. & Bass'haih, G.S. (2000) A study on the effect of date palm dust mite *Oligonychus afrasiaticus* (McGregor) (Acarina: Tetranychidae) on the physiochemical characters of three different date varieties in Wadi Hadramout, Yemen. *Arab Journal of Plant Protection*, 18: 82–85.
- Bardner, R. & Fletcher, K.E. (1974) Insect infestations and their effects on the growth and yield of field crops: A review. *Bulletin of Entomology Research*, 64: 141–60.
- Bass'haih, G.S. (1999) *Studies on the occurrence of the date palm dust mite Oligonychus afrasiaticus (McGregor) (Acarina: Tetranychidae) and its natural enemies on different date palm varieties in Wadi Hadramout*. M.Sc. Thesis, Department of Plant Protection, College of Agriculture, University of Aden, Yemen, 55 pp.
- Blumberg, D. (2008) Date palm arthropod pests and their management in Israel. *Phytoparasitica*, 36: 411–448.
- Chaaban, S., Ben Chaaban, B.C. & Kreiter, S. (2011) *Oligonychus afrasiaticus* and phytoseiid predators seasonal occurrence on date palm *Phoenix dactylifera* (Deglet Noor cultivar) in Tunisia oases. *Bulletin of Insectology*, 1: 15–21.
- Chung, B.K. (2001) Analysis of damage by *Frankliniella occidentalis* economic thresholds of western flower thrips (Thysanoptera: Thripidae) in eggplants. *Journal of Asia Pacific Entomology*, 4: 149–155.
- Cocco, A., Serra, G., Lentini, A., Deliperi, S. & Delrio, G. (2015) Spatial distribution and sequential sampling plans for *Tuta absoluta* (Lepidoptera: Gelechiidae) in greenhouse tomato crops. *Pest Management Science*, 71: 1311–1323.
- Damos, P. (2014) Stochastic modeling of economic injury levels with respect to yearly trends in price commodity. *Journal of Insect Science*, 14(1): 59. DOI: [10.1093/jis/14.1.59](https://doi.org/10.1093/jis/14.1.59)
- El-Wakeil, N.E. (2010) Insect economic levels in relation to crop production. *Archives of Phytopathology and Plant Protection*, 43(17): 1710–1744. DOI: [10.1080/03235400902753584](https://doi.org/10.1080/03235400902753584)
- Elwan, A.A. (2000) Survey of the insect and mite pests associated with date palm trees in Al-Dakhliya region, Sultanate of Oman. *Egyptian Journal of Agricultural Research*, 78: 653–664.
- Hall, D.G. & Teetes, G.L. (1982) Yield loss-density relationships of four species of panicle-feeding bugs in sorghum. *Environmental Entomology*, 11: 738–41.
- Higgins, R.A., Pedigo, L.P. & Staniforth, D.W. (1984) Effect of velvetleaf competition and defoliation simulating a green cloverworm (Lepidoptera: Noctuidae) outbreak in Iowa on indeterminate soybean yield, yield components, and economic decision levels. *Environmental Entomology*, 13(9): 17–25.

- Humeres, E. & Morse, J. (2005) Baseline susceptibility of perseas mite (Acari: Tetranychidae) to abamectin and milbemectin in avocado groves in Southern California. *Experimental & Applied Acarology*, 36: 51–59. DOI: [10.1007/s10493-005-1545-7](https://doi.org/10.1007/s10493-005-1545-7)
- Jaques, R.P. (1962) Stress and nuclear polyhedrosis in crowded populations of *Trichoplusia ni* (Hubner). *Journal of Insect Pathology*, 4: 1–22.
- Kadjabaf Vala, G.R. & Kamali, K. (1993) Biology of old world date mite *Oligonychus afrasiaticus* (McG.) in Khuzestan. *The Scientific Journal of Agriculture*, 16(1 & 2): 31–41. DOI: [10.22055/PPR.1993.12807](https://doi.org/10.22055/PPR.1993.12807)
- Latifian, M., Marashi, S.S., Ahmadizadeh, S. & Nikbakht, P. (2007) Host preference of date palm spider mite, *Oligonychus afrasiaticus* (McGregor), to native date palm cultivars of Khuzestan. *Journal of Seeds Plant Improvement*, 23: 245–255.
- Latifian, M. (2012) Voracity and feeding preferences of larvae and adult stages of *Stethorus gilvifrons* Mulsant (Coleoptera: Coccinellidae) on larvae and adult of *Oligonychus afrasiaticus* McGregor (Acarina: Tetranychidae). *International Journal of Agriculture and Crop Sciences*, 4: 540–546.
- Latifian, M. (2014) Date palm spider mite (*Oligonychus afrasiaticus* McGregor) forecasting and monitoring system. *Walia Journal*, 30(S2): 79–85.
- Latifian, M. (2017) Integrated pest management of date palm fruit pests: A review. *Journal of Entomology*, 14: 112–121.
- Latifian, M., Rahnama, A.A., & Amani, M. (2014) The effects of cultural management on the Date spider mite (*Oligonychus afrasiaticus* McG) infestation. *International Journal of Farming and Allied Sciences*, 3(9): 1009–1014.
- Latifian, M. & Kajbafvala, G. (2016) *Studying the efficiency of Stethorus gilvifrons inoculate release for Date palm spider mite (Oligonychus afrasiaticus) biological control in field condation*. Ministry of Jihad-E-Agriculture. Research and education organization. Date palm and Tropical Fruits Research Institute of Iran, Tehran, Iran, 75 pp.
- Maoz, Y., Galand, S., Zilberstein, M. & Palevsky, E. (2010) Determining an economic injury level for the perseas mite, *Oligonychus perseae*, a new pest of avocado in Israel. *Entomologia Experimentalis et Applicata*, 138(2): 110–116.
- Machlitt, D. (1998) Perseas mite on avocados: quick field counting method. *Subtropical Fruit*, 6: 1–4.
- Martínez-Ferrer, M.T., Jacas, J.A., Ripollés-Moles, J.L. & Aucejo-Romero, S. (2006) Approaches for sampling the two spotted spider mite (Acari: Tetranychidae) on clementines in Spain. *Journal of Economic Entomology*, 99: 1490–1499. DOI: [10.1093/jee/99.4.1490](https://doi.org/10.1093/jee/99.4.1490)
- Martins, J.C., Picanço, M.C. & Silva, R.S. (2017) Assessing the spatial distribution of *Tuta absoluta* (Lepidoptera: Gelechiidae) eggs in open-field tomato cultivation through geostatistical analysis. *Pest Management Science*, 74(1): 30–36. DOI: [10.1002/ps.4664](https://doi.org/10.1002/ps.4664)
- Morse, J.G. (2007) *Management and resistance monitoring of avocado thrips and perseas mite*. Production Research Report, California Avocado Commission, Irvine, CA, USA, 7 pp.
- Norgaard, R.B. (1976) The economics of improving pesticide use. *Annual Review of Entomology*, 21: 45–60.
- Ordish, G. & Dufour, D. (1969) Economic bases for protection against plant diseases. *Annual Review of Phytopathology*, 7: 31–50.
- Palevsky, E., Ucko, O., Peles, S., Yablonski, S., & Gerson, U. (2003) Species of *Oligonychus* infesting date palm cultivars in the Southern Arava Valley of Israel. *Phytoparasitica*, 31(2): 350–355.
- Pedigo, L.P., Hammond, R.B. & Poston, F.L. (1977) Effects of green cloverworm larval intensity on consumption of soybean leaf tissue. *Economic Entomology*, 70(1): 59–62.
- Pedigo, L.P. & Higley, L.G. (1992) A new perspective of the economic injury level concept and environmental quality. *American Entomologist*, 38: 12–21.

- Pimentel, D. (2009) Environmental and economic costs of the application of pesticides primarily in the United States. *In: Peshin, R. & Dhawan, A.K. (Eds.), Integrated Pest Management: Innovation-Development Process*. Springer, Dordrecht, pp. 89–111. DOI: [10.1007/978-1-4020-8992-3_4](https://doi.org/10.1007/978-1-4020-8992-3_4)
- Regev, U., Gutierrez, A.P. & Feder, G. (1976) Pests as a common property resource: A case study of alfalfa weevil control. *American Journal of Agricultural Economics*, 5(81): 86–99.
- Riley, D.G. (2008) Economic Injury Level (EIL) and Economic Threshold (ET) concepts in pest management. *In: Capinera, J.L. (Ed.), Encyclopedia of Entomology*. Springer, Dordrecht. DOI: [10.1007/978-1-4020-6359-6_3497](https://doi.org/10.1007/978-1-4020-6359-6_3497)
- Shelton, A.M., Andaloro, J.T. & Barnard, J. (1982) Effects of cabbage looper, imported cabbage-worm, and diamondback moth on fresh market and processing cabbage. *Economic Entomology*, 75: 742–45.
- Shiberu, T. & Getu, E. (2018a) Experimental analysis of economic action level of tomato leaf miner, *Tuta absoluta* Meyrick (Lepidoptera: Gelechiidae) on tomato plant under open field. *Advances in Crop Science and Technology*, 6: 1–5.
- Shiberu, T. & Getu, E. (2018b) Determination of the economic threshold level of tomato leaf miner, *Tuta absoluta* Meyrick (Lepidoptera: Gelechiidae) on tomato plant under glasshouse conditions. *Journal of Horticulture and Forestry*, 10: 9–16.
- Shipp, J.L., Wang, K. & Binns, M.R. (2000) Economic injury levels for western flower thrips (Thysanoptera: Thripidae) on greenhouse cucumber. *Journal of Economic Entomology*, 93: 1732–1740.
- Southwood, T.R.E. & Norton, G.A. (1973) Economic aspects of pest management strategies and decisions. *In: Geier, P.W., Clark, L.R., Anderson, D.J. & Nix, H.A. (Ed.), Insects: studies in population management*. Ecological Society of Australia, Canberra, Memoir 1, pp. 168–184.
- Stefanou, S.E. (1984) *Pest management concepts-past, present, and future*. Farm Economics, July/August, 4 pp.
- Stern, V.M. (1975) The bioeconomics of pest control. *Iowa State Journal of Research*, 49(4): 467–472.
- Stern, V.M., Smith, R.F., Van den Bosch, R. & Hagen, K.S. (1959) The integrated control concept. *Hilgardia*, 29: 81–101.
- Surendra, K.D. (2019) The New integrated pest management paradigm for the modern age. *Journal of Integrated Pest Management*, 10(1): 12. DOI: [10.1093/jipm/pmz010](https://doi.org/10.1093/jipm/pmz010)
- Tammes, P.M.L. (1961) Studies of yield losses. II. Injury as a limiting factor of yield. *Tijdschrift Over Plantenziekten*, 67: 257–263. DOI: [10.1007/BF01984045](https://doi.org/10.1007/BF01984045)

COPYRIGHT

Latifian *et al.* Persian Journal of Acarology is under a free license. This open-access article is distributed under the terms of the Creative Commons-BY-NC-ND which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original author and source are credited.

سطح زیان اقتصادی کنه تارتن خرما، *Oligonychus afrasiaticus* (Acari: Tetranychidae) در شش رقم تجاری خرما

مسعود لطیفیان^{۱*}، محمد جواد عصار^۲، سید سعید مدرسی نجف آبادی^۳، مجید امانی^۱، فرزانه بساوند^۴، محمد تقی فصیحی^۵، هادی زهدی^۲ و عبدالنبی باقری^۳

۱. سازمان تحقیقات، آموزش و ترویج کشاورزی، پژوهشکده علوم باغبانی، مرکز تحقیقات خرما و میوه‌های گرمسیری، اهواز، ایران؛ رایانامه‌ها: majidamani2008@yahoo.com Masoud_latifian@yahoo.com
۲. گروه تحقیقات حفاظت از گیاهان، مرکز تحقیقات و آموزش کشاورزی و منابع طبیعی کرمان، سازمان آموزش و ترویج تحقیقات کشاورزی، کرمان، ایران؛ رایانامه‌ها: h.zohdi@areeo.ac.ir m.assari@areeo.ac.ir
۳. گروه تحقیقات گیاهپزشکی، مرکز تحقیقات و آموزش کشاورزی و منابع طبیعی هرمزگان، سازمان آموزش و ترویج تحقیقات کشاورزی، بندرعباس، ایران؛ رایانامه‌ها: abibagheri53@gmail.com s_modarres_705@yahoo.com
۴. گروه تحقیقات گیاهپزشکی، مرکز تحقیقات و آموزش کشاورزی و منابع طبیعی ایرانشهر، سازمان آموزش و ترویج تحقیقات کشاورزی، ایرانشهر، ایران؛ رایانامه: basavand@hotmail.com
۵. گروه تحقیقات حفاظت از گیاهان، مرکز تحقیقات و آموزش کشاورزی و منابع طبیعی بوشهر، سازمان آموزش و ترویج تحقیقات کشاورزی، بوشهر، ایران؛ رایانامه: fassih47@yahoo.com

* نویسنده مسئول

چکیده

کنه تارتن خرما، *Oligonychus afrasiaticus* (McGregor) (Acari: Tetranychidae) یکی از آفات زیان‌آور نخل خرما است که موجب خسارت اقتصادی زیادی می‌شود. در این پژوهش، رابطه بین انبوهی جمعیت *O. afrasiaticus* و سطح آسیب آن و خسارت و شاخص‌های کاهش عملکرد خرما در شش رقم تجاری خرما در پنج استان خرماخیز ایران از جمله خوزستان (سایر و برحی)، هرمزگان (پیارم)، کرمان (مضافتی)، بوشهر (کبکاب) و سیستان و بلوچستان (ربی) بررسی شدند. آزمایش‌ها در قالب طرح بلوک‌های کامل تصادفی با پنج تیمار و سه تکرار انجام شد. به این منظور، در هر تکرار، چهار خوشه خرما از چهار جهت جغرافیایی مختلف انتخاب و از هر یک از آنها ۲۵ میوه به طور تصادفی بررسی شد و تعداد میوه‌های سالم و آلوده مشخص شدند. نمونه‌گیری در فواصل هفت روزه از اواخر ماه خرداد تا اوایل مهرماه تکرار شد. از مدل نورتون برای برآورد سطح زیان اقتصادی (EIL) در شرایط مهار زیستی و شیمیایی استفاده شد. بیشترین مقدار EIL در سال ۱۳۹۸ برای رقم سایر در روش مهار شیمیایی (۱۸۲۷ کنه-روز) و کمترین آن برای پیارم در روش مهار زیستی (۲۵/۵ کنه-روز) برآورد شد. همچنین نتایج نشان داد که هزینه مهار زیستی به مقدار زیادی کمتر از مهار شیمیایی است. بیشترین و کمترین میزان آسیب خرما (علایم تغذیه آفت) به ترتیب در ارقام برحی و مضافتی مشاهده شد. بیشترین و کمترین میزان خسارت خرما به ترتیب در رقم‌های کبکاب و سایر مشاهده شد.

واژگان کلیدی: مهار زیستی؛ مهار شیمیایی؛ نخل خرما؛ سطح زیان اقتصادی؛ مدیریت آفات.

اطلاعات مقاله: تاریخ دریافت: ۱۴۰۰/۳/۳۱، تاریخ پذیرش: ۱۴۰۰/۴/۳۱، تاریخ چاپ: ۱۴۰۰/۷/۲۳