# **ACCEPTED ARTICLE**

# Population Changes and Spatial Distribution Pattern of the Date Palm Spider Mite Oligonychus afrasiaticus (McGregor) in Natural Conditions of Ramshir, Khuzestan Province

# Manuchehr Jahangiri<sup>1</sup>, Leila Ramezani<sup>2\*</sup>, and Ebrahim Tamoli Torfi<sup>3</sup>

<sup>1</sup> Department of Plant Protection, Faculty of Agriculture, Agricultural Science and Natural
 Resources University of Khuzestan.

 <sup>2</sup> Department of Plant Protection, Faculty of Agriculture, Agricultural Sciences and Natural Resources University of Khuzestan, Mollasani, Khuzestan, Islamic Republic of Iran.

<sup>3</sup> Department of Plant Protection, Faculty of Agriculture, Agricultural Science and Natural
 Resources University of Khuzestan.

16 \*Corresponding author; e-mail: ramezani@asnrukh.ac.ir or danaus.lpp@gmail.com

17

15

1 2

3

4

5 6

7 8

#### **18 ABSTRACT**

The date palm dust mite Oligonychus afrasiaticus (McGregor) is one of the most important 19 pests of the date palms *Phoenix dactylifera* L. around the world. This pest causes reduction in the 20 21 economic value of the product, and sometimes its damage reaches up to 100% in the southern 22 provinces of Iran. The population fluctuations and spatial distribution of this pest on two more common varieties (Sayer and Barhi) were investigated in Ramshir city, Khuzestan province, 23 24 southwestern Iran. For this purpose, two date palm plantations of 2 ha planted with mixed those two varieties of date palm trees were selected and 10 trees of each variety in each orchard were 25 selected randomly. Sampling was done from four directions (North, South, East, and West) of each 26 date palm every four days from mid-May to Early-November during 2020 and 2021. The results 27 showed that the spider mite appeared on the clusters of two varieties from the beginning of June 28 and the peak population of mites on both varieties was recorded in September in 2020 and 2021. 29 30 Significant difference was observed between different sampling times during those two years and two varieties: Sayer (F<sub>1.916</sub>, 9.580=183. 695, P<0.0001) and (F<sub>2.344</sub>, 11.720=58. 104, P<0.0001) and 31 Barhi ( $F_{1.541, 4.622}$ =89.010, P<0.0001) and ( $F_{1.688, 5.065}$ =31. 137, P<0.002) in 2020 and 2021 32 respectively. The spatial distribution pattern of mites on both varieties in two years were assessed 33 34 through the regression models of Taylor's power low and Iwao's patchiness regression method. The results of dispersion indicated an aggregated pattern of this pest in both varieties. The 35 36 information obtained from the results can be used to prepare a successful integrated pest management program to reduce the consumption of chemical poisons for control of this pest. 37

38 Keywords: Barhi, Date spider mite, Sayer, Iran, Spatial distribution.

39

#### 40 INTRODUCTION

Dates palm (Phoenix dactylifera L.) with more than four thousand years old are one of the most 41 42 important and strategic products in Iran. The countries of Iran, Iraq, Pakistan, Tunisia, Egypt and Saudi Arabia, are the most important exporters of date around the world. With more than 250 43 thousand hectares of date orchards, Iran is one of the largest producers and exporters of dates in 44 the world. Currently, dates are cultivated and produced in 13 provinces of the country, of which 45 five provinces produce more than 99% of the country's dates. In terms of the amount of production, 46 47 Sistan and Baluchistan province ranks first and followed by Kerman, Fars, Bushehr, Khuzestan and Hormozgan provinces (Ahmadi et al., 2021). 48

49 One of the most important pests on date palm trees is the date spider mite Oligonychus afrasiaticus (McGregor) (El-Shafie, 2022). This pest has a global distribution and can be found in 50 the Afrotropical, Nearctic, and Palearctic regions. It has been reported in several countries, 51 including Iran, Iraq, Saudi Arabia, United Arab Emirates, Bahrain, Oman, Kuwait, Yemen, Jordan, 52 Israel, Libya, Tunisia, Algeria, Morocco, Egypt, Sudan, Chad, Mauritania, Mali, and Nigeria (Al-53 Zadjali, 2006; Alatawi and Kamran, 2018; Sanad et al., 2017 Migeon and Dorkeld, 2021). In Iran, 54 55 this mite is distributed in the palm cultivation areas including Khuzestan, Bushehr, Fars, Isfahan (Khour and Biabanak) and it have also been collected from ornamental date palm, corn, sugarcane, 56 57 sorghum and weeds (Farahbakhsh, 1961; 32. Modarres Awal, 1994; Gharib, 1991; Mossadegh and Kocheili, 2002). The damage of this pest is high in Khuzestan province and Bushehr and the 58 infestation may lead high economic losses (Arbabi et al., 2010; Latifian et al., 2021). 59

One of the important features of phytophagous mite's population, is their spatial distribution 60 61 and population dynamics which can help determining the time of infestations, time of pest outbreak, and the period when they frequently occur in the field (Ferraz et al., 2020). Different 62 63 developmental stages of a species can create different distribution patterns according to their 64 activity level. The distribution pattern is the result of the interaction between a population and its 65 surrounding environment. Being aware of this pattern in the environment allows us to have more information and the ability to describe and recognize the studied population (Pool, 1974). The 66 67 spatial distribution pattern can be used in modeling, determining the appropriate sampling method 68 and designing sampling programs (Taylor, 1984; Franco et al., 2008; Ramezani et al., 2016). Therefore, the better the spatial distribution of a species is known, the more and better the 69

population dimensions of that species in natural and agricultural ecosystems can be measurable(Pool, 1974).

Population members can be described in three types: random, regular, and aggregated dispersion. Random distribution uses all points equally, while regular distribution is suitable for small areas and rarely describes large areas. (Pool, 1974). Aggregative distribution occurs when one species' presence increases the likelihood of another species' presence near the same point, often due to irregularly distributed environmental factors or species' tendency to aggregate. (Pool, 1974, Latifian *et al.*, 2012, 2018, 2021; Ramezani and Zandi sohani, 2013; Ramezani *et al.*, 2016; Ghaedi *et al.*, 2020).

Although a number of researchers have investigated the population fluctuations of O. 79 afrasiaticus in different parts of the world, for example, Elhalawany et al. (2020), investigated the 80 population dynamics of O. afrasiaticus on dates fruits in Qalyubia and New Valley governorates 81 82 of Egypt, while Ben-Chaban et al. (2011) assessed the seasonal occurrence of O. afrasiaticus and phytoseiid predators on date palm in Tunisian oases and again Ben-Chaban et al. (2017) conducted 83 84 another study on the seasonal occurrence of the date palm spider mite O. afrasiaticus on the cultivar Deglet Nour in a pesticide-free Tunisian date palm oasis, however, such studies are rare in Iran and 85 researchers have worked more in the field of studying the biology and control of this pest (Latifian 86 et al., 2006; Latifian, 2017; Arbabi et al., 2017). Aims of this research were studying population 87 fluctuations and spatial distribution of date spider mite in order to better understand the behavioral 88 89 characteristics and help the effective control methods.

# 90

# 91 MATERIALS AND METHODS

### 92 Study site

In order to investigate the population changes of the date spider mite *O. afrasiaticus* in Ramshir city (E 30°53'28.0" N49°24'26.3"), Khuzestan Province, Iran, two separate date palm orchards, with two varieties (one with Barhi and the other with Sayer) were selected and 10 date palm trees (two date palm trees from the center of date palm plantation and two from each geographical direction: East, West, North and South) from each variety with relatively uniform infestation were chosen randomly. Sampling palm trees were between 13-15 years old and their height was about two meters and they were not treated with any insecticides or acaricides during the study.

# 100 Sampling

Mite populations were sampled every four days from June to November of two years (2020 and 101 102 2021). In each sampling date eight fruits were chosen randomly from the four directions of the north, south, east and west (two fruits from each direction and about 80 fruits per sampling date in 103 each date palm plantation for each variety) and mites were extracted by washing the fruits in 70% 104 ethanol and then counted under a stereomicroscope. Also the minimum and maximum temperature 105 106 values and the average temperature were recorded on each sampling date. To analyze the effect of 107 sampling date (during 2020 and 2021) and date varieties (Barhi and Sayer) on mite population, one-way analysis of variance were used. Also, to determine the significant difference between the 108 109 average populations of mites in each of the geographical directions and compare it with the average population in all directions (all four directions) Student's t method at the level of 0.05 was used. 110

#### 111 Spatial distribution

In order to determine the spatial distribution of mites on each date palm tree, linear regression method (Taylor's power law and Iwao's patchiness regression method) was used. In this method, the data related to each date was considered separately and the variance and average of each sampling date were calculated.

116

#### 117 Taylor's power law b index

118 Taylor (1961) found a function between mean and variance as:

119  $S^2 = a\overline{x}^b \Longrightarrow \log S^2 = \log a + b \log(\overline{x})$ 

In this relationship, "a" and "b" are two constant parameters, where "a" depends on the sample size and "b" indicates the amount of accumulation. To calculate Taylor's *b* index, after calculating the mean and variance of the samples, by establishing a regression relationship between the logarithm of the variance as the dependent variable and the logarithm of the mean as the independent variable, the slope of the regression line or Taylor's *b* coefficient is calculated. If *b* is greater, equal or smaller than one, it indicates a negative binomial (aggregated), a Poisson (random), or a positive binomial (regular) distribution, respectively (Taylor, 1984).

128 129

127

Downloaded from jast.modares.ac.ir on 2024-05-08

# Iwao's patchiness regression method

The average Lloyd's crowding index is denoted by *m*\*. This index was calculated by the followingrelationship.

$$m^* = m + \frac{s^2}{m-1}$$

132 In this relationship, *m* and *s* are the mean and variance of the investigated samples, respectively.

133 Iowa established the following regression relationship between Lloyd's crowding index and 134 average samples:  $m^* = \alpha + \beta m$ 

135  $\alpha$ : indicates the tendency of individuals to crowding and is one of the inherent properties of the

- 136 species and  $\beta$  reflects the population distribution in space and is interpreted in the same manner as
- 137 the *b* of Taylor's power law (Iwao, 1968). If  $\beta$  is greater than or equal to one, the distribution of
- 138 samples corresponds to negative binomial or Poisson, respectively, while  $\beta$  less than one is not
- biologically defined (Southwood, 2000). Then the calculated t was compared with the Student's t-
- table and based on that the type of mite spatial distribution was determined (Southwood, 2000).
- 141 Test b = 1  $t = (b 1) / SE_b$  and Test  $\beta = 1$   $t = (b 1) / SE_{\beta}$

where SE<sub>b</sub> and SE<sub>β</sub> are the standard errors of the slope for the mean crowding regression. Calculated values are compared with Two-tailed *t*-test at n-2 degrees of freedom. If the calculated  $t(t_c) < t$ -table  $(t_t)$ , the null hypothesis (b=1) would be accepted and spatial distribution would be random and if it is the opposite, then the null hypothesis would be rejected and if b > 1 and < 1, the spatial distribution would be aggregated and uniform, respectively. SPSS software (version 16.0) was used to perform all analyzes and Excell (2010) software was used to draw graphs.

149 **RESULTS** 

148

Based on the sampling results, the emergence and activity of the date palm dust mite was from 150 151 the beginning of June on the fruits of both Sayer and Barhi varieties (Figure 1 and 2). Beginning of O. afrasiaticus infestation was recorded from the early of Jun on Sayer and late of May on Barhi 152 153 in 2020 and 2021. On the other hand, the peak population (98.31 and 97.38 mites per fruit) of spider mite was observed on Sayer on 10<sup>th</sup> September 2020 and 17<sup>th</sup> August 2021, respectively and (111.8 154 and 158.09 mites per fruit) on Barhi on 13<sup>th</sup> September 2020 and 24<sup>th</sup> August 2021, respectively. 155 The mean temperature at those times was between 37-39°C for both years. After the peak of mite 156 157 population, the trend of population changes decreased and the lowest population was recorded in mid-October for both varieties (mean temperature was about 14.5°C) and after the end of October, 158 159 due to the entry of fruit into the Rutab and mature stage and crop harvest, no mite were observed (Figure 1 and 2). Significant differences were observed between different sampling times in 2020 160 and 2021 on Sayer (F<sub>1.916, 9.580</sub>=183.695, P<0.0001) and (F<sub>2.344,11,720</sub>=58.104, P<0.0001) and Barhi 161  $(F_{1.541, 4.622}=89.010, P<0.0001)$  and  $(F_{1.688, 5.065}=31.137, P<0.002)$ , respectively. In addition, a 162

significant difference was observed in population dynamics of the spider mite on the two varieties 163 during the sampling dates in 2020 ( $t_{1,342}$ =8.630, P=0.004). However, no significant difference was 164 observed in  $2021(t_{1,438}=0.283, P=0.595)$ . The analysis of variance revealed no significant 165 difference in the changes of mite population on the Saver variety between the two years of sampling 166  $(t_{1,434}=1.823, P=0.178)$ . However, a significant difference was observed in the mite population on 167 the Barhi variety between the two sampling years ( $t_{1,345}$ =16.856, P=0.0001), with the population 168 density on Barhi higher in 2021 compared to 2020. According to Table 1 the population dynamics 169 of the spider mite on four directions of each tree during two years of sampling on both Barhi and 170 Sayer varieties was similar and the statistical analysis showed that the changes in the mite 171 population in the north, south, east and west directions of date palm were not significantly different 172 for both varieties (Sayer and Barhi) during 2020 (*F*<sub>3,168</sub>=0.010, *P*=0.999; *F*<sub>3,168</sub>=0.029, *P*=0.993) 173 and 2021 ( $F_{3,172}=0.514$ , P=0.673;  $F_{3,172}=0.420$ , P=0.739), respectively. These findings suggest that 174 the presence and distribution of date spider mite on the Sayer and Barhi varieties in all directions 175 of the tree in the studied date palm plantations was relatively uniform. 176

177

(I)	(J)	M			95% Confidence Interval		
Directi on	Directi on	Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound	
	South	-0.0233	8.17677	0.998	-16.0778	16.0313	
North	East	3.151	8.17677	0.700	-12.9034	19.2057	
	West	-1.384	8.17677	0.866	-17.4383	14.6709	
	North	0.0233	8.17677	0.998	-16.0313	16.0778	
South	East	3.174	8.17677	0.698	-12.8802	19.2290	
	West	-1.361	8.17677	0.868	-17.4151	14.6941	
	North	-3.151	8.17677	0.700	-19.2057	12.9034	
East	South	-3.174	8.17677	0.698	-19.2290	12.8802	
	West	-4.535	8.17677	0.579	-20.5895	11.5197	
	North	1.384	8.17677	0.866	-14.6709	17.4383	
West	South	1.361	8.17677	0.868	-14.6941	17.4151	
	East	4.535	8.17677	0.579	-11.5197	20.5895	

Table 1. Multiple Comparisons of the spider mite population in four geographical directions ofsampling date palm trees.



Figure 1. Population fluctuation of *Oligonychus afrasiaticus* on Sayer and Barhi varieties of datepalm orchards in 2020.



**Figure 2.** Population fluctuation of *Oligonychus afrasiaticus* on Sayer and Barhi varieties of date palm orchards in 2021.



190 Figure 3. The time duration of different developmental stages of date palm fruit in Ramshir.

The spatial distribution patterns and parameters of O. afrasiaticus in general (Table 2) and in 192 different geographical directions (Figure 3 and 4) was assessed according to Taylor's power law 193 and Iwao's patchiness regression on both varieties and the slope of the regression line was 194 calculated during 2020 and 2021. The results showed that both methods provided a significant 195 relationship between variance and mean density (in Taylor's power law), and between mean 196 crowding and mean density (in Iwao's patchiness regression). Also in both methods the calculated 197 t (t<sub>c</sub>) was greater than the t in the table, thus indicating a significant difference in the slope of the 198 199 line with the number one (b>1) (Table 2). In other words, the spatial distribution of spider mite was aggregative (variance is greater than the average). Although the Iwao's patchiness method 200 compared to Taylor's power law better demonstrated fitness to this spider mite data, the results of 201 two years sampling showed that in both methods the explanatory coefficients ( $\mathbb{R}^2$ ) have a good 202 203 correlation with the data (Table 2) and both methods showed that the spatial distribution pattern of 204 this spider mite was aggregated in general and in four geographical directions (Figure 3 and 4).

Table 2. Spatial distribution statistics of *Oligonychus afrasiaticus* on two varieties of date palm
 (Sayer and Barhi) using Taylor's power law and Iwao's patchiness regression analysis.
 .

Spatial distribution method	Year of sampling	Variety	N	Regression slope ± SE	Intercept $\pm$ SE	R <sup>2</sup>	Spatial distribution	$t_c$	$F_{(df)}$	Pregression
-----------------------------------	------------------	---------	---	-----------------------------	--------------------	----------------	----------------------	-------	------------	-------------

205

189

	2020	Sayer	44	1.584±0.073	0.517±0.147	0.921	Clumped	8	475.034(1,41)	< 0.0001
Taylor		Barhi	44	1.589±0.078	0.366±0.161	0.910	Clumped	7.551	412.467(1,43)	< 0.0001
	2021	Sayer	44	1.369±0.052	0.182±0.122	0.941	Clumped	7.096	691.405(1,43)	< 0.0001
	2021	Barhi	44	1.391±0.081	0.390±0.201	0.875	Clumped	4.827	293.543(1,43)	< 0.0001
Iwao	2020	Sayer	44	1.043±0.012	$1.483 \pm 1.028$	0.995	Clumped	3.583	7.983(1,43)	< 0.0001
	2020	Barhi	44	1.050±0.020	1.243±1.814	0.985	Clumped	2.5	2.784(1,43)	< 0.0001
	2021	Sayer	44	1.032±0.005	1.779±2.527	0.999	Clumped	6.4	4.391(1,43)	< 0.0001
		Barhi	44	1.028±0.009	17.684±5.670	0.996	Clumped	3.111	1.182(1,43)	< 0.0001

209 Taylor: Taylor's power law and Iwao.: Iwao's patchiness regression.

211 Table 3. Linear regression between temperature and the mean population densities of *Oligonychus* 

212	afrasiaticus on	varieties	of Barhi	and Sayer	during	2020	and 2021	in Ramshir.
-----	-----------------	-----------	----------	-----------	--------	------	----------	-------------

Year of sampling Variety		Ν	Regression slope ± SE	$Intercept \pm SE$	R <sup>2</sup>	F <sub>(df)</sub>	Pregression
2020	Sayer	44	$1.441 \pm 0.422$	18.682±13.746	0.453	11.634(1,43)	< 0.0001
2020	Barhi	44	$1.867 \pm 0.417$	29.46±13.753	0.556	20.091(1,43)	< 0.0001
2021	Sayer	44	2.819±0.215	48.526±6.987	0.793	172.441(1,43)	< 0.0001
	Barhi	44	$3.597 \pm 0.402$	53.647±13.075	0.640	80.138(1,43)	< 0.0001

213

#### 214 DISCUSSION

215 According to the current research, the appearance of the date spider mite on the Sayer and Barhi during two consecutive years was at the beginning of June. With the increase in temperature, the 216 mite's population increased and the peak population was recorded in the beginning and middle of 217 September 2020 and in the middle to the end of August 2021 in Sayer and Barhi, respectively. The 218 219 effect of temperature on the mite population is shown in Table 3. As it shown, temperature has a positive effect on increasing the mite population. Faez et al. (2018) assessed the population density 220 221 of *Panonychus citri* on Thomson navel orange in Ghaemshahr, Iran. They showed that the peak of 222 mite population occurred in the summer during July to September and they conclude that the 223 temperature is one of the reasons for the increase of mite population. Elhalawany et al. (2020) indicated that the population dynamics of O. afrasiaticus started with attacks fruits at second week 224 225 of April during Kimri stages, and reached its peak on June on Sayer date palm variety. After that the mites migrate from fruits to fronds during Khalal stage. 226

Other researchers have shown that climatic factors such as temperature and dust affect the spider mite population (Ikegami *et al.*, 2000). Latifian (2014) assessed the effect of dust phenomenon on

<sup>210</sup> 

229 date palm important pests and diseases and showed that the dust phenomenon had the highest effects on the incidence of the date spider mite. According to the observations of different 230 231 researchers, the population of date spider mites increases until the beginning of the Khalal stage then decreases. At this stage, when the fruits color change from green to yellow or red, the increase 232 in fruit weight is slow, but the sucrose content increases. In the moist stage, the weight of the fruit 233 decreases due to the decrease in humidity, the color of the skin becomes light brown and the texture 234 235 of the fruit becomes soft. In these stages, the reduction of the mite population continues. As it can be seen in Figures 1, 2 and 3, this decrease in our research started from the middle of September 236 237 and continued until the middle of October, and it is completely correlated with the ripening stages (Rutab and Tamr) of date fruits. Also at the full ripening stage (Tamr), mites are rarely found on 238 239 the fruit and this time coincides with mid-October in Khuzestan province (Figure 3), which the mite population extremely reduces and rarely be seen on the fruits (Figure 1 and 2). These 240 observations are completely consistent with the observations of other researchers (Paloski et al., 241 2005; Aldosari and Ali, 2007; Ben Chaaban et al., 2011). Based on the results of Latifian (2014), 242 243 the activity and damage of O. afrasiaticus starts from May and gradually increases with the warming of the air and the increase of relative humidity. Also, this researcher reported the peak 244 activity of the mite in the months of July and August. On the other hand, the decrease in population 245 and mite damage was reported from September and when the fruit entered the moist stage (Latifian, 246 247 2014). In another study, Latifian and Kajbaf Vala (2016) investigated the effect of releasing 248 Stethorus gilvifrons (Mulsant) ladybug inoculum to control the date spider mite O. afrasiaticus in Shadegan, Khuzestan. According to their results, the emergence and activity of date mite started 249 from the beginning of June and the peak population was also announced in July which is slightly 250 251 different from our result in the present study. As can be seen in Figure 3, in the present study, the 252 rate of increase in the spider mite population was observed in the Kimri stage and the peak 253 population was seen in the Khalal stage, which is completely consistent with the observations of 254 Alatawi et al. (2019). In another study, the density of date spider mite O. afrasiaticus was investigated in Tunisia from 2006-2007. The results showed peak populations in 2006 on Kentichi, 255 256 Alig, Deglent Noor, Besser recorded in July and August; and in July 2007 on Deglent Noor, Kentichi, Alig, and Besser varieties. (Ben Chaaban et al., 2011). Ben Chaaban et al. (2017) and 257 Hussain (1969) found that O. afrasiaticus infestation on date palms starts in mid-May to June, 258 peaking in July and August, and declining at Khalal stage. Resistance to mite infestation varies 259

among different date palm cultivars, with some cultivars more susceptible to infestation than others (Palevsky *et al.* 2005; Aldosari and Ali 2007; Ben Chaaban and Chermiti 2009). Therefore, the results of our study are consistent with the results of other researchers in terms of the appearance and activity of the date spider mite. But in terms of the time of the peak population of spider mites, it does not match with some of the reported results. This inconsistency can be caused by different studied varieties and different geographical regions with different weather conditions.

The results of analyzing the spatial distribution of the spider mite O. afrasiaticus using Taylor's 266 power law and Iwao's patchiness regression (Table 2) during 2020 and 2021 showed that there was 267 268 a significant relationship between mean log and variance of population density. In Both method, the coefficient (b or  $\beta$ ) was greater than 1 and the distribution was aggregated and follows the 269 270 negative binomial pattern. Aggregative spatial distribution of other species of spider mites (Panonychus ulmi in apple orchards (Rahmani et al., 2010), Panonychus citri on Thomson navel 271 272 orange (Faez et al., 2018), and Eotetranychus frosti on apple (Darbemamieh et al. 2012)) has been reported by several researchers. Rahmani et al. (2010) studied the spatial distribution and seasonal 273 274 activity of P. ulmi and its predator Zetzellia mali in Zanjan apple orchards using Taylor's power law and Iwao's patchiness regression methods. They found higher accuracy in Iwao's and Tylor's 275 methods, and Taylor's power law provided more accurate population estimations. In the oresent 276 study, Iwao's patchiness regression showed more accurate estimations of populations than Taylor's 277 278 power law, however, both of them had a high correlation with the data (Table 2). Gharib (1996) 279 during the study on date palm sucking pests declared that the relative density of this group of pests is high and their distribution in date palm plantations is mostly uniform but varies on clusters and 280 leaves. Also, according to different researches, aggregative distribution is the most common pattern 281 of spatial distribution among insects, especially pest insects (Ramezani & Zandi Sohani, 2017; 282 Ramezani et al., 2016; Zarei Sarchogha et al., 2018). This distribution may be seen in all 283 284 developmental stages of the pest or in some developmental stages.



Figure 4. Spatial distribution of *Oligonychus afrasiaticus* in four directions of Barhi cultivar in
2020: left and 2021: right, using Taylor's Power law. B: Barhi, N: North, S: South, W: West, E:
East



Figure 5. Spatial distribution of *Oligonychus afrasiaticus* in four directions of Sayer cultivar in
2020: left and 2021: right, using Taylor's Power law. Es: Sayer, N: North, S: South, W: West, E:
East.

293

### 294 CONCLUSIONS

295 The results of the current study provided valuable information about the population dynamics, appearance time, peak population, and spatial distribution of the date spider mite O. afrasiaticus 296 297 on two important date palm varieties (Sayer and Barhi) in the climatic conditions of Ramshir city, 298 Khuzestan Province, Iran. These findings are essential in the development of effective management 299 strategies and the preparation of successful integrated pest management programs for the date spider mite. By reducing the consumption of chemical poisons and protecting the environment, 300 these programs can help to minimize the economic losses caused by this pest and maintain the 301 productivity of date palm crops. Overall, this research provides a foundation for further studies on 302 the behavior and management of the date spider mite, which can help to improve the sustainability 303 and profitability of date palm cultivation. 304

305

#### 306 ACKNOWLEDGEMENTS

This study was funded by the Agricultural Science and Natural Resources University ofKhuzestan, Iran.

309

314

315

316

317

318

319

320

321

322

### 310 **REFERENCES**

- Ahmadi, K., Hatami, F., Hoseinpoor, R., Abdeshah, H. and Ebadzadeh, H. R. 2021.
   *Agricultural Statistics*. Ministry of Jihad-Agriculture. Deputy of Planning and Economics.
   Tehran, 392pp.
  - Alatawi, F. J. and Kamran, M. 2018. Spider mites (Acari: Tetranychidae) of Saudi Arabia: two new species, new records and a key to all known species. *J. Nat. His.*, 52(7–8): 429– 55.
    - Alatawi, F. J., Mirza, J. H., Alsahwan, K. A. and Kamran, M. 2019. Field population sex ratio of the date date palm mite, *Oligonychus afrasiaticus* (McGregor). *Afr. Entomol.*, 27(2):336–43.
  - Aldosari, S. and Ali, A. G. 2007. Susceptibility of date palm fruit cultivars to the natural infestation by *Oligonychus afrasiaticus* (Mcg.) (Acari: Tetranychidae) in relation to their chemical composition. *Ass. Univ. Bull. Environ. Res.*, 10(2):1–7.

- 5. Al-Zadjali, T. S., Abd-Allah, F. F. and El-Haidari, H. S. 2006. Insect pests attacking date
  palms and dates in Sultanate of Oman. *Egypt. J. Agric. Res.*, 84:51–9.
- Arbabi, M., Latifian, M., Askari, M., Fasihi, M. T., Damghani, M. R.,
  Golmohammadzadeh-Khiaban, N. and Rezai, H. 2017. Evaluation of different treatments
  in control of *Oligonychus afrasiaticus* in date date palm orchards of Iran. *Persian J. Acarol.*,
  6(2):125–35.
- Arbabi, M., Asgari, M., Fasihi, M. T., Golmohammadzadeh-Khiaban, N., Damghani, M.
  R., Latifian, M. and Babai, M. 2010. Evaluation of water spray application for organic
  control of date date palm spider mite *Oligonychus afrasiaticus* (McGregor)
  (Acari:Tetranychidae) of date date palm orchards in southern parts of Iran. *J. Entomol. Res.*,
  1: 269–77.
- Ben Chaaban, S. and Chermiti, B. 2009. Characteristics of date fruit and its influence on population dynamics of *Oligonychus afrasiaticus* in the southern of Tunisia. *Acarologia*, 49(1–2): 29–37.
- 9. Ben Chaaban, S., Chermiti, B. and Kreiter, S. 2011. *Oligonychus afrasiaticus* and phytoseiid predators' seasonal occurrence on date palm *Phoenix dactylifera* (Deglet Noor cultivar) in Tunisian oases. *Bull. Insectology*, 64 (1): 15–21.
- 10. Ben Chaaban, S., Chermiti, B. and Kreiter, S. 2017. The spatio-temporal distribution
  patterns of the spider mite, *Oligonychus afrasiaticus*, on date date palm (Deglet Nour
  cultivar) in a pesticide free Tunisian oasis. *Tunis. J. Plant Prot.*, 12(2):159–72.
- 11. Darbemamieh, M., Fathipour, Y., and Kamali, K. 2012. Seasonal activity and spatial
  distribution pattern of *Eotetranychus frosti* (Acari: Tetranychidae) in an unsprayed apple
  orchard of Kermanshah, Western Iran. *Persian J. Acarol.*, 1(2): 137-146.
  - Elhalawany, A. S., Sayed, A. A. and Khalil, A. E. 2020. Biodiversity and population dynamics of mites inhabiting date palm trees in Qalyubia and New Valley Governorates, *Egypt. J. Plant Prot. Res. Inst.*, 3(1):346–364.
  - El-Shafie, H. A. 2022. The Old World date palm mite Oligonychus afrasiaticus (McGregor 1939) (Acari: Tetranychidae), a major fruit pest: biology, ecology, and management. *CABI Reviews*, 17(020), 1-15.

347

348

349

350

- 14. Faez, R., Shojaii, M., Fathipour, Y., and Ahadiyat, A. 2018. Effect of initial infestation on
  population fluctuation and spatial distribution of *Panonychus citri* (Acari: Tetranychidae)
  on Thomson navel orange in Ghaemshahr, Iran. *Persian J. Acarol.*, 7(3):256-278
- 355 15. Farahbakhsh, Q. 1961. *List of important pests of plants and agricultural products of Iran.*356 Publications of the Plant Protection Organization. Tehran, 153 pp.
- 16. Ferraz, J. C. B., Da Silva, S. M., De França, S. M., Silva, P. R. R., Melo, J. W. D. S., & De
  Lima, D. B. 2020. Host preference, population dynamics, distribution, and injuries of *Oligonychus punicae* (Acari: Tetranychidae) in an eucalyptus clonal minigarden. *Syst. Appl. Acarol.*, 25(9), 1649-1660.
- 361 17. Franco, R. A., Reis, P. R., Zacarias, M. S., Altoe, B. F., & Pedro, N. 2008. Population
  362 dynamics of *Oligonychus ilicis* (McGREGOR, 1917) (Acari: Tetranychidae) in coffee
  363 plants and of their associated phytoseiids. *Coffee Sci.*, 3(1), 38-46.
- 364 18. Ghaedi, H., Kocheili, F., Latifian, M., & Nejad, R. F. 2020. Spatial and temporal
  365 distribution of rhinoceros beetles *Oryctes Hellwig* (Col.: Scarabaeidae) in date palm
  366 plantations of Khuzestan province. *Plant Pest Res.*, 10(2).
- 367 19. Gharib, A. R. 1996. *Fauna of insects and animal pests, diseases and weeds in date orchards* 368 *production of Iran.* Plant Pests and Diseases Research Institute Publication, Ministry of
   369 Agriculture and Rural Development, Tehran, 24 pp.
- 370 20. Gharib, A. R. 1991. *Important date palm pests in Iran*. Agricultural Extension Organization
  371 Publication, 41 pp.
- 21. Hussain, A. A. 1969. Biology of *Paratetranychus afrasiaticus* McG. infesting date date
  palm in Iraq. *Egypt. Acad. J. Biolog. Sci.*, 33: 221–5.
  - Ikegami, Y., Yano, S., Takabasyi, J. and Takafuji, A. 2000. Function of quiescence of *Tetranychus kanzawai* (Acari: Tetranychidae), as a defense mechanism against rain. *Appl. Entomol. Zool.*, 35: 339–343.
    - 23. Iwao, S. 1968. A new regression method for analyzing the aggregation pattern of animal populations. *Res. Popul. Ecol.*, 10: 1–20.
  - 24. Latifian, M., Rahnama, A. A., & Sharifnezhad, H. 2012. Effects of planting pattern on major date palm pests and diseases injury severity. *Intl. J. Agri. Crop. Sci.*, 4(19), 1443-1451.

375

376

377

378

379

380

- 25. Latifian, M. 2014. Date palm spider mite (Oligonychus afrasiaticus McGregor) forecasting
  and monitoring system. *WALIA journal*, 30: 79-85.
- 26. Latifian M. 2017. Integrated pest management of date palm fruit pests: A review. J.
   *Entomol.*, 14(3):112–121.
- 27. Latifian, M., Rad, B., & Habibpour, B. 2018. Termites of Iranian date palm orchards and
  their spatial and temporal distribution. *Sociobiology*, 65(1), 24-30.
- 28. Latifian, M., Ahmadi, A., and Pezhman, H. A. 2006. A study of the extension factors
  affecting suitable control of date date palm pests and diseases. *Iran. J. Agric. Sci.*,
  37(2):155–63.
- 29. 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 J. Acarol*, 10(4), 451-466.
- 30. Latifian, M. and Kajbafevala, G. 2016. Studying the efficiency of *Stethorus gilvifrons*inoculate release for date palm spider mite (*Oligonychus afrasiaticus*) biological control in
  field condition. Tehran, Iran: Ministry of Jahad-E-Agriculture. Research and education
  organization. Date palm and Tropical Fruits Research Institute of Iran, 75 pp.
- 31. Migeon, A, Dorkeld, F. 2021. Spider Mites Web: a comprehensive database for the
  Tetranychidae. Available from: http://www1.montpellier.inra.fr/CBGP/spmweb
  [Accessed: February 24, 2022].
- 402 32. Modarres Awal, M. 1994. *List of agricultural pests of Iran and their natural enemies*.
  403 Publications of Ferdowsi University of Mashhad, 364 pages.
  - 33. Mossadegh, M. S. and Kocheili, F. 2002. Semi-descriptive list of identified identified agricultural arthropods, health and other agricultural pests of Khuzestan province.
     Publications of Shahid Chamran University of Ahvaz, 475 pages.
  - 34. Palevsky, E., Borochov-Neori, H. & Gerson, U. 2005. Population dynamics of *Oligonychus afrasiaticus* in the southern Arava Valley of Isreal in relation to date fruit characteristics and climatic conditions. *Agric. and Forest Entomol.*, 7: 283–290.
  - Poole, R.W. 1974. An introduction to quantitative ecology. McGraw Hill. NewYork, 532 pp.

405

406

407

408

409

410

412	36. Rahmani, H., Fathipour, Y., & Kamali, K. 2010. Spatial distribution and seasonal activity
413	of Panonychus ulmi (Acari: Tetranychidae) and its predator Zetzellia mali (Acari:
414	Stigmaeidae) in apple orchards of Zanjan, Iran. J. Agric. Sci. Technol., 12: 155-165.
415	37. Ramezani, L., and Zandi Sohani, N. 2013. Population dynamics and spatial distribution of
416	important Thysanoptera species on wheat. Iran J. Plant Prot. Sci., 44(2):283-290.
417	38. Ramezani, L., Rajabpour, A., Zandi Sohani, N. and Yarahamdi. F. 2016. Sequential
418	sampling with constant accuracy of aphids in wheat fields in Ahvaz. Iran Plant Prot.
419	<i>Research</i> , 29(4): 582-588.
420 421 422 423	<b>39</b> . Sanad, A. S., Elhalawany, A. S., Abou-Setta, M. M., and El-Khateeb, H. M. 2017. Partial survey of date palm dust mite, <i>Oligonychus afrasiaticus</i> (McGregor) in Egypt including historical trait. <i>Acarines: J. Egyptian Soc. Acarol</i> , 11(1): 53-55.
424	40. Southwood, T. R. E. 2000. Ecological methods, with the particular reference to the study
425	of insect populations. 3rd edition. Chapman & Hall Pub. London, 524 pp.
426	41. Taylor, L. R. 1984. Assessing and interpreting the spatial distribution of insect populations.
427	Annu. Rev. Entomol., 29: 321–357.
428	42. Taylor, L. R. 1961. Aggregation, variance to the mean. Nature, 189: 732-735.
429	43. Zarei Sarchogha, R., Zandi-Sohani, N. and Ramezani, L. 2018. Spatial dispersion and
430	sequential sampling of Sitobion avenae (Fabricius) in wheat fields of SarPol-e Zahab,
431	Kermanshah province. <i>Plant Protection (Sci. Journal Agri.)</i> , 41(2): 49-60.
432	
433	
434	تغییرات جمعیت و الگوی پراکنش فضایی کنه تارتن خرما Oligonychus afrasiaticus McGregor در شرایط طبیعی
435	رامشیر، استان خوزستان
436	کنه تارتن خرما (Oligonychus afrasiaticus (McGregor) یکی از آفات مهم خرما در مناطق خرما خیز دنیا می باشد. خسارت
437	ین کنه باعث کاهش ارزش اقتصادی محصول می شود، به طوری که خسارت آن در سال های طغیانی در استان های جنوبی ایران
438	تا 100 درصد نيز مي رسد. بررسي تغييرات جمعيت، تعيين زمان اوج جمعيت و توزيع فضايي جهت مديريت اين آفت در نخلستان
439	ها اهمیت فراوانی دارد. در پژوهش حاضر، تغییرات جمعیت و توزیع فضایی این آفت روی دو واریته استعمران و برحی طی سالهای
440	1399 و 1400 در شهرستان رامشير مورد بررسي قرار گرفت. بدين منظور پنج تكرار از هر واريته خرما با آلودگي نسبتا يكسان جهت
441	نمونه برداری انتخاب شد. نمونه برداری از چهار جهت نخل خرما و به صورت دو روز در هفته از اواسط بهار تا اواخر تابستان انجام
442	شد. نتایج نشان داد که ظهور کنه تارتن خرما روی خوشههای دو واریته استعمران و برحی از اوایل خرداد ماه و به صورت پراکنده
443	میباشد. همچنین اوج جمعیت کنه روی هر دو واریته در سال 1399 و 1400 به ترتیب در شهریور و مرداد ماه ثبت گردید. بین
444	زمانهای مختلف نمونهبرداری طی سالهای 1399 و 1400 به ترتیب روی دو واریته استعمران .F=1. 916, 9. 580=183.695, P<0)

445	$(F_{2.\ 688,5.\ 065}=31.137, P<0.\ 0001)$ $(F_{1.\ 541,4.\ 622}=89.\ 010 e H_2 = 344,11.\ 720=58.104, P<0.\ 0001)$ ( $F_{1.\ 541,4.\ 622}=89.\ 010 e H_2 = 344,11.\ 720=58.104, P<0.\ 0001$
446	P<0.002) اختلاف معنی دار مشاهده شد. همچنین اختلاف معنی داری بین تغییرات جمعیت کنه تارتن خرما روی دو واریته طی
447	سال 1399مشاهده شد. از طرفی توزیع فضایی کنه تارتن خرما روی هر دو واریته خرما طی دو سال مورد بررسی تجمعی بود. از
448	اطلاعات نتایج حاصل از این پژوهش جهت تهیه یک برنامه موفق مدیریت تلفیقی آفت جهت کاهش مصرف سموم شیمیایی در
449	شهرستان رامشير مي توان استفاده نمود.