

## ACCEPTED ARTICLE

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

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#### ABSTRACT

The date palm dust mite *Oligonychus afrasiaticus* (McGregor) is one of the most important pests of the date palms *Phoenix dactylifera* L. around the world. This pest causes reduction in the economic value of the product, and sometimes its damage reaches up to 100% in the southern 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, 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 selected randomly. Sampling was done from four directions (North, South, East, and West) of each date palm every four days from mid-May to Early-November during 2020 and 2021. The results showed that the spider mite appeared on the clusters of two varieties from the beginning of June and the peak population of mites on both varieties was recorded in September in 2020 and 2021. Significant difference was observed between different sampling times during those two years and two varieties: Sayer ( $F_{1.916, 9.580}=183.695, P<0.0001$ ) and ( $F_{2.344, 11.720}=58.104, P<0.0001$ ) and 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 respectively. The spatial distribution pattern of mites on both varieties in two years were assessed through the regression models of Taylor's power law and Iwao's patchiness regression method. The results of dispersion indicated an aggregated pattern of this pest in both varieties. The 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.

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

39  
40 **INTRODUCTION**

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

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

60 One of the important features of phytophagous mite's population, is their spatial distribution  
61 and population dynamics which can help determining the time of infestations, time of pest  
62 outbreak, and the period when they frequently occur in the field (Ferraz *et al.*, 2020). Different  
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  
66 information and the ability to describe and recognize the studied population (Pool, 1974). The  
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).  
69 Therefore, the better the spatial distribution of a species is known, the more and better the

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

72 Population members can be described in three types: random, regular, and aggregated  
73 dispersion. Random distribution uses all points equally, while regular distribution is suitable for  
74 small areas and rarely describes large areas. (Pool, 1974). Aggregative distribution occurs when  
75 one species' presence increases the likelihood of another species' presence near the same point,  
76 often due to irregularly distributed environmental factors or species' tendency to aggregate. (Pool,  
77 1974, Latifian *et al.*, 2012, 2018, 2021; Ramezani and Zandi sohani, 2013; Ramezani *et al.*, 2016;  
78 Ghaedi *et al.*, 2020).

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

90

## 91 **MATERIALS AND METHODS**

### 92 **Study site**

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

### 100 **Sampling**

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

### 111 **Spatial distribution**

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

116

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

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

$$119 \quad S^2 = a\bar{x}^b \Rightarrow \log S^2 = \log a + b \log(\bar{x})$$

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

127

### 128 **Iwao's patchiness regression method**

129 The average Lloyd's crowding index is denoted by  $m^*$ . This index was calculated by the following  
130 relationship.

$$131 \quad m^* = m + \frac{s^2}{m - 1}$$

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  
139 biologically defined (Southwood, 2000). Then the calculated  $t$  was compared with the Student's  $t$ -  
140 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  $\beta = 1$   $t = (b - 1) / SE_\beta$   
142 where  $SE_b$  and  $SE_\beta$  are the standard errors of the slope for the mean crowding regression.  
143 Calculated values are compared with Two-tailed  $t$ -test at  $n-2$  degrees of freedom. If the calculated  
144  $t (t_c) < t$ -table ( $t_t$ ), the null hypothesis ( $b= 1$ ) would be accepted and spatial distribution would be  
145 random and if it is the opposite, then the null hypothesis would be rejected and if  $b > 1$  and  $< 1$ , the  
146 spatial distribution would be aggregated and uniform, respectively. SPSS software (version 16.0)  
147 was used to perform all analyzes and Excell (2010) software was used to draw graphs.

## 148 149 **RESULTS**

150 Based on the sampling results, the emergence and activity of the date palm dust mite was from  
151 the beginning of June on the fruits of both Sayer and Barhi varieties (Figure 1 and 2). Beginning  
152 of *O. afrasiaticus* infestation was recorded from the early of Jun on Sayer and late of May on Barhi  
153 in 2020 and 2021. On the other hand, the peak population (98.31 and 97.38 mites per fruit) of spider  
154 mite was observed on Sayer on 10<sup>th</sup> September 2020 and 17<sup>th</sup> August 2021, respectively and (111.8  
155 and 158.09 mites per fruit) on Barhi on 13<sup>th</sup> September 2020 and 24<sup>th</sup> August 2021, respectively.  
156 The mean temperature at those times was between 37-39°C for both years. After the peak of mite  
157 population, the trend of population changes decreased and the lowest population was recorded in  
158 mid-October for both varieties (mean temperature was about 14.5°C) and after the end of October,  
159 due to the entry of fruit into the Rutab and mature stage and crop harvest, no mite were observed  
160 (Figure 1 and 2). Significant differences were observed between different sampling times in 2020  
161 and 2021 on Sayer ( $F_{1.916, 9.580}=183.695, P<0.0001$ ) and ( $F_{2.344, 11.720}=58.104, P<0.0001$ ) and Barhi  
162 ( $F_{1.541, 4.622}=89.010, P<0.0001$ ) and ( $F_{1.688, 5.065}=31.137, P <0.002$ ), respectively. In addition, a

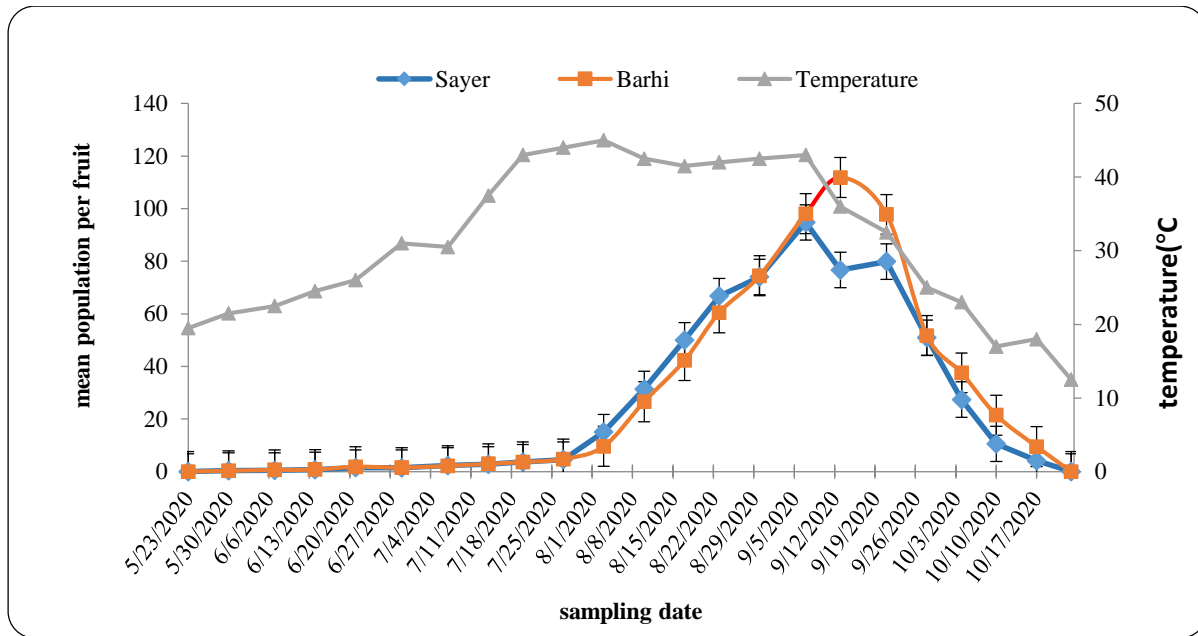
163 significant difference was observed in population dynamics of the spider mite on the two varieties  
 164 during the sampling dates in 2020 ( $t_{1,342}=8.630, P=0.004$ ). However, no significant difference was  
 165 observed in 2021 ( $t_{1,438}= 0.283, P=0.595$ ). The analysis of variance revealed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

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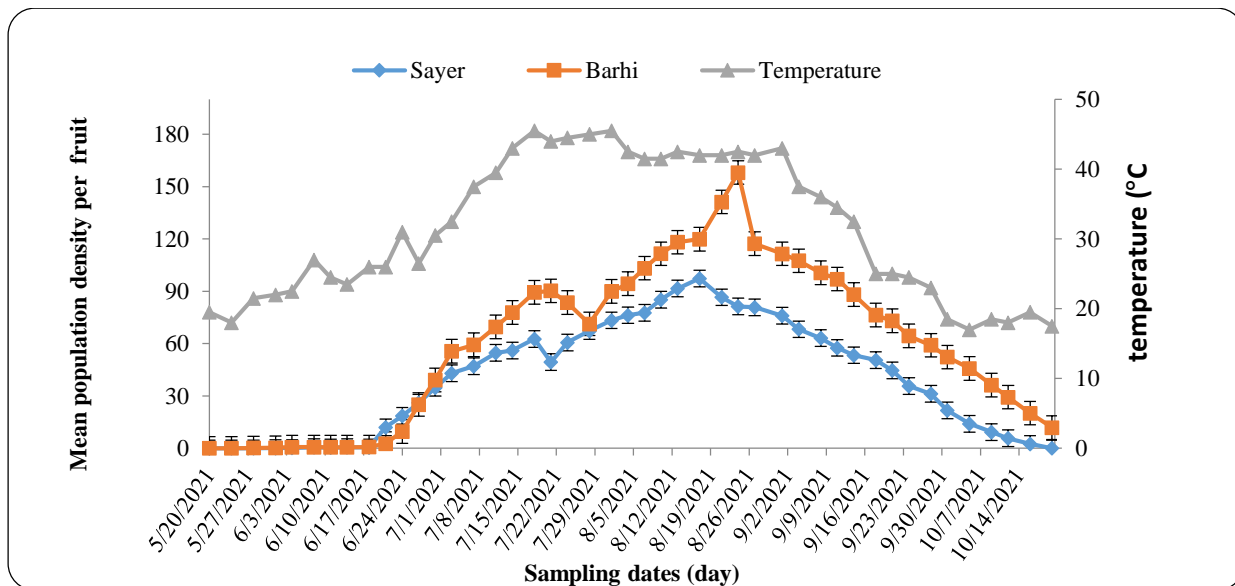
178 **Table 1. Multiple Comparisons of the spider mite population in four geographical directions of**  
 179 **sampling date palm trees.**

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

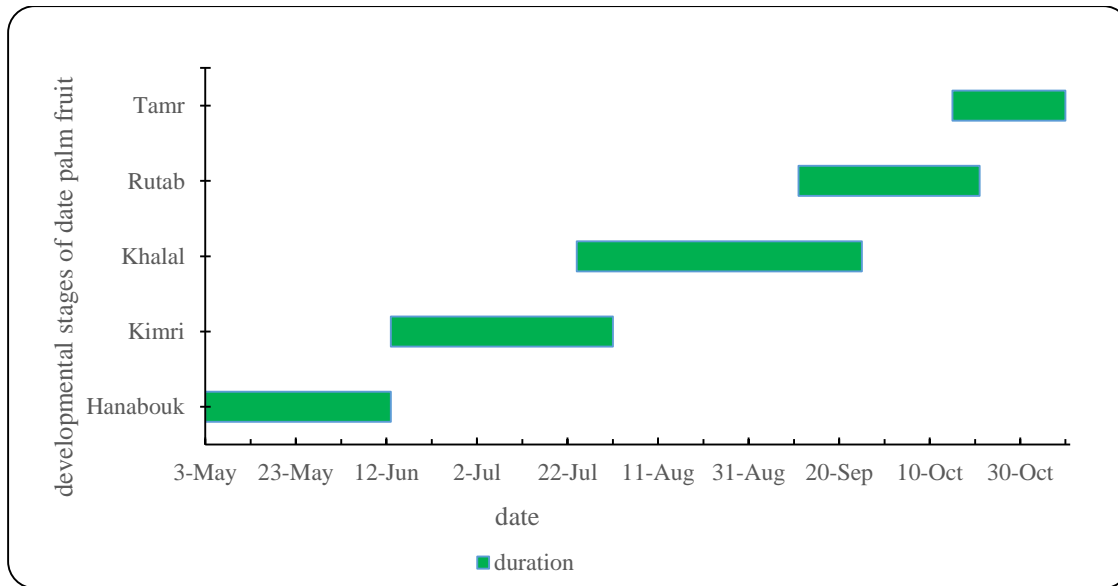
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181  
 182 **Figure 1.** Population fluctuation of *Oligonychus afrasiaticus* on Sayer and Barhi varieties of date  
 183 palm orchards in 2020.  
 184



185  
 186 **Figure 2.** Population fluctuation of *Oligonychus afrasiaticus* on Sayer and Barhi varieties of date  
 187 palm orchards in 2021.  
 188



189  
190 **Figure 3.** The time duration of different developmental stages of date palm fruit in Ramshir.

191  
192 The spatial distribution patterns and parameters of *O. afrasiaticus* in general (Table 2) and in  
193 different geographical directions (Figure 3 and 4) was assessed according to Taylor's power law  
194 and Iwao's patchiness regression on both varieties and the slope of the regression line was  
195 calculated during 2020 and 2021. The results showed that both methods provided a significant  
196 relationship between variance and mean density (in Taylor's power law), and between mean  
197 crowding and mean density (in Iwao's patchiness regression). Also in both methods the calculated  
198  $t$  ( $t_c$ ) was greater than the  $t$  in the table, thus indicating a significant difference in the slope of the  
199 line with the number one ( $b > 1$ ) (Table 2). In other words, the spatial distribution of spider mite was  
200 aggregative (variance is greater than the average). Although the Iwao's patchiness method  
201 compared to Taylor's power law better demonstrated fitness to this spider mite data, the results of  
202 two years sampling showed that in both methods the explanatory coefficients ( $R^2$ ) have a good  
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).

205  
206 **Table 2.** Spatial distribution statistics of *Oligonychus afrasiaticus* on two varieties of date palm  
207 (Sayer and Barhi) using Taylor's power law and Iwao's patchiness regression analysis.

Spatial distribution method	Year of sampling	Variety	N	Regression slope $\pm$ SE	Intercept $\pm$ SE	$R^2$	Spatial distribution	$t_c$	$F_{(df)}$	$P_{\text{regression}}$
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Taylor	2020	Sayer	44	1.584±0.073	0.517±0.147	0.921	Clumped	8	475.034(1,41)	<0.0001
		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
		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±1.028	0.995	Clumped	3.583	7.983(1,43)	<0.0001
		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.

210  
211 **Table 3.** Linear regression between temperature and the mean population densities of *Oligonychus*  
212 *afraziaticus* on varieties of Barhi and Sayer during 2020 and 2021 in Ramshir.

Year of sampling	Variety	N	Regression		R <sup>2</sup>	F <sub>(df)</sub>	P <sub>regression</sub>
			slope ± SE	Intercept ± SE			
2020	Sayer	44	1.441±0.422	18.682±13.746	0.453	11.634(1,43)	<0.0001
	Barhi	44	1.867±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±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  
216 during two consecutive years was at the beginning of June. With the increase in temperature, the  
217 mite's population increased and the peak population was recorded in the beginning and middle of  
218 September 2020 and in the middle to the end of August 2021 in Sayer and Barhi, respectively. The  
219 effect of temperature on the mite population is shown in Table 3. As it shown, temperature has a  
220 positive effect on increasing the mite population. Faez *et al.* (2018) assessed the population density  
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)  
224 indicated that the population dynamics of *O. afraziaticus* started with attacks fruits at second week  
225 of April during Kimri stages, and reached its peak on June on Sayer date palm variety. After that  
226 the mites migrate from fruits to fronds during Khalal stage.

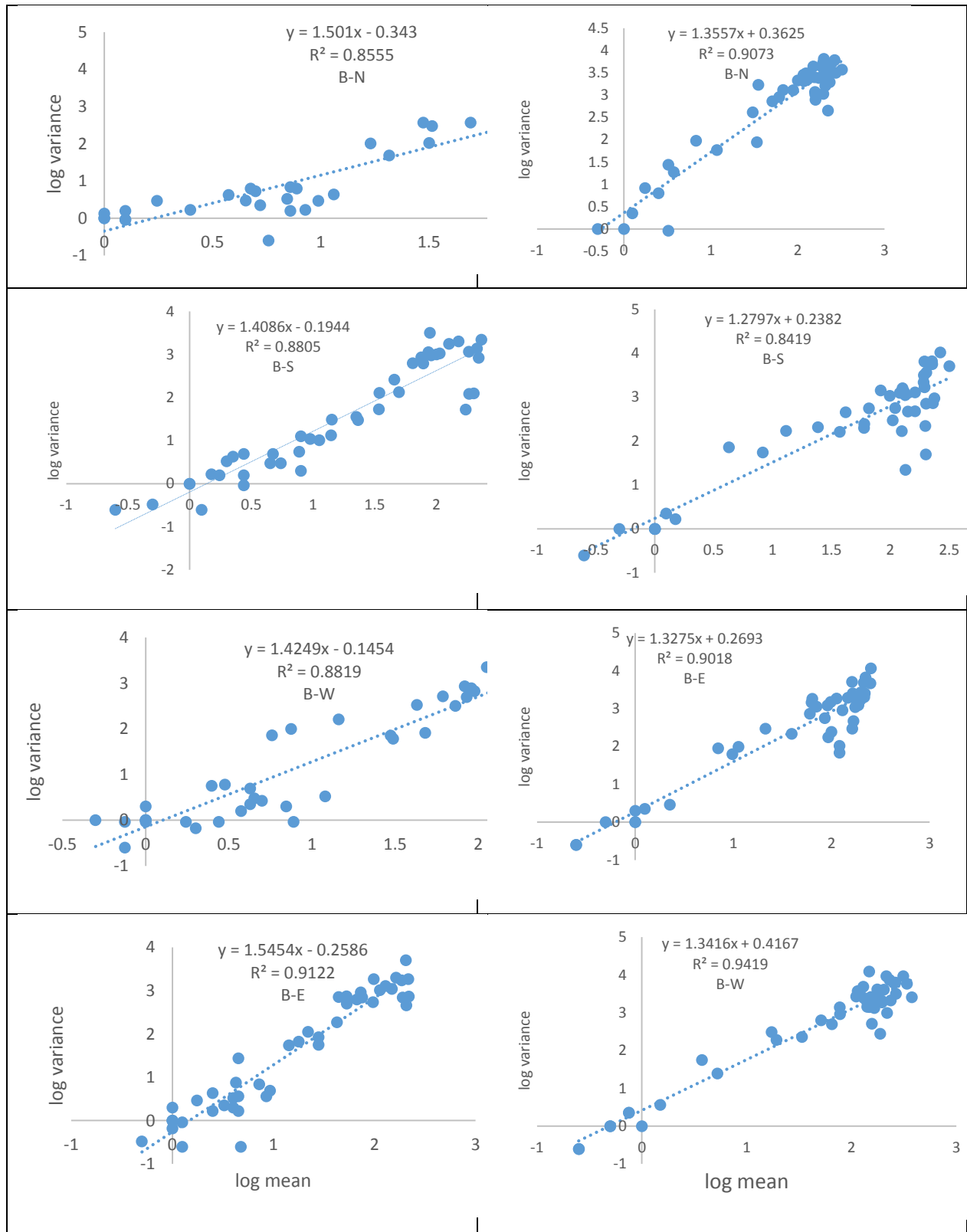
227 Other researchers have shown that climatic factors such as temperature and dust affect the spider  
228 mite population (Ikegami *et al.*, 2000). Latifian (2014) assessed the effect of dust phenomenon on

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

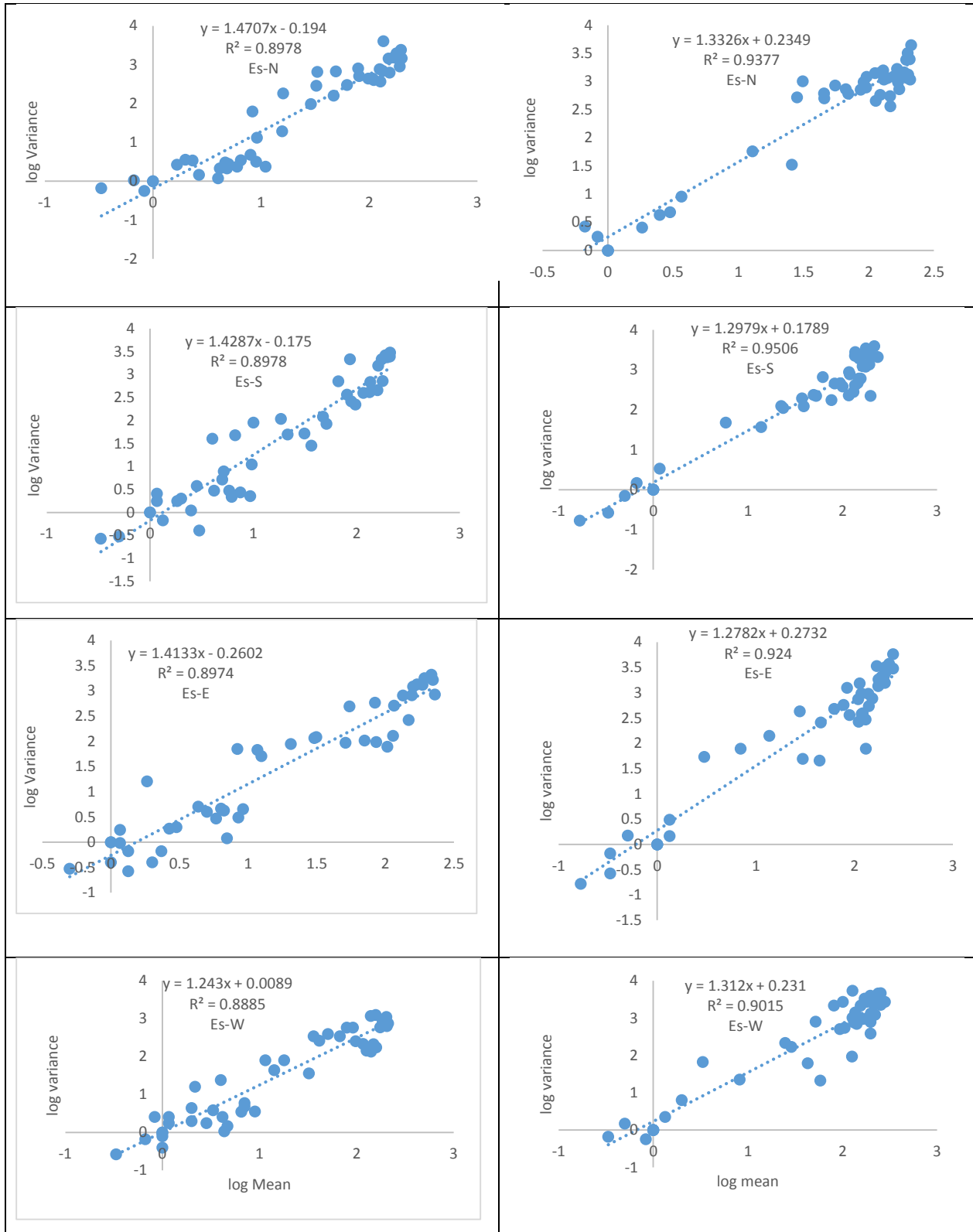
260 among different date palm cultivars, with some cultivars more susceptible to infestation than others  
261 (Palevsky *et al.* 2005; Aldosari and Ali 2007; Ben Chaaban and Chermiti 2009). **Therefore, the**  
262 **results of our study are consistent with the results of other researchers in terms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

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

285



286 **Figure 4.** Spatial distribution of *Oligonychus afrasiaticus* in four directions of Barhi cultivar in  
 287 2020: left and 2021: right, using Taylor's Power law. B: Barhi, N: North, S: South, W: West, E:  
 288 East



290 **Figure 5.** Spatial distribution of *Oligonychus afrasiaticus* in four directions of Sayer cultivar in  
291 2020: left and 2021: right, using Taylor's Power law. Es: Sayer, N: North, S: South, W: West, E:  
292 East.

293

## 294 CONCLUSIONS

295 The results of the current study provided valuable information about the population dynamics,  
296 appearance time, peak population, and spatial distribution of the date spider mite *O. afrasiaticus*  
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  
300 spider mite. By reducing the consumption of chemical poisons and protecting the environment,  
301 these programs can help to minimize the economic losses caused by this pest and maintain the  
302 productivity of date palm crops. Overall, this research provides a foundation for further studies on  
303 the behavior and management of the date spider mite, which can help to improve the sustainability  
304 and profitability of date palm cultivation.

305

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309

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 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 این 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 نیز می رسد. بررسی تغییرات جمعیت، تعیین زمان اوج جمعیت و توزیع فضایی جهت مدیریت این 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 سال های  
 440 1399 و 1400 در شهرستان رامشیر مورد بررسی قرار گرفت. بدین منظور پنج تکرار از هر واریته خرما با آلودگی نسبتاً یکسان 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 خوشه های دو واریته استعمران و برحی از اوایل خرداد ماه و به صورت پراکنده  
 443 می باشد. 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 نمونه برداری طی سال های 1399 و 1400 به ترتیب روی دو واریته استعمران  $(F=1.916, 9.580=183.695, P<0)$ .

445 (F<sub>2, 688, 5. 065</sub>=31.137, و  $P < 0. 0001$ ) (F<sub>1, 541, 4. 622</sub>=89. 010 و برحی (F=2. 344, 11. 720=58.104,  $P < 0. 0001$ ) و 0001)  
446 ( $P < 0. 002$ ) اختلاف معنی دار مشاهده شد. همچنین اختلاف معنی داری بین تغییرات جمعیت کنه تارتن خرما روی دو وارپته طی  
447 سال 1399 مشاهده شد. از طرفی توزیع فضایی کنه تارتن خرما روی هر دو وارپته 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 رامشیر می توان استفاده نمود.

450