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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 low 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.

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

INTRODUCTION

Dates palm (*Phoenix dactylifera* L.) with more than four thousand years old are one of the most 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 thousand hectares of date orchards, Iran is one of the largest producers and exporters of dates in the world. Currently, dates are cultivated and produced in 13 provinces of the country, of which five provinces produce more than 99% of the country's dates. In terms of the amount of production, Sistan and Baluchistan province ranks first and followed by Kerman, Fars, Bushehr, Khuzestan and Hormozgan provinces (Ahmadi *et al*., 2021).

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 the Afrotropical, Nearctic, and Palearctic regions. It has been reported in several countries, including Iran, Iraq, Saudi Arabia, United Arab Emirates, Bahrain, Oman, Kuwait, Yemen, Jordan, Israel, Libya, Tunisia, Algeria, Morocco, Egypt, Sudan, Chad, Mauritania, Mali, and Nigeria (Al-Zadjali, 2006; Alatawi and Kamran, 2018; Sanad *et al.*, 2017 Migeon and Dorkeld, 2021). In Iran, 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, 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 infestation may lead high economic losses (Arbabi *et al*., 2010; Latifian *et al*., 2021).

One of the important features of phytophagous mite’s population, is their spatial distribution 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 developmental stages of a species can create different distribution patterns according to their activity level. The distribution pattern is the result of the interaction between a population and its 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 spatial distribution pattern can be used in modeling, determining the appropriate sampling method 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 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. afrasiaticus* in different parts of the world, for example, Elhalawany *et al.* (2020), investigated the population dynamics of *O. afrasiaticus* on dates fruits in Qalyubia and New Valley governorates 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 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 researchers have worked more in the field of studying the biology and control of this pest (Latifian *et al*., 2006; Latifian, 2017; Arbabi *et al.*, 2017). Aims of this research were studying population fluctuations and spatial distribution of date spider mite in order to better understand the behavioral characteristics and help the effective control methods.

MATERIALS AND METHODS

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.

Sampling

Mite populations were sampled every four days from June to November of two years (2020 and 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 each date palm plantation for each variety) and mites were extracted by washing the fruits in 70% ethanol and then counted under a stereomicroscope. Also the minimum and maximum temperature values and the average temperature were recorded on each sampling date. To analyze the effect of 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 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.

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.

Taylor's power law b index

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

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

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).

Iwao's patchiness regression method

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

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

In this relationship, *m* and *s* are the mean and variance of the investigated samples, respectively. Iowa established the following regression relationship between Lloyd's crowding index and average samples: $m^* = \alpha + \beta m$

α: indicates the tendency of individuals to crowding and is one of the inherent properties of the species and *β* reflects the population distribution in space and is interpreted in the same manner as the *b* of Taylor's power law (Iwao, 1968). If *β* is greater than or equal to one, the distribution of samples corresponds to negative binomial or Poisson, respectively, while *β* 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).

Test b = 1 $t = (b - 1) / SE_b$ and Test β = 1 $t = (b - 1) / SE_\beta$

where SE_b and SE_β 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.

RESULTS

Based on the sampling results, the emergence and activity of the date palm dust mite was from 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 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 10th September 2020 and 17th August 2021, respectively and (111.8 and 158.09 mites per fruit) on Barhi on 13th September 2020 and 24th August 2021, respectively. The mean temperature at those times was between 37-39°C for both years. After the peak of mite 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, 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 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 ($F_{1.541, 4.622}$=89.010, P<0.0001) and ($F_{1.688, 5.065}$=31.137, P <0.002), respectively. In addition, a significant difference was observed in population dynamics of the spider mite on the two varieties during the sampling dates in 2020 ($t_{1,342}$=8.630, P=0.004). However, no significant difference was observed in 2021($t_{1,438}$= 0.283, P=0.595). The analysis of variance revealed no significant difference in the changes of mite population on the Sayer variety between the two years of sampling ($t_{1,434}$=1.823, P=0.178). However, a significant difference was observed in the mite population on the Barhi variety between the two sampling years ($t_{1,345}$=16.856, P=0.0001), with the population density on Barhi higher in 2021 compared to 2020. According to Table 1 the population dynamics of the spider mite on four directions of each tree during two years of sampling on both Barhi and Sayer varieties was similar and the statistical analysis showed that the changes in the mite population in the north, south, east and west directions of date palm were not significantly different for both varieties (Sayer and Barhi) during 2020 ($F_{3,168}$=0.010, P=0.999; $F_{3,168}$=0.029, P=0.993) and 2021 ($F_{3,172}$=0.514, P=0.673; $F_{3,172}$=0.420, P=0.739), respectively. These findings suggest that the presence and distribution of date spider mite on the Sayer and Barhi varieties in all directions of the tree in the studied date palm plantations was relatively uniform.

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

(I) Direction	(J) Direction	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

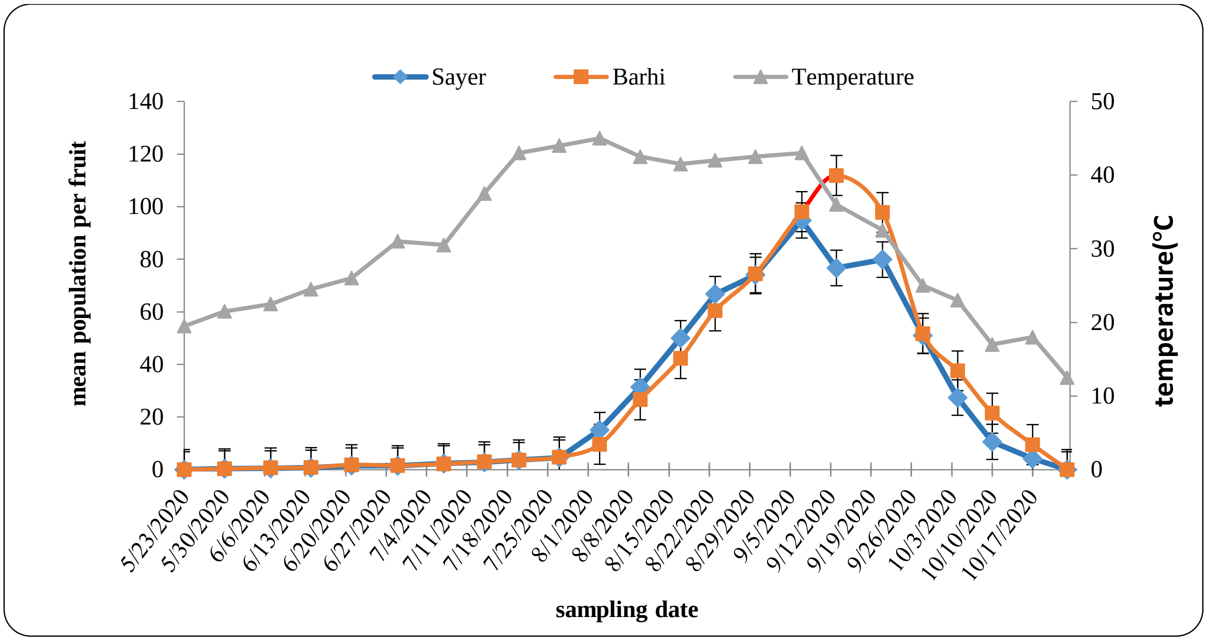

Figure 1. Population fluctuation of *Oligonychus afrasiaticus* on Sayer and Barhi varieties of date palm orchards in 2020.

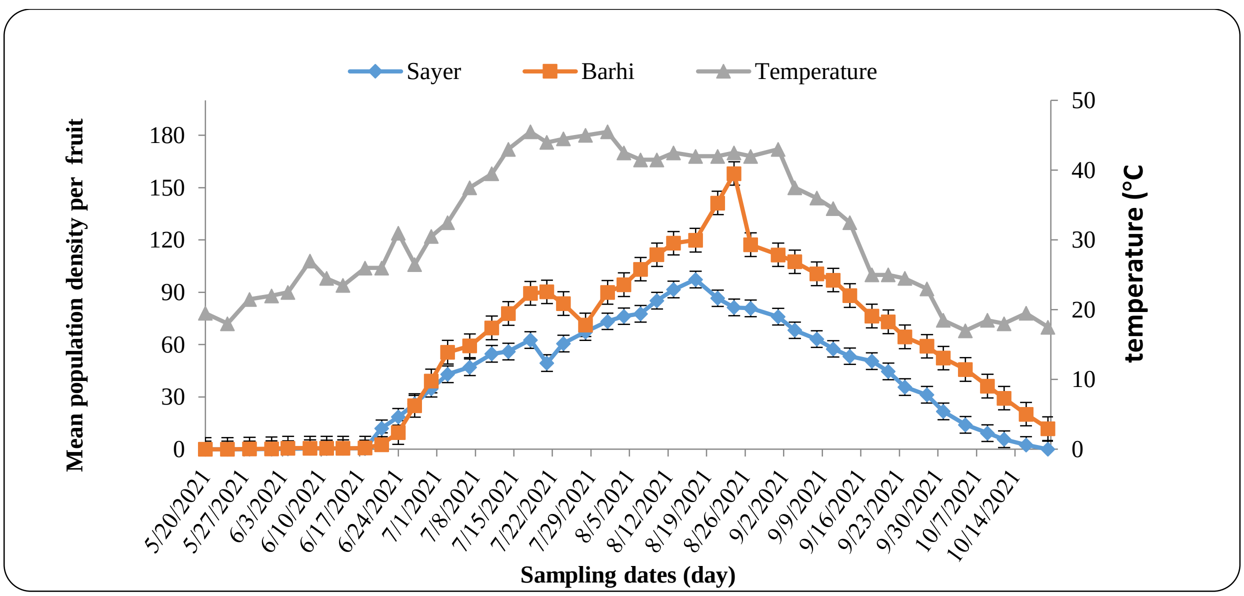

Figure 2. Population fluctuation of *Oligonychus afrasiaticus* on Sayer and Barhi varieties of date palm orchards in 2021.

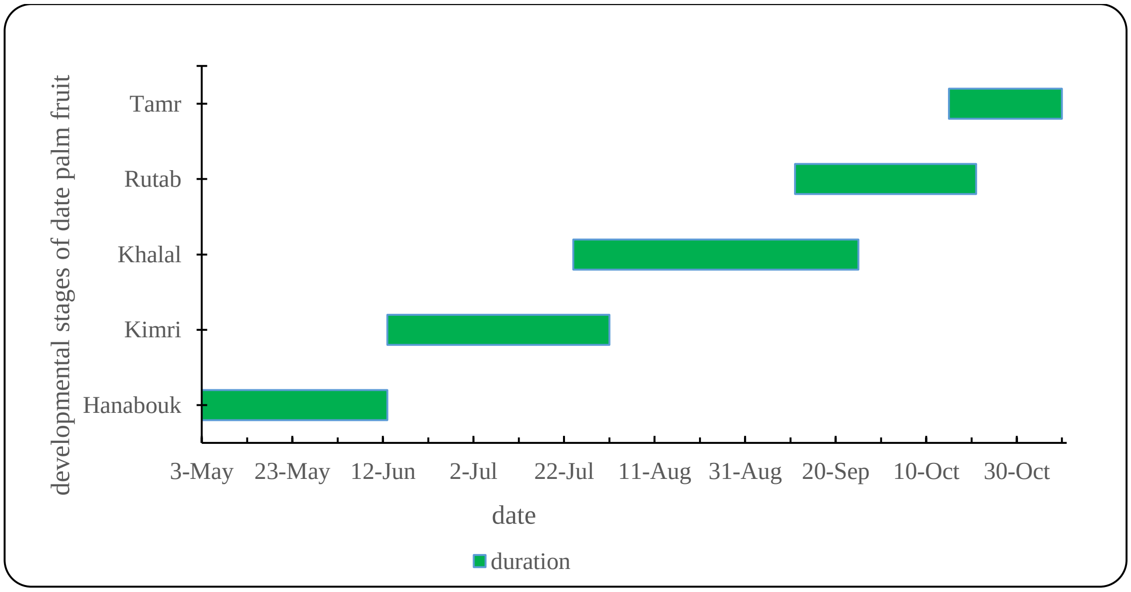

Figure 3. The time duration of different developmental stages of date palm fruit in Ramshir.

The spatial distribution patterns and parameters of *O. afrasiaticus* in general (Table 2) and in different geographical directions (Figure 3 and 4) was assessed according to Taylor's power law and Iwao's patchiness regression on both varieties and the slope of the regression line was calculated during 2020 and 2021. The results showed that both methods provided a significant relationship between variance and mean density (in Taylor's power law), and between mean crowding and mean density (in Iwao's patchiness regression). Also in both methods the calculated t (t_c) was greater than the t in the table, thus indicating a significant difference in the slope of the 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 compared to Taylor's power law better demonstrated fitness to this spider mite data, the results of two years sampling showed that in both methods the explanatory coefficients (R^2) have a good correlation with the data (Table 2) and both methods showed that the spatial distribution pattern of 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.
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Spatial distribution method	Year of sampling	Variety	N	Regression slope ± SE	Intercept ± SE	R^2	Spatial distribution	t_c	$F_{(df)}$	$P_{regression}$

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

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

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

Year of sampling	Variety	N	Regression slope ± SE	Intercept ± SE	R^2	$F_{(df)}$	$P_{regression}$
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

DISCUSSION

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 mite's population increased and the peak population was recorded in the beginning and middle of September 2020 and in the middle to the end of August 2021 in Sayer and Barhi, respectively. The 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 of *Panonychus citri* on Thomson navel orange in Ghaemshahr, Iran. They showed that the peak of mite population occurred in the summer during July to September and they conclude that the 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 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.

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 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 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 in fruit weight is slow, but the sucrose content increases. In the moist stage, the weight of the fruit decreases due to the decrease in humidity, the color of the skin becomes light brown and the texture 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 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 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 observations are completely consistent with the observations of other researchers (Paloski *et al*., 2005; Aldosari and Ali, 2007; Ben Chaaban *et al*., 2011). Based on the results of Latifian (2014), 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 activity of the mite in the months of July and August. On the other hand, the decrease in population and mite damage was reported from September and when the fruit entered the moist stage (Latifian, 2014). In another study, Latifian and Kajbaf Vala (2016) investigated the effect of releasing *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 from the beginning of June and the peak population was also announced in July which is slightly different from our result in the present study. As can be seen in Figure 3, in the present study, the rate of increase in the spider mite population was observed in the Kimri stage and the peak population was seen in the Khalal stage, which is completely consistent with the observations of 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, 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 Hussain (1969) found that *O. afrasiaticus* infestation on date palms starts in mid-May to June, peaking in July and August, and declining at Khalal stage. Resistance to mite infestation varies 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 power law and Iwao's patchiness regression (Table 2) during 2020 and 2021 showed that there was a significant relationship between mean log and variance of population density. In Both method, the coefficient (b or β) was greater than 1 and the distribution was aggregated and follows the 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 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 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 methods, and Taylor's power law provided more accurate population estimations. In the oresent study, Iwao's patchiness regression showed more accurate estimations of populations than Taylor's power law, however, both of them had a high correlation with the data (Table 2). Gharib (1996) 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 leaves. Also, according to different researches, aggregative distribution is the most common pattern of spatial distribution among insects, especially pest insects (Ramezani & Zandi Sohani, 2017; Ramezani *et al*., 2016; Zarei Sarchogha *et al*., 2018). This distribution may be seen in all developmental stages of the pest or in some developmental stages.

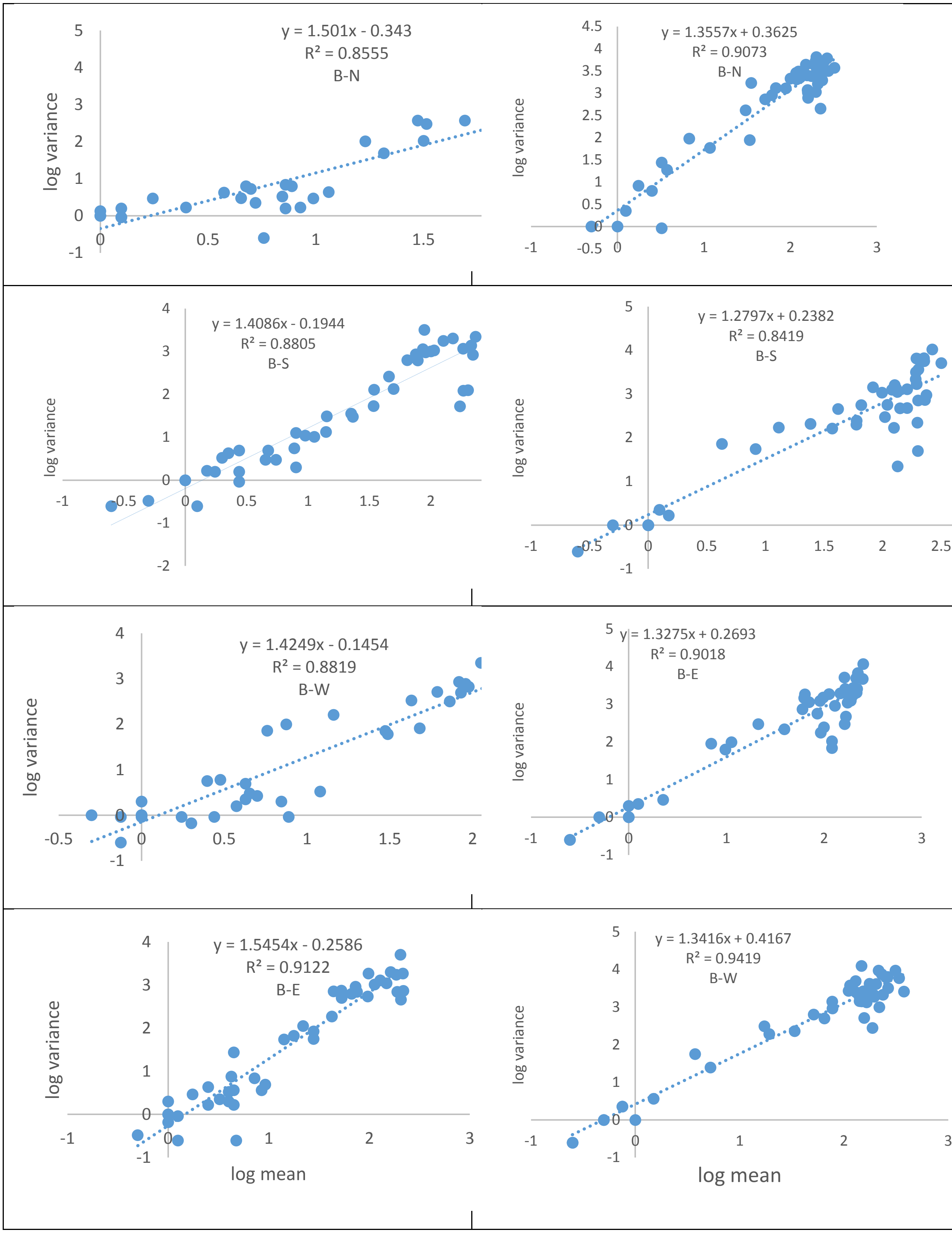

Figure 4. Spatial distribution of *Oligonychus afrasiaticus* in four directions of Barhi cultivar in 2020: left and 2021: right, using Taylor's Power law. B: Barhi, N: North, S: South, W: West, E: East

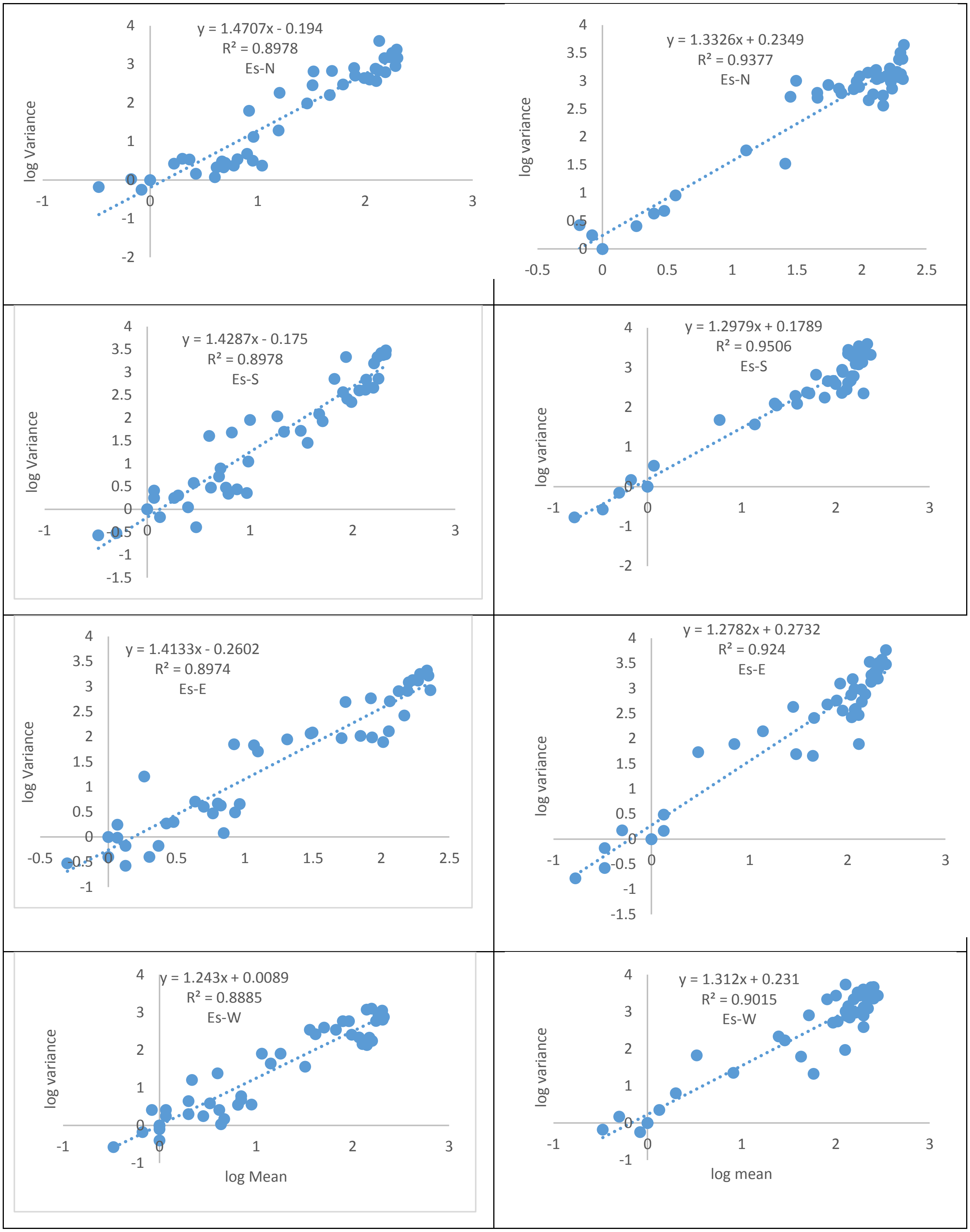
y = 1.4707x - 0.194
R² = 0.8978
Es-N
log Variance
y = 1.3326x + 0.2349
R² = 0.9377
Es-N
log variance
y = 1.4287x - 0.175
R² = 0.8978
Es-S
log Variance
y = 1.2979x + 0.1789
R² = 0.9506
Es-S
log variance
y = 1.4133x - 0.2602
R² = 0.8974
Es-E
log Variance
y = 1.2782x + 0.2732
R² = 0.924
Es-E
log variance
y = 1.243x + 0.0089
R² = 0.8885
Es-W
log variance
log Mean
y = 1.312x + 0.231
R² = 0.9015
Es-W
log variance
log mean

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.

CONCLUSIONS

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* on two important date palm varieties (Sayer and Barhi) in the climatic conditions of Ramshir city, Khuzestan Province, Iran. These findings are essential in the development of effective management 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, these programs can help to minimize the economic losses caused by this pest and maintain the productivity of date palm crops. Overall, this research provides a foundation for further studies on the behavior and management of the date spider mite, which can help to improve the sustainability and profitability of date palm cultivation.

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REFERENCES

1. 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.
2. 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.
3. 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.
4. 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.
6. 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.
7. 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.
8. 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.
12. 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.
13. 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.

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
15. Farahbakhsh, Q. 1961. *List of important pests of plants and agricultural products of Iran*. 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.
17. Franco, R. A., Reis, P. R., Zacarias, M. S., Altoe, B. F., & Pedro, N. 2008. Population dynamics of *Oligonychus ilicis* (McGREGOR, 1917) (Acari: Tetranychidae) in coffee plants and of their associated phytoseiids. *Coffee Sci.*, 3(1), 38-46.
18. Ghaedi, H., Kocheili, F., Latifian, M., & Nejad, R. F. 2020. Spatial and temporal distribution of rhinoceros beetles *Oryctes Hellwig* (Col.: Scarabaeidae) in date palm plantations of Khuzestan province. *Plant Pest Res.*, 10(2).
19. Gharib, A. R. 1996. *Fauna of insects and animal pests, diseases and weeds in date orchards production of Iran*. Plant Pests and Diseases Research Institute Publication, Ministry of Agriculture and Rural Development, Tehran, 24 pp.
20. Gharib, A. R. 1991. *Important date palm pests in Iran*. Agricultural Extension Organization 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.
22. 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.

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].

32. Modarres Awal, M. 1994. *List of agricultural pests of Iran and their natural enemies*. 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.

35. Poole, R.W. 1974. *An introduction to quantitative ecology*. McGraw – Hill. NewYork, 532 pp.

36. Rahmani, H., Fathipour, Y., & Kamali, K. 2010. Spatial distribution and seasonal activity of *Panonychus ulmi* (Acari: Tetranychidae) and its predator *Zetzellia mali* (Acari: Stigmaeidae) in apple orchards of Zanjan, Iran. *J. Agric. Sci. Technol*., 12: 155-165.

37. Ramezani, L., and Zandi Sohani, N. 2013. Population dynamics and spatial distribution of important Thysanoptera species on wheat. *Iran J. Plant Prot. Sci*., 44(2):283-290.

38. Ramezani, L., Rajabpour, A., Zandi Sohani, N. and Yarahamdi. F. 2016. Sequential sampling with constant accuracy of aphids in wheat fields in Ahvaz. *Iran Plant Prot. Research*, 29(4): 582-588.

39. Sanad, A. S., Elhalawany, A. S., Abou-Setta, M. M., and El-Khateeb, H. M. 2017. Partial survey of date palm dust mite, *Oligonychus afrasiaticus* (McGregor) in Egypt including historical trait. *Acarines*: *J. Egyptian Soc. Acarol*, 11(1): 53-55.

40. Southwood, T. R. E. 2000. *Ecological methods, with the particular reference to the study of insect populations*. 3rd edition. Chapman & Hall Pub. London, 524 pp.

41. Taylor, L. R. 1984. Assessing and interpreting the spatial distribution of insect populations. *Annu. Rev. Entomol*., 29: 321−357.

42. Taylor, L. R. 1961. Aggregation, variance to the mean. *Nature*, 189: 732−735.

43. Zarei Sarchogha, R., Zandi-Sohani, N. and Ramezani, L. 2018. Spatial dispersion and sequential sampling of *Sitobion avenae* (Fabricius) in wheat fields of SarPol-e Zahab, Kermanshah province. *Plant Protection (Sci. Journal Agri.)*, 41(2): 49-60.

تغییرات جمعیت و الگوی پراکنش فضایی کنه تارتن خرما ***Oligonychus afrasiaticus*** **McGregor** در شرایط طبیعی رامشیر، استان خوزستان

کنه تارتن خرما (McGregor) *Oligonychus afrasiaticus* یکی از آفات مهم خرما در مناطق خرما خیز دنیا می باشد. خسارت این کنه باعث کاهش ارزش اقتصادی محصول می شود، به طوری که خسارت آن در سال های طغیانی در استان های جنوبی ایران تا 100 درصد نیز می رسد. بررسی تغییرات جمعیت، تعیین زمان اوج جمعیت و توزیع فضایی جهت مدیریت این آفت در نخلستان ها اهمیت فراوانی دارد. در پژوهش حاضر، تغییرات جمعیت و توزیع فضایی این آفت روی دو واریته استعمران و برحی طی سال‌های 1399 و 1400 در شهرستان رامشیر مورد بررسی قرار گرفت. بدین منظور پنج تکرار از هر واریته خرما با آلودگی نسبتا یکسان جهت 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 شد. نتایج نشان داد که ظهور کنه تارتن خرما روی خوشه‌های دو واریته استعمران و برحی از اوایل خرداد ماه و به صورت پراکنده می‌باشد. همچنین اوج جمعیت کنه روی هر دو واریته در سال 1399 و 1400 به ترتیب در شهریور و مرداد ماه ثبت گردید. بین زمانهای مختلف نمونه‌برداری طی سال‌های 1399 و 1400 به ترتیب روی دو واریته استعمران $(F_{1.916, 9.580}=183.695, P<0.$

$(F_{2.344,11.720}=58.104, P<0.0001)$ و برحی $(F_{1.541,4.622}=89.010, P<0.0001)$ و $(F_{2.688,5.065}=31.137, P<0.002)$ اختلاف معنی دار مشاهده شد. همچنین اختلاف معنی داری بین تغییرات جمعیت کنه تارتن خرما روی دو واریته طی سال 1399 مشاهده شد. از طرفی توزیع فضایی کنه تارتن خرما روی هر دو واریته خرما طی دو سال مورد بررسی تجمعی بود. از اطلاعات نتایج حاصل از این پژوهش جهت تهیه یک برنامه موفق مدیریت تلفیقی آفت جهت کاهش مصرف سموم شیمیایی در شهرستان رامشیر می توان استفاده نمود.