Journal of Agricultural Science and Technology (2025) Vol. 27 (1): 203-216

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

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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 that had 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 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 both years. Significant difference was observed between different sampling times during those two years and the two varieties: Sayer ($F_{1\cdot916,\ 9.580}$= 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<B 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 the control of this pest.

Keywords: cv. Barhi, cv. Sayer, Iwao's patchiness regression, *Phoenix dactylifera* L., Taylor's power law.

INTRODUCTION

Dates palm (*Phoenix dactylifera* L.), with more than four thousand years history, 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 the first, 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-

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[DOI: 10.22034/JAST.27.1.203]

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 has also been collected from ornamental date palm, corn, sugarcane, sorghum and weeds (Farahbakhsh, 1961; 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 to high economic losses (Arbabi *et al*., 2010; Latifian *et al*., 2021).

One of the important features of phytophagous mite's population is its 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 recognize and control 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 is the spatial distribution of a species, the more and better the population dimensions of that species in natural and agricultural ecosystems can be measured (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).

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 date's fruits in Qalyubia and New Valley governorates of Egypt. Ben-Chaaban *et al*. (2011) assessed the seasonal occurrence of *O. afrasiaticus* and phytoseiid predators on date palm in Tunisian oases, and 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).

This research aimed to study 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″, N 49° 24′ 26.3″), Khuzestan Province, Iran, two separate date palm orchards, with two varieties (one with Barhi and the other with Sayer) were selected.

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There, 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. 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 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). Mites were extracted by washing the fruits in 70% ethanol, and counted under a stereomicroscope. Also, the minimum and maximum air 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 was 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:

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

Where, "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 was calculated. If *b* were greater, equal or smaller than one, it indicated a negative binomial (aggregated), a Poisson (random), or a positive binomial (regular) distribution, respectively (Taylor, 1984).

? Iowa's Patchiness Regression Method

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

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

Where, 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:

$$m^* = \alpha + \beta m$$

Where, 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).

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Test b= 1 t= (b−1)/SE_b and Test β= 1 t= (b−1)/$SE_β$

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. If it is the opposite, 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 analyses 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 (Figures 1 and 2). Beginning of *O. afrasiaticus* infestation was recorded from early Jun on Sayer and late 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 10 September 2020 and 17 August 2021, respectively, and (111.8 and 158.09 mites per fruit) on Barhi on 13 September 2020 and 24 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 mites were observed (Figures 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. 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). These findings suggest that, in the studied date palm plantations, the presence and distribution of date spider mite on the Sayer and Barhi varieties in all directions of the tree were relatively uniform.

The spatial distribution patterns and parameters of *O. afrasiaticus* in general (Table 2) and in different geographical directions (Figures 4 and 5) were assessed according to Taylor's power law, and Iwao's patchiness regression on both varieties and the slope of the regression line were 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

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Table 1. Multiple Comparisons of the spider mite population in four geographical directions of the date palms.

(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

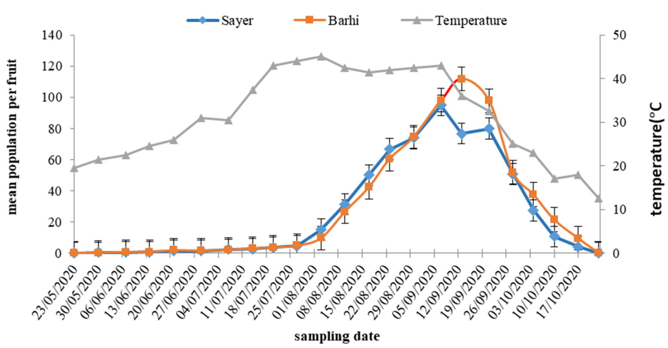

Figure 1. Population fluctuation of *Oligonychus afrasiaticus* on Sayer and Barhi varieties of date palm orchards in 2020.

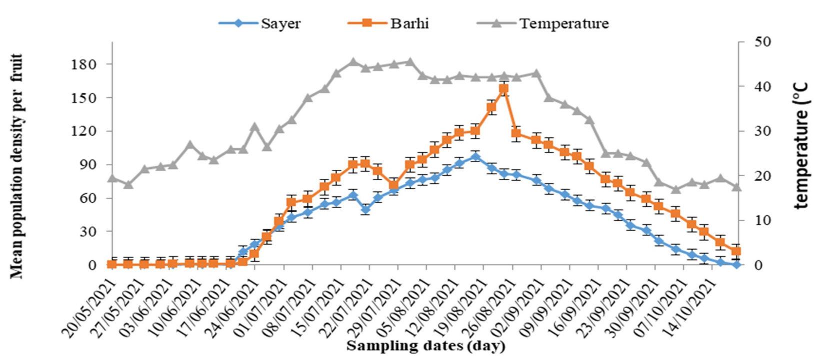

Figure 2. Population fluctuation of *Oligonychus afrasiaticus* on Sayer and Barhi varieties of date palm orchards in 2021.

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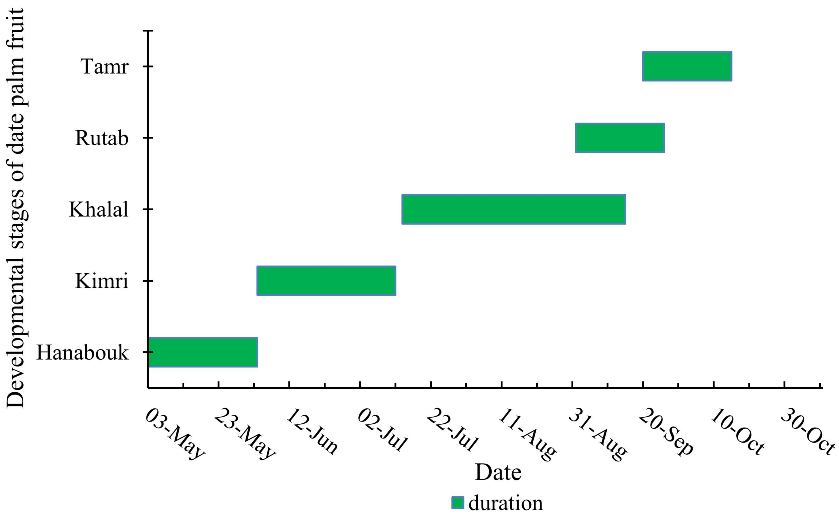

Figure 3. The time duration of different developmental stages of date palm fruit in Ramshir.

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[a]	Year of sampling	Variety	N	Regression slope±SE	Intercept±SE	R2	Spatial distribution	tc	F(df)	Pregression
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

distribution of spider mite was aggregative, i.e. variance being greater than the average. Although the Iwao's patchiness method compared to Taylor's power law demonstrated better fitness to this spider mite data, the results of the two years sampling showed that, in both methods, the explanatory coefficients (R^2) had a good correlation with the data (Table 2). This means that both methods showed that the spatial distribution pattern of this spider mite was, in general, aggregated and in four geographical directions (Figures 4 and 5).

DISCUSSION

According to the current research, the appearance date of the spider mite on the Sayer and Barhi varieties during two consecutive years was at the beginning of June. With the increase in temperature, the mite's population increased and the peak population for the two varieties was recorded in the beginning and middle of September 2020 and in the middle to the end of August 2021. The effect of temperature

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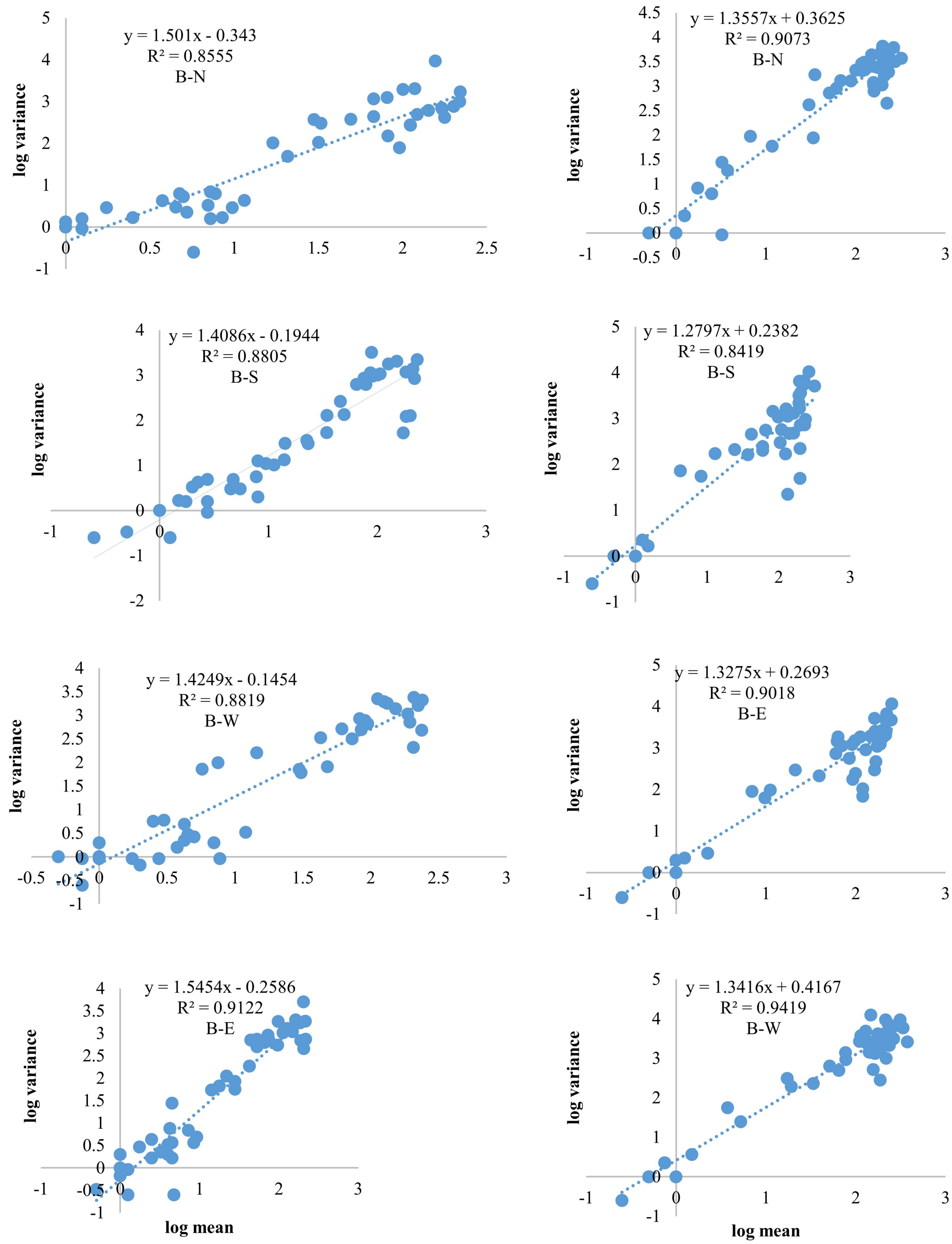

Figure 4. Spatial distribution of *Oligonychus afrasiaticus* in four directions of Barhi cultivar in 2020: left graphs and 2021: right graphs, using Taylor's Power law. B: Barhi, N: North, S: South, W: West, E: East.

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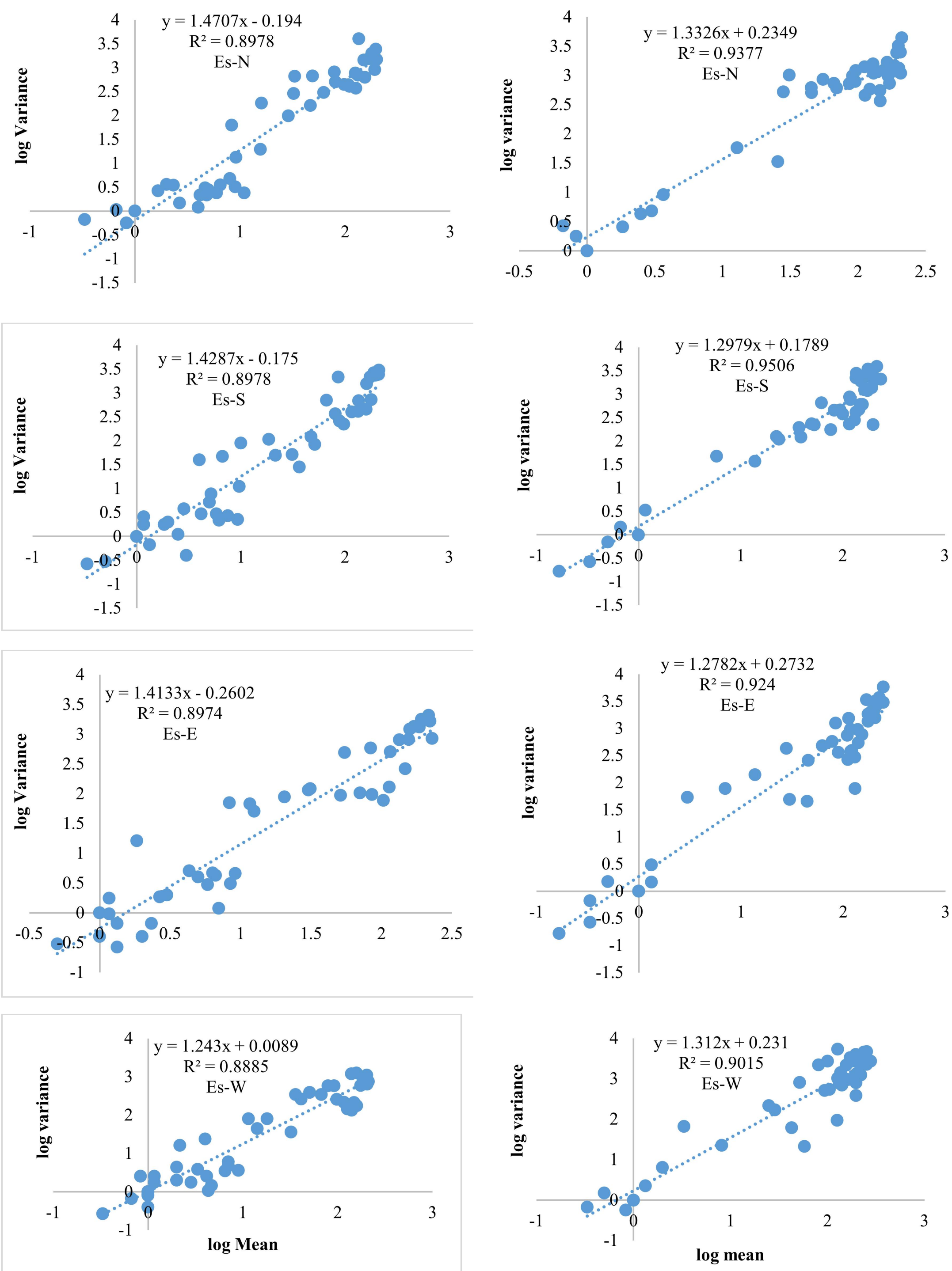

Figure 5. Spatial distribution of *Oligonychus afrasiaticus* in four directions of Sayer cultivar in 2020: Left graphs, and 2021: Right graphs, using Taylor's Power law. Es: Sayer, N: North, S: South, W: West, E: East. Figure 5 didn't mention in the text.

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on the mite population is shown in Table 3. As 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 concluded that the temperature was one of the reasons for the increase of mite population. Elhalawany *et al.* (2020) indicated that the population dynamics of *O. afrasiaticus* started with attacking fruits at the second week of April during Kimri stages, and reached its peak on June for Sayer variety. After that, the mites migrated 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), when the mite population extremely reduces and is rarely seen on the fruits (Figures 1 and 2).

These observations are completely consistent with the observations of other researchers (Palevsky *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 Figures 1, 2 and 3, the rate of increase in the spider mite population was observed in the Kimri stage and the peak population was in the Khalal stage, which is completely consistent

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

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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 the peak populations in 2006 on Kentichi, Alig, Deglent Noor, and Besser varieties 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 started 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. However, 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 varieties and difference in geographical regions and 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 methods, the coefficient (b or β) was greater than 1 and the distribution was aggregated and followed 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 present 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). During a study on date palm sucking pests, Gharib (1996) declared that the relative density of this group of pests was high and their distribution in date palm plantations was mostly uniform, but varied 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 and Zandi Sohani, 2013; Ramezani *et al*., 2016; Zarei Sarchogha *et al*., 2018). This distribution may be seen in all or some developmental stages of the pest.

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 palms. 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 palms production.

ACKNOWLEDGEMENTS

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

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[DOI: 10.22034/JAST.27.1.203]

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

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چکیده

کنه تارتن خرما *Oligonychus afrasiaticus* (McGregor) 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 ۱۰۰ درصد نیز می رسد. بررسی تغییرات جمعیت، تعیین زمان اوج جمعیت و توزیع فضایی جهت مدیریت این آفت در نخلستان‌ها اهمیت فراوانی دارد. در پژوهش حاضر، تغییرات جمعیت و توزیع فضایی این آفت روی دو واریته استعمران و برحی طی سال‌های ۱۳۹۹ و ۱۴۰۰ 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 ۱۳۹۹ و ۱۴۰۰ به ترتیب در شهریور و مرداد ماه ثبت گردید. بین زمانهای مختلف نمونه‌برداری طی سال‌های ۱۳۹۹ و ۱۴۰۰ به ترتیب روی دو واریته استعمران ($F=_{1.916, 9.580}=183.695$, $P<0.0001$) و ($F=_{2.344,11.720}=58.104$, $P<0.0001$) و برحی ($F_{1.541,4.622}=89.010$ $P<0.0001$) و ($F_{2.688,5.}$

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(P<0. 002, 31.137=$_{065}$) اختلاف معنی دار مشاهده شد. همچنین اختلاف معنی داری بین تغییرات جمعیت کنه تارتن خرما روی دو واریته طی سال **۱۳۹۹** 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.

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