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Research Article

The Effect of Seasonal Climate Changes on the Growth and Abundance of the Olive Fly Pest

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Abstract

Olive is one of the strategic products that it is very important to maintain its position in the areas that benefit from it. The olive fly is the most important pest of this tree, and a comprehensive investigation of the negative effects and consequences of this problem can greatly help to preserve this strategic product. The findings of the research showed that climate changes are effective on the abundance of the olive fly and the highest abundance occurs with temperature changes in the summer season. Considering its many effects on the social and economic life of farmers and the problems of farmers in fighting this plant pest, emphasizing the effective preservation of the environment from pesticides and olive fly repellants, training and promotion courses by expert experts are suggested. Agricultural institutes should be held for farmers.

Keywords: Climate Change; Olive Fly; Seasonal Changes; Social Effects

Introduction

Considering the economic importance of olives in the daily and social lives of the residents of olive growing areas, the assessment of the frequency of the olive fly pest due to seasonal climate change can be effective with timely training to reduce the damage caused by this pest (Azizi, 2011). An increase in the damage to the product causes a decrease in income, followed by economic and social problems (Azizi, 2008b and Askarie Besaye, 2019). Therefore, by increasing the awareness of the olive fly pest, the climatic conditions and the process of its changes, a more appropriate fight against this pest can be carried out and increase the economic and social welfare in the region is considered one of the most important pests of this product and fighting it is one of the most important agricultural operations in olive orchards (Ghiasi and et al, 2017). The fight against this pest causes changes in the social and economic behavior of this region due to the damage caused to the crop and the costs caused by the fight against the pest (Taghddosi and et al., 2013). This pest is directly affected by climatic conditions and its life cycle is highly dependent on humidity and air temperature, so changes in weather conditions over time or climate change may affect its population and spread. In this research, an attempt has been made to evaluate the trend of seasonal changes by means of meteorological data, and by examining the frequency of this pest in the region, the correlation of changes in the frequency of the pest has been evaluated and validated (Soroush and et al. 2012 ; Davari and et al. 2018). Olive tree It grows and yields in Mediterranean climatic conditions (Azizi, 2008)a. Mediterranean regions have wet and mild winters, hot and rainless summers, and in fact it is considered a dry season (Kayhanian and et al. 2009). Olives are practically cultivated in the northern hemisphere, and more than 95% of them are concentrated in the Mediterranean basin and in the plains and slopes nearby. The northern border of olive cultivation at 45 degrees north latitude corresponds to the southern regions of France (Ozdemir, 2016). A region where the winter and spring temperatures are below zero degrees Celsius and its southern border is limited to 30 degrees north latitude, that is, it corresponds to the desert and desert areas on the southern shores of the Mediterranean, which is a dry, hot and rainless region (El-Salam and et al. 2019). Although olive grows well in tropical or subtropical regions with abundant rains and intense heat, it does not bear fruit due to the lack of plant rest (winter sleep) (Shahbazi, 2010). Olive is not cold-loving. Because the occurrence of low temperatures, especially during flowering, is considered an inhibiting factor, even after harvest and during plant rest, if the temperature drops below 5 to 7 degrees Celsius, it is dangerous not only for cold-resistant cultivars, but for all its cultivars (Sibbett and et al. 2008). The sensitivity of the olive tree to low temperatures depends on factors such as: the growth stage of the plant, the duration of low temperatures, air humidity, the type of variety and the health quality of the tree (Azizi and et al. 2004). Olive is compatible with Mediterranean and sub-Mediterranean climates. Olives perform best in areas with mild winters and long, hot, dry summers (Dias and et al. 2012, Ponti and et al. 2014) . This plant is sensitive to severe frosts, but this temperature varies during the growth period of the plant, young plants tolerate up to -9 °C and older trees tolerate up to -12 °C (Manousis, and et al.1987; Gutierrz and et al. 2009). Olive grows and develops well in areas with annual rainfall between 500 and 800 mm and is full of crops (Azizi and et al. 2022). The high amount of moisture provides the attack of fungal and bacterial diseases, therefore, it should be avoided to plant it by the sea . Goncalves and et al. in a study carried out during a three-year period (2006 to 2008) in traditional olive groves in the Terra Quente region of north-eastern Portugal to evaluate the potential of two commercially available traps for predicting infestations by olive fly, Bactrocera oleae (Rossi). They used yellow sticky traps baited with pheromone, and McPhail traps baited with diammonium phosphate. The results showed that the variation in infestation is explained by captures of adults in both traps. Thus, even if infestation has changed significantly between years as well as groves and olive tree varieties, captures obtained by both types of trap can be valuable indicators of fruit infestation in Terra Quente, and probably in other regions that have a continental Mediterranean climate. The information obtained can enable growers and consultants to time treatments, and so avoid the use of more labour-intensive visual sampling methods (Goncaves an et al, 2013). In a study, Varikou and et al in 2021. dealt with the method of dealing with the olive fly. Key to the success of the ground bait spray application method ('attract and kill') against Bactrocera oleae is to effectively suppress its population by inducing good levels of attraction and stimulate flies to ingest a lethal dose of the toxicant. A 2-year long field bioassay (fly captures to sticky panels) was developed to evaluate the exposure and response of olive flies to hydrolyzed protein based and ammonium salt baits in combination with various insecticides. A significantly higher attractive response of fruit flies was recorded in the case of the protein Entomella/phosmet combinations among protein bait/combination. Though next year, an enhanced attractive effect and a longer residual activity of ammonium salts compared to the tested protein to the olive fruit fly was clearly demonstrated. Especially in the case of beta-cyfluthrin mixed with ammonium salts, the mean number of captured flies were at least 3 to 11-fold (depending on the salt) higher compared to the respective protein-containing mixture baits instead of the organophosphate phosmet. Ammonium salts can successfully replace proteins in bait sprays (Varikou and et al, 2021).

In 2021, Diaz-Alvarez and et al in 2021, investigated the effects of climate change on Spodoptera frugiperda in Mexico. Maize is one of the most important crops in the world, particularly in Mexico where it was domesticated and is central to traditional cultures. The fall armyworm (Spodoptera frugiperda [J.E. Smith]), is a major pest that can greatly reduce production of this crop. Climate change also threatens maize production, as projections estimate an increase of fall armyworm outbreaks. For these reasons, (1) we assessed the changes in the S. frugiperda life cycle along a temperature gradient ranging from 23 °C to 31 °C, and (2) assessed the development of larvae feeding on two Mexican landraces and the responses of each landrace to herbivory under current and predicted climatic conditions; both assessments were conducted under laboratory conditions. Development was faster and each life cycle stage was shorter at higher temperatures. The effect of herbivory differed between the landraces; herbivory was more harmful for White Ranchero than for Yellow. As warmer and drier conditions are expected during this century, sowing appropriate maize landraces that can cope with herbivores under climate change could mitigate potential economic losses (Diaz-Alvarez and et al, 2021). Kylie and et al in 2019 studied about Eco-climatic niche models. They are powerful tools for assessing the potential range of plant pests and pathogens, widely applied in comprehensive pest risk assessments globally. We conducted a bibliometric analysis comparing the number of CLIMEX models developed for plant pathogens and plant arthropod pests. We found that plant pathogens were statistically significantly under-represented, with fungal plant pathogens less than half as likely as plant insect pests to be the subject of a published CLIMEX niche model. We explore key factors that may account for this disparity, including inconsistent experimental paradigms and lack of cross-disciplinary (i.e., plant pathology and modelling) expertise (Kylie and et al, 2019). Stacey in 2010 states in an article that Organic farming has increased in popularity in recent years, primarily as a response to the perceived health and conservation benefits. While it is likely that conventional farming will be able to respond rapidly to variations in pest numbers and distribution resulting from climatic change, it is not clear if the same is true for organic farming. Few studies have looked at the responses of biological control organisms to climate change. He review the direct and indirect effects of changes in temperature, atmospheric carbon dioxide and other climatic factors on the predators, parasitoids and pathogens of pest insects in temperate agriculture. Finally, he consider what research is needed to manage the anticipated change in pest insect dynamics and distributions (Stacey, 2010).

Materials and Methods

The studied area is Tarom city in Iran and geographically it is located at 48 degrees and 30 minutes to 49 degrees and 15 minutes east longitude and 36 degrees and 41 minutes to 37 degrees and 12 minutes north latitude. This research has first investigated the climatic changes of the studied area by using the data of the meteorological station in the statistical period of 10 years (2008-2017). Because the olive fruit fly pest is directly affected by temperature, humidity, rainfall and radiation, so these factors have been investigated and displayed in the graphs. By examining the frequency of hunting caused by the traps set in the orchards, the olive fly pest, the correlation between the changes in the frequency of the pest and the changes in weather conditions was evaluated. The trend of changes in these two weather indicators and the changes in the olive fly pest population were investigated using SPSS, EXCEL software, and as a result, its correlation coefficient and standard deviation were investigated. In this research, in order to determine the effect of the olive fruit fly pest on the quality and quantity of the olive crop and the damages caused by it and the costs caused by chemical and combined control on the economic and social conditions, a number of 50 questionnaires were collected among farmers and gardeners. Olives were distributed in the study area and after collection, they were interpreted. Considering the geographical distribution of olive groves and gardeners, 50 forms were distributed among the users and according to the answers received; the results were analyzed by SPSS software.

Results

Super temperature and its changes during the period of time can affect the growth and development of the olive tree and its related pests. Diagram1 shows the trend of temperature changes in Tarom region using the data of meteorological synoptic station. The general trend of annual temperature changes is increasing. The average annual minimum temperature of this region fluctuates between 11.2 degrees Celsius in 1390 and 13.1 degrees Celsius in 1396. The maximum annual temperature in this region fluctuates between 22 degrees Celsius in 2013 and 24.5 degrees in 2013. The long-term average temperature of this region is 18 degrees Celsius.

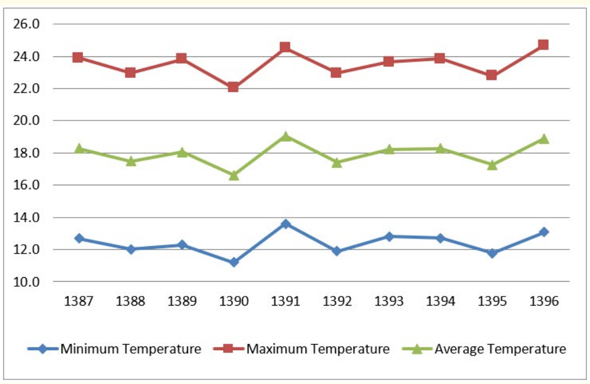

Figure 1: Chart of changes in maximum, minimum and 10-year average temperature of Tarom region.

According to the title of this research, which examines the trend of climate change, it is important to determine the trend of temperature changes in the statistical period of 10 years. Based on this, graph 2 below shows the changes of the three-year moving or shaking average. According to this graph, it can be confirmed that the trend of temperature changes in this region is increasing, which shows the trend of changes from 17.9 degrees of silicon to 18.1 degrees of silicon, which indicates a change of 0.2 degrees of silicon.

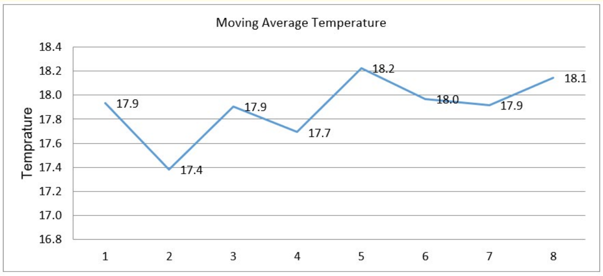

Figure 2: The graph of three-year moving average temperature changes in Tarom region.

By comparing the hunting of traps over several years, it can be seen that the amount of hunting and catching of olive fruit fly insects in August 2013 is much higher than in the following years, and the direct relationship between pest activity and climate and weather conditions in the same period year, so that the population of the pest has overflowed in parallel, and as a result, the most damage of the pest has been observed in the last few years.

Max Temperature °C	***RH%***	***Time***	***Mean max Temperature °C***
23.8	49	06/17/15 00:32:20	27.7
21.1	53.1	06/17/15 04:32:20	
24.3	41.9	06/17/15 08:32:20	
35.6	27.1	06/17/15 12:32:20	
33.2	34.3	06/17/15 16:32:20	
27.9	45.5	06/17/15 20:32:20	
24.5	55.2	06/18/15 00:32:20	28.6
22.2	60	06/18/15 04:32:20	
26.8	45.5	06/18/15 08:32:20	
36.6	26.2	06/18/15 12:32:20	
33.7	35.3	06/18/15 16:32:20	
27.9	47.3	06/18/15 20:32:20	

Table 1: Comparison of the maximum daily temperature in different hours with the average maximum temperature.

As can be seen in Table 1, the maximum daily temperature was recorded at intervals of 4 hours by the temperature and humidity stability device (data logger) and it can be seen that the maximum temperature reaches its highest value around 12 noon. As the sun sets and the intensity of sunlight decreases, the temperature of the plant also decreases. The important point about the biological activities of the pest is that the olive fly has more nutritional and sexual activities around sunset, and as a result, when the temperature of the plant reaches its maximum value. It turns out that the nutritional and sexual activities of the insect have been minimized and it spends most of its time in shelters and behind the leaves and the shaded part of the tree. Another point in this table is the general perception of people and gardeners about the maximum daily temperature. The maximum temperature announced for 6/17/2015 is equal to 35.6 degrees Celsius, while if the daily average temperature is calculated on the same date, it is 27.7 degrees Celsius, and the maximum temperature decrease is from 12:00 noon to 8:00 p.m. Night occurs, which is the best time for olive fruit fly activity. In this research, the process of reducing the maximum temperature every hour was investigated and evaluated. When whole olive fly insects are exposed to different temperatures for two hours, even at 36°C, up to 94% survival is observed in whole insects. This means that even if the air temperature is reported in the 36°C region. Because the maximum temperature is momentary, it cannot cause much harm to the insect, because the insects also deal with this increase in temperature in different ways, and even the temperature in different parts of the crown of the tree is different from each other.

Annual fluctuations of olive fruit fly

Diagram 3 shows the annual fluctuations of the olive fruit fly pest during the years 2012 to 2016. The left column shows the average values of olive fruit fly hunting (traps per day). If you pay attention to the fluctuations of the graph in 2013, it can be seen that in the summer of this year, the abundance of the olive fly has increased significantly compared to other years. According to the previous explanations and according to the chart of changes in the average temperature of this year and the comparison with the temperature of other years in this season, it can be seen that the temperature conditions in the summer of 2013 were more balanced and special climatic conditions prevailed in the region. The result of these favorable temperature conditions is an increase in pests and, as a result, an increase in hunting in pheromone traps. Due to the formation and growth of the fruit in this season, the damage caused to the product in case of not paying attention to the weather conditions and recommendations related to this sector can be irreparable and have many economic and social consequences. The egg-laying time of the first generation of the olive fruit fly coincides with the beginning of hardening of the olive kernel, which occurs around the first half of June to the first half of July, so the increase of the pest at this point in time can have many economic and social effects. be In the following sections, some tips are provided regarding the review of the summer season.Some tips are provided to review the summer season.

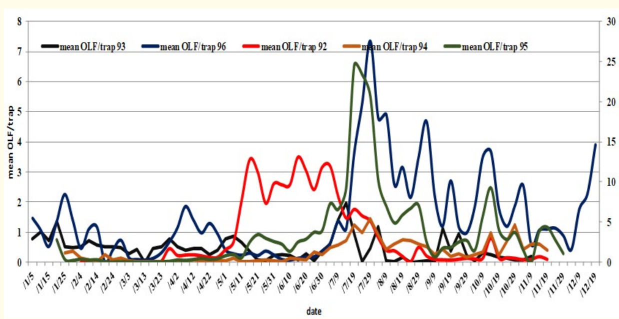

Figure 3: Annual fluctuations of the olive fruit fly pest during the years 2013 to 2017.

Population fluctuations of olive fruit fly based on season

According to the presented materials regarding the relationship between climatic conditions and the growth and abundance of olive fruit fly and hunting data of this pest during the years 2013 to 2017, the trends of the abundance of this pest and its relationship with climatic conditions were investigated. Chart 4 shows the frequency of hunting during the spring months in the statistical period from 2013 to 2017. Considering the almost homogeneous temperature trend in these years and in this season, the hunting trend and in other words the abundance of olive fly is also almost homogeneous. According to the graph below, with the increase in pest hunting in the spring season, it indicates a temporary increase in hunting in some days when the temperature has temporarily increased due to the occurrence of hot wind. But the general process is similar. It should be noted that the hunting statistics are related to the number of flies caught every 5 days.

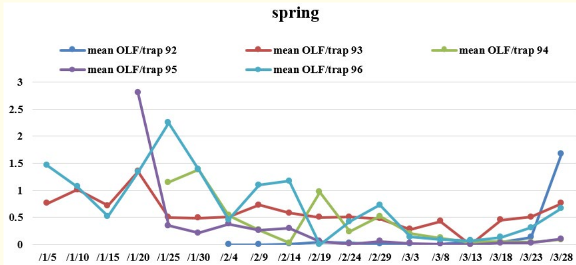

Figure 4: Population fluctuations of olive fruit fly in spring.

As previously stated, like the obvious difference in the graph of the average temperature in the summer season during 2013 compared to other years due to the adjustment of temperature and changes in weather conditions, in graph 5 of the frequency of olive flies during the summer of 2013, there is also a significant difference with other We have been together for years. These changes indicate the increase in hunting and the abundance of the pest in summer 2013, which is due to the adjustment of temperature and weather conditions, which gave the pest the opportunity to grow and develop more appropriately and as a result increase more.

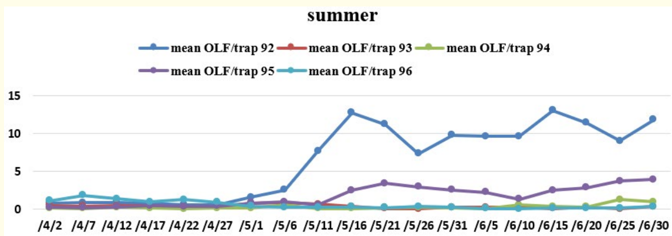

Figure 5: Population fluctuations of olive fruit fly in the summer season.

Chart 6 shows the number of hunts in the fall season. Due to the relative similarity of temperature conditions during the years investigated in this season, the graph of olive fruit fly pest frequency is also similar. The difference in the frequency of the pest was observed during about one month in 2016, which is the same factor as the increase in the average temperature this year and the increase in hunting.

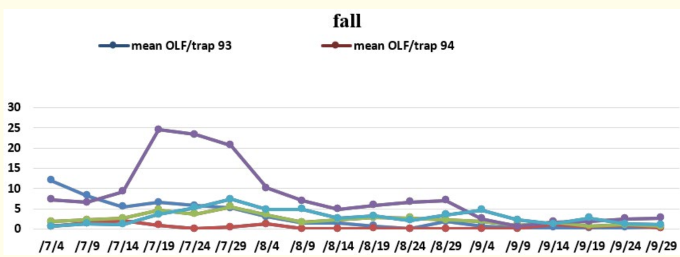

Figure 6: Population fluctuations of olive fruit fly in autumn.

The olive fly pest does not have an obvious activity in winter, and its activity in this season is limited to days with favorable temperatures, along with days when southern atmospheric systems are active in the region. In this case, the occurrence of south winds in the region, which is known for its hot wind, will cause a significant increase in temperature and decrease in humidity within a limited number of days. This temporary increase in temperature is a factor for increasing the biological reactions of the pest and as a result, increasing the flight and hunting of pheromone traps. In winter, the activity of this pest does not cause economic losses and socially affecting farmers, and it only affects the pest's more suitable wintering. In diagram 7, this disorder is clear for a few days.

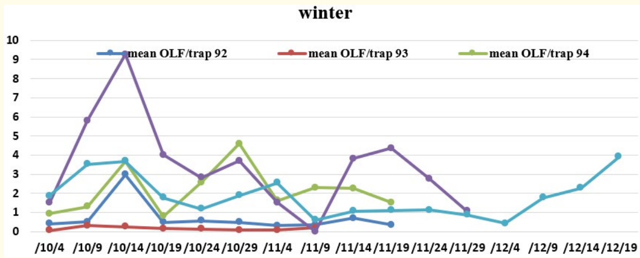

Figure 7: Population fluctuations of olive fruit fly in winter.

The relationship between olive fruit fly hunting frequency and average daily temperature

Figure 5 shows the frequency of olive fruit fly hunting, average temperature and time together. The left column shows the average daily temperature and the left column shows the average olive fruit fly hunting (number per day) and the horizontal line shows the sampling date (day). Considering the importance of the abundance of this pest during the fruiting season, i.e. in summer, the occurrence of suitable temperatures for the growth and development of the pest during this time has led to an increase in hunting, which indicates the greater abundance of the pest. The occurrence of low (moderate) temperatures at this time, as in the event of 2013, results in the abundance of pests and as a result, increased damage. Considering the economic importance of this product in the region under investigation and the possibility of economic and social damage, it can be acknowledged that insufficient attention is paid to the weather conditions and its annual and seasonal changes, as well as the failure to carry out the stated measures to control the pest, one should expect the occurrence of economic and social in the region. Reliance on single-crop agriculture in the region and heavy economic reliance on this product will have wider social consequences.

According to figure 8, it can be seen to what extent the adjustment of temperature and weather conditions (in the summer of 2013) has been effective on the frequency of the pest, and the simultaneous occurrence of this event at the time of fruit formation and growth, as well as non-observance of agricultural and control points. The plague will cause economic damage.

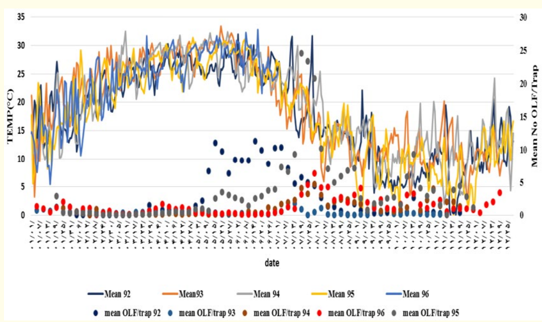

Figure 8: Relationship between average daily temperature and olive fruit fly hunting.

Examining social variables

Based on the results of the descriptive statistics of social variables, according to Table 2, the highest average value is related to the variable of cooperation with related devices and the highest average value is related to the variable of technical knowledge.

Indicator	*Number of Samples*	*At least*	*Maximum*	*Average*	*Standard Deviation*
Social penetration	217	1	5	3.46	0.4112
Cooperation with related devices	217	1	5	3.78	0.5672
Social participation	217	1	5	3.59	0.3419
Educational-promotional activities	217	1	5	3.12	0.3881
Technical knowledge	217	1	5	3.27	0.4194

Table 2: Descriptive statistics of social variables.

Pest control method

In this component, according to Table 3, different methods of olive fruit fly pest control in orchards were evaluated. that the whole community has taken at least one pest control method and no farmer has been indifferent to this matter and has not taken any action. 58% of users received low satisfaction and feedback with pest control and control, and 42% of their satisfaction level was average. The method of baiting trees with protein solution and the use of poisons was announced as the most widely used method to fight this pest by gardeners, and after that the use of pheromone traps was announced as the most widely used method to fight.

How to control the pest	*Abundance*	*Frequency*
Using pheromone traps	21	0.42
Tree plowing in winter	0	0
Use of yellow cards	0	0
Use of protein traps	0	0
Collecting infected fruits from the base of the tree and on the tree and destroying it	0	0
Baiting in trees with protein solution and poison	29	0.58
Timely harvesting of canned fruits	0	0
I have not used any of the above methods	0	0

Table 3: Component analysis of pest control.

Lack of motivation

The level of lack of motivation of users compared to the control was evaluated in six options, as a result, according to Table 4, lack of access to knowledge of meteorology or agricultural meteorology has been stated as a factor in the lack of motivation. More frequency of response to the component of lack of motivation of users to fight this pest has been declared as 40% average and 38% high.

According to table 5, the average ranks of the investigated social variables are respectively for social penetration (3.92), cooperation with related institutions (3.15), social participation (3.88), educational-promotional activities (3.36). and technical knowledge (3/11). which indicates that among the elements related to social and economic status, the highest rank is related to the dimension of social permeability.

How to control the pest	*Abundance*	*Frequency*
Lack of availability of meteorological information	30	0.6
Lack of knowledge of the effect of climatic conditions on crops and pests	0	0
Not having enough information to control the olive fly pest	0	0
Non-availability of olive fly pest control equipment and facilities	0	0
Absence during special weather phenomena	10	0.2
Lack of belief in the knowledge of agricultural meteorology	10	0.2

Table 4: Analysis of the lack of motivation component in the fight against the olive fruit fly pest.

Dimensions of social and economic status	*Average ratings*
Social penetration	3.92
Cooperation with related devices	3.15
social participation	3.88
Educational-promotional activities	3.36
Technical knowledge	3.11

Table 5: Average ranks of the variables.

Conclusion

By distributing 50 forms among gardeners and analyzing the answers received and demographic survey and analysis of a questionnaire, it was determined that climate changes in Tarom region have a significant effect on the abundance of olive fly in the region, its abundance is very high in the summer season. Among the economic and social components that have been affected by the abundance and incidence of olive fly in Tarom city and among the olive gardeners of this region, the most effects are related to the component of social participation and increasing social penetration among farmers, and the lowest amount The effects have been related to promotional and educational activities and technical knowledge, and it is suggested that educational and promotional courses by expert experts of agricultural institutes be held for farmers in order to combat this plant pest with an emphasis on protecting the environment from the effects of pesticides and poisons. Olive fly disposal should be held.

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