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Pear Production (*Pyrus communis* L.) in Jerusalem, Palestine

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

Pear is a tree belonging to the Rosaceae family, sensitive to different environmental conditions. It is spread in East and West Asia, America and the European Union, and its production has an economic role for many countries of the world, including Palestine. Average annual temperatures and precipitation were analyzed using data from the Palestinian Meteorological Station affiliated with the city of Jerusalem, which was recorded between the years (1993-2014), and equal to the number of years of pear production, noting that the data for pear production was taken from the Palestinian Central Bureau of Statistics. On the other hand, we used Professor Salvador Ravers Martins' methodology to classify the Earth in the process of analyzing environmental factors, there are two aspects of the factors: The first is climatic, which is the amount of rain or precipitation, mean monthly temperature and soil water reserve, and the second factor is the bioclimatic, which is annual ombrothermic index, simple continentality index, compensated thermicity index, and water deficit.

Moreover, we used Professor Salvador Rivers Martinez's methodology for classifying the land in the process of analyzing dependent and independents factors (environmental factors). There are two aspects to the factors: First is climatic, precipitation, mean monthly temperature and soil water reserve, and the second factor (bioclimatic factor), as simple continentality thermicity index, annual ombrothermic index, water deficit and compensated thermicity index.

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In conclusion, The city of Jerusalem is negatively affected by some climatic and bioclimatic factors such as average monthly temperatures, rainfall, compensated thermicity index, water deficit, and annual ombrothermic index during (1997-2002 and 2007-2014), but it was positively affected by soil water reserves in relation to pear production during (1993 -1996 and 2002-2007), with an increase in the variance of F1 axis (98.8%), the F2 axis (0.821%), and the symmetrical drawing axes F1 and F2 (99.8%), when applying correspondence analysis. However, humid areas characterized by moderate summers are the appropriate area for pear growth and productivity, as the temperature ranges between 18-24 degrees Celsius, where high-quality production can be obtained, and the amount of rain ranges more than 600 mm annually.

Keywords: Palestine; Jerusalem; pear; plant; production.

1. INTRODUCTION

The common pear, (*Pyrus communis* L.), is a native of western Asia and central & eastern Europe. Being the species from which most orchard pear varieties grown in Europe, North America, and Australia have been derived, it is one of the most significant fruits of temperate regions. In East Asia, two more pear species are more often grown: The Nashi pear and the hybrid Chinese white pear, Pears have been cultivated in China since 2000 BC [1], and according to Zohary et al. [2], archeological evidence indicates that these pears "were collected from the wild long before their introduction into cultivation". One of the favored materials for high-end woodwind instruments and furniture construction is pear wood. Pears come in about 3,000 known varieties, differing in shape and flavor, and are grown all over the world. The fruit is eaten raw, dried, juiced from a fermented to make Perry, while one or two kinds of pears are evergreen in Southeast Asia, most pears are deciduous. With the exception of evergreen plants, which can endure temperatures as low as -15 °C, the majority can withstand wintertime lows of -25 to -40 °C., Pears are grown in temperate and subtropical conditions because of their adaptation to a wider climate and soil. Scattered pear plantations are found growing right from the temperate mountainous zone to the warm subtropical valley regions of the region. Pears grow best in deep, medium-textured, well-drained soil. In general, many pear varieties need about 900-1000 hours of cold during the winter (less than 7°C) in order to complete the period of bud rest, and flowering in pear trees depends on moderate temperatures during the months preceding the flowering process, the cold period is important to overcome the internal state of stillness [3].

Pears play an important economic role in many countries of the world, such as in the Asian region, especially China, America, and the European Union countries, such as Italy, Spain, and others. The largest producer of pears is China with 19.3 million tons, followed by Argentina (0.9 million tons), the United States of America (0.73 million tons), Italy (0.7 million tons), and Turkey (0.47 million tons). South Africa, India, the Netherlands, Spain and Belgium completed the top ten [4]. Pears contribute an important economic role in Palestine, where the production of one dunum is estimated at between 400-700 kilograms/dunum, while in Jerusalem it is estimated at about 400-570 kilograms/dunum annually [5]. The climate of the Holy City (Al-Quds Al-Sharif) is somewhat moderate, with hot and dry summers and rainy and mild winters, which represents a vital model for the climate of the Mediterranean basin region [6,7,8,9,10]. In addition, to the many studies conducted on many plants or fruit trees, including peaches, grapes, olives and apricot [6,7,8,11,12,13,14,15,16,17,9] and the impact of climatic and bioclimatic factors on these plants and the agricultural system in Palestine [18] a, b, c [19,20,21,22,23,24] and the Mediterranean Sea [25,26,27,28,29,24,10, 30,31,32]. In this study aims to determine the impact of environmental factors on the pears crop in the Jerusalem in occupied Palestine.

2. METHODS

2.1 Study Area

Jerusalem is a Canaanite Palestinian city built and founded by the first Jebusites, who lived there in the fourth millennium BC. (Copper Age). The Holy City is distinguished by a very important geographical location, as it is located on the Jerusalem Plateau and above the mountain peaks that represent the central chain of the occupied Palestinian territories. It is located (54 km.) east of the Mediterranean Sea, (23 km.) west of the northern of the Dead Sea, and (250 km.) north of the Red Sea. The area of the city of Jerusalem is 652 thousand dunum, and its elevation is (754 m.) above sea level, with coordinates (31°47′ north, 35°13′ east), while the meteorological station in Jerusalem is located at (35°13′ east, 31°52 ′ north).

2.2 Data Analysis and Statistics

In this research, we selected plant production (dependent variables) data from the Palestinian Central Bureau of Statistics, and meteorological data from the Palestinian Meteorological Station for the occupied city of Jerusalem (http://www pcbs.gov.ps/), during the period between 1993 to 2014. It is shown in (Table 1) and (Figs. 1 and 2), with emphasis that the study included the East Jerusalem area (which is the area occupied by Israel in the year one thousand nine hundred and sixty-seven).

In the analysis process, we focus on two factors: temperature and precipitation, and on the basis of these factors, environmental factors (bioclimatic and climatic factors; independent variables) were analyzed. The climatic factors consist of temperature or mean (average) monthly temperature (T), precipitation (P) and soil water reserve (R), while the bioclimatic factors (independent variables) include the annual ombrothermic index (Io) and a simple continental thermicity index (Ic), compensated thermicity index (It/Itc) and water deficit (Df).

Furthermore, we used Salvador Rivas Martinez's land classification methodology to analyze climate and bioclimatic factors [33,34,35,36,37] Jarque & Bera [38,39] Shapiro Wilk [40] and Shapiro et al. [41] test was used to determine the probability of seven variables, taking into account that these variables were statistical analyzes performed Using XLSTAT program.

However, we applied analysis of variance (ANOVA) to the eight variables, the independent variables (three climatic factors & four bioclimatic factors), and (pear production (dependent variable), to perform a principal component analysis (PCA) to detect the effect of independent variables on pear production.

Fig. 1. Location of occupied Jerusalem in Palestine via satellite

Fig. 2. Palestinian weather stations, including Jerusalem

Table 1. Shows pear production data and independent variables in Jerusalem during 1993-2014

Years	T	P	Df	R	It/Itc	Ic	Io	Yield of pears
1993-1996	18.9	549	576	413	422	17.4	2.26	480
1997-2002	19.9	495	618	444	475	16.1	1.89	405
2002-2007	18.1	577	566	398	390	18.9	2.48	568
2007-2012	19.3	533	586	408	433	18.6	2.32	500

Yield: kg/dunum, Production: metric ton

3. RESULTS AND DISCUSSION

3.1 Analysis of Climatic and Bioclimatic Factors and their Impact on Pear Production

3.1.1 Principal component analysis

In this study, and after we performed the analysis process using the aforementioned Salvador Rivers Martinez methodology to analyze environmental factors, in addition to the natural tests of Jarque & Bera & Shapiro-Wilk, with used of the XLASTAT program, the resulting probability value obtained from the environmental variables was to less than 0.05, which is significant acceptable, and it has been done principal component analysis which is used to load factor analysis, exploratory analysis data, eigenvalues, and eigenvectors.

In this research, after we analyzed using the methodology of Salvador Rivers Martinez, the natural tests of Jarque & Bera and Shapiro-Wilk, and using the XLASTAT program mentioned above, the probability value resulting from the environmental variables was obtained, which is less than 0.05, which is morally acceptable, so we conducted Principal components analysis, which is used to analyze factor loadings, eigenvectors, exploratory analysis data, eigenvalues, etc.

3.1.2 Eigenvalue and factors loading analyses

Hirstein (1964) and Nering Ivar [42-47] emphasized that while eigenvalues and eigenvectors are used in matrix methods or linear transformations, the linear transformation vector in linear algebra is a non-zero vector, and can only change by the amount of a scalar factor while applying this linear transformation.

Principal component analysis was used to help identify different variables, and the factor cardinality of an eigenvalue more than one was used after a varimax sequence. The results of the principal component analysis included factor loadings with varimax sequences and eigenvalues, which were indicated in (Table 2) and (Fig. 3).

However, the eigenvalues were less than ***(1)***, and the total variable factors (98.88%) were the first factor dominated by environmental factors, such as the simple continental thermcity index (0.722), annual ombrothermal index (1.317), precipitation (0.600), accounting for (98.88%) of the total variance, temperature and the rest of the other factors were negative, such as the average monthly temperature (-0.60), water deficit (-0.50), and the compensated thermicity index (-1.107). In the second factor, the soil water reserve factor (1.530) positively (0.812%) of the variance, while it is negative for the rest of the factors, whereas, the last factor is dominated by annual ombrothermic index (-2.045), and water deficit (1.071), and positively for the rest of the factors, and a percentage of (0.294%) of the total variable appears in (Table 2).

3.1.3 Correspondence analysis

The productivity of pear plants in Jerusalem is negatively affected by some bioclimatic factors [24], such as the simple continentality thermicity index, annual ombrothermic index, water deficit, and the compensated thermicity index, compared to other climatic factors such as rainfall and average monthly temperature, with a high variance at the F1 axis (98.88%). And the F2 axis (0.821%), and the symmetrical row plot of F1 and F2 axis (99.88%), during the years (1997 - 2002 and 2007 - 2014), when correspondence analysis was applied, all of these factors came below zero with respect to the xy- axis, and were positively affected by the soil water reserve factor during (1993-1996 and 2002-2007), perhaps related to the soil type fertile and its suitability for growth and production pear. In addition, this factor has a value higher than one and is located to the far right of the x-axis (Fig. 4). In the other side, the results confirmed that the soil type is suitable for growing pears and increasing their productivity during the analysis process in this research, and to obtain a high quality of production and growth of pear trees, this plant gives good production and adapts to humid areas in moderate summers with a temperature of 18-22 degrees Celsius, and an amount of precipitation of more than 600 mm annually, including Mesomediterranean environment areas.

Table 2. Factors represent the eigenvalue and loading of principal component analysis

Dependent & independents Variables	F1	F2	F3
T	-0.6	-1.912	-1.235
P	-0.627	-0.465	-1.52
Df	-0.5	-0.357	1.071
R	0.623	1.53	-0.346
It/Itc	-1.107	-0.401	-0.071
Ic	0.72	-6.158	1.63
Io	1.317	-8.123	-2.045
Pear production	1.856	0.478	0.942
Eigenvalue	0.003	0	0
Inertia (%)	98.88	0. 821	0.292
Variance %	98.88	99.88	100

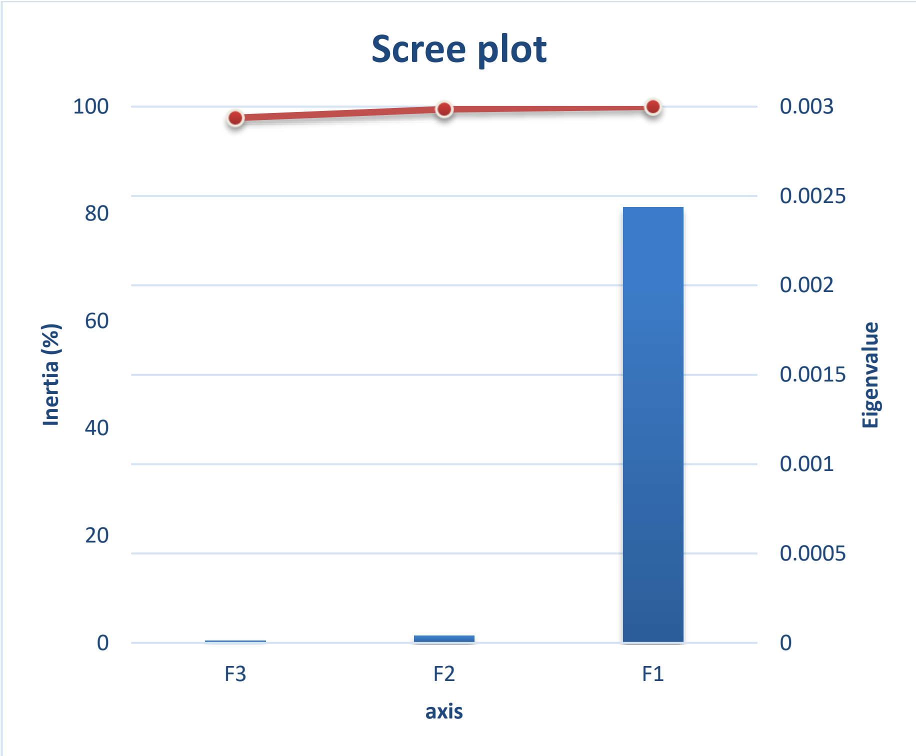


Fig. 3. Principal component analysis of the eigenvalue and loading factors

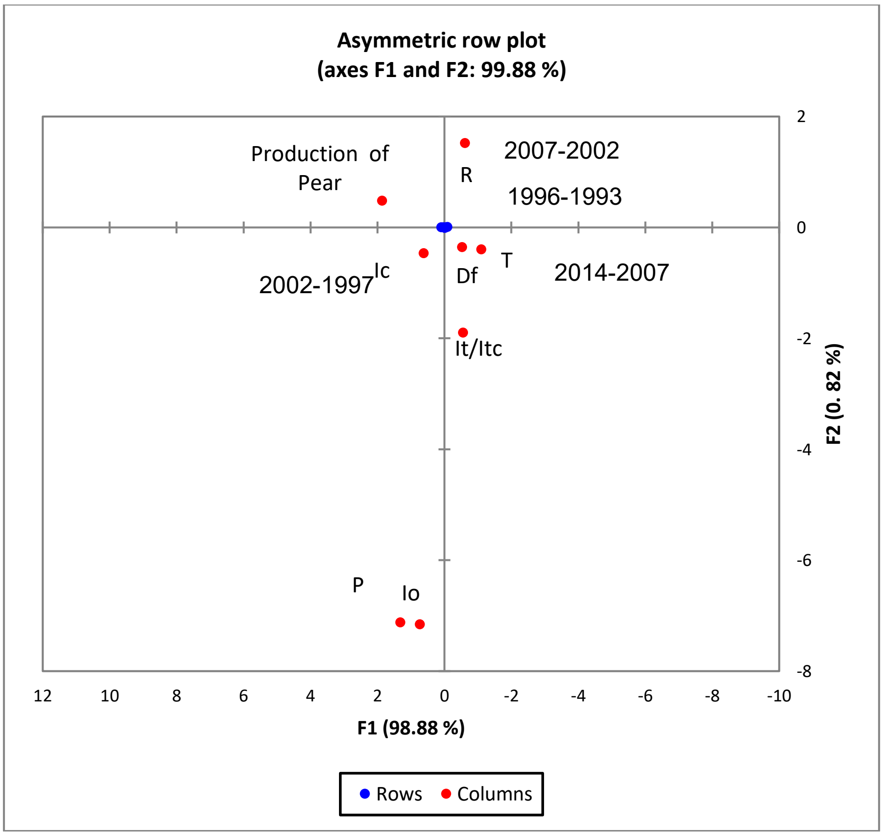
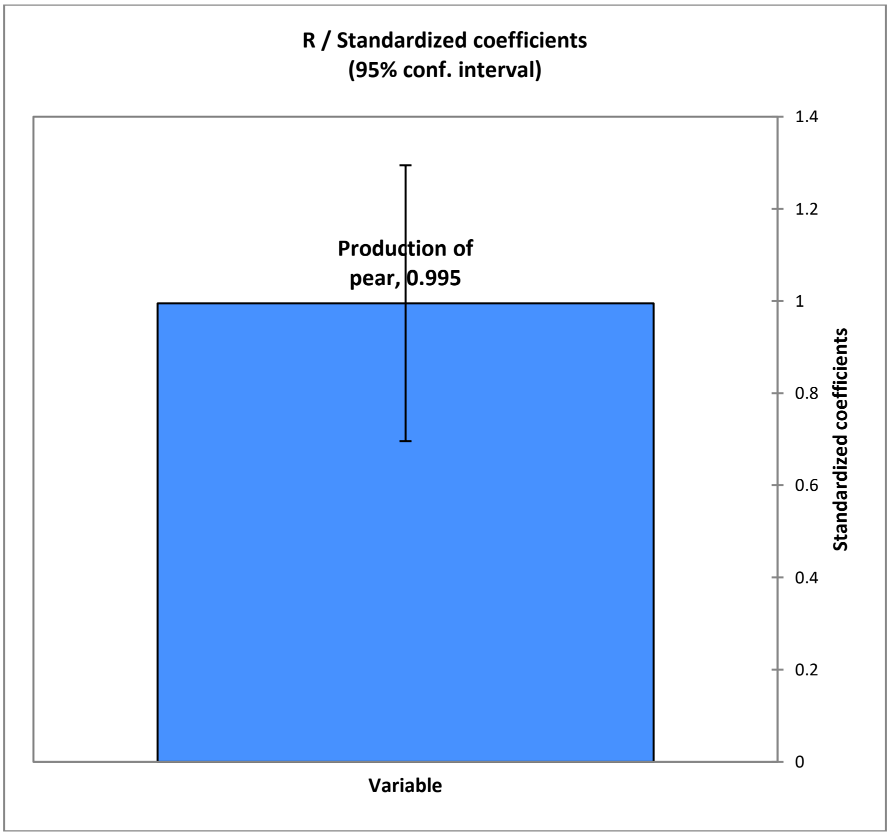
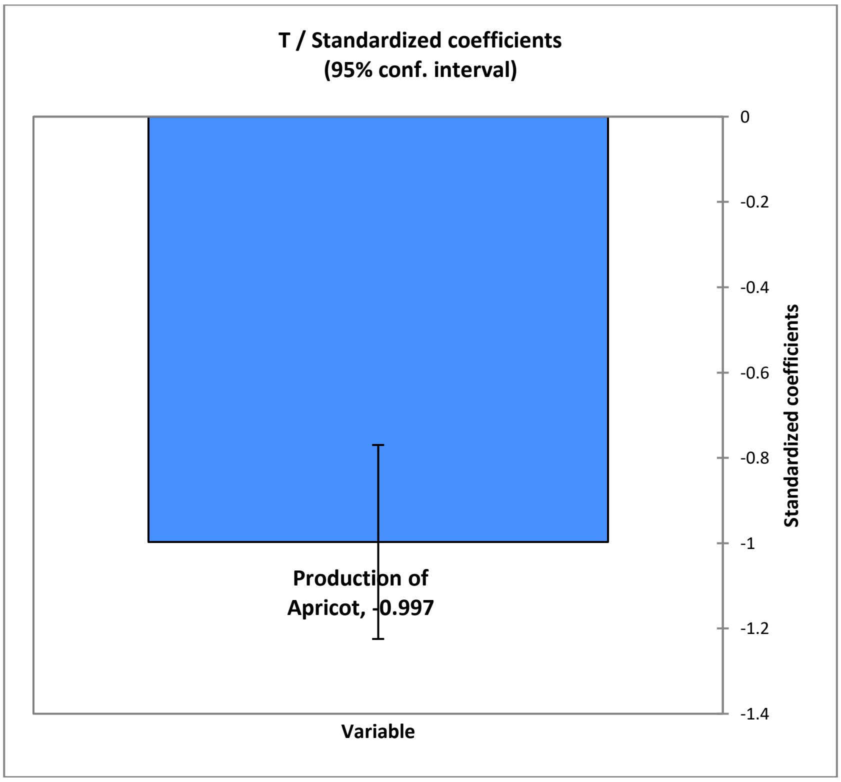


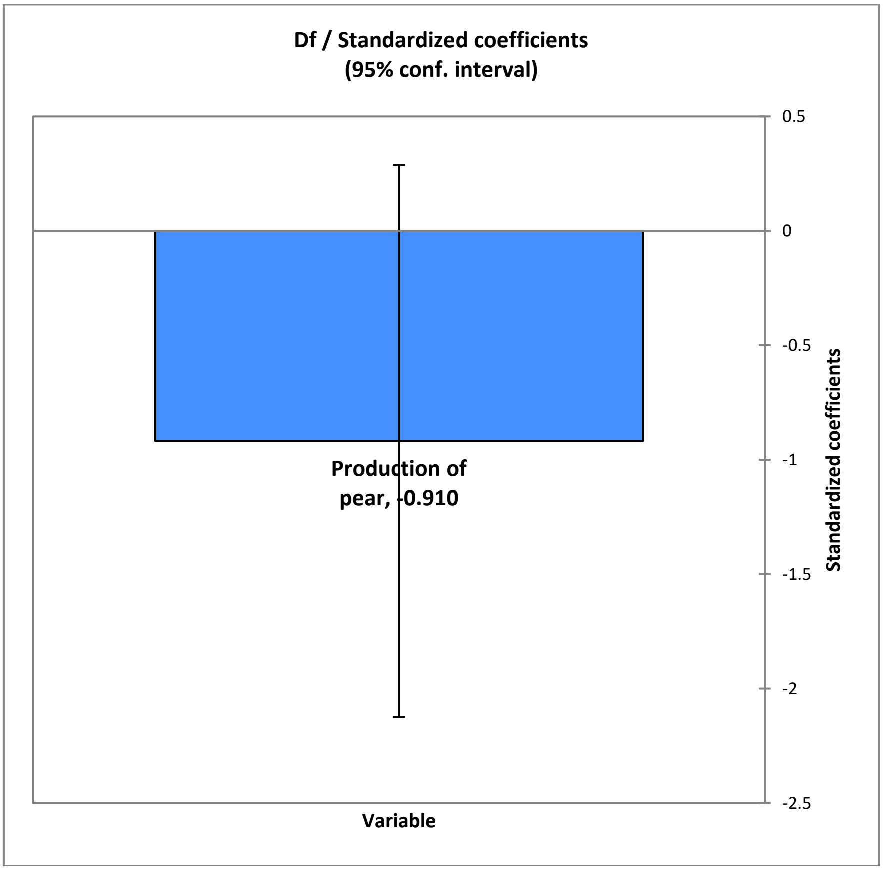
Fig. 4. Correspondence analysis of various variables, dependent and independents variables



Graphic a.



Graphic b.



Graphic c.

Fig. 5. Graphics of environmental variables and their impact on pear production and standardized coefficients (a-c)

In ANOVA, a 95% confidence interval was applied to the pear yield, with both the influence of different environmental factor variables such as (T, Io, It/Itc, P, Df and Ic), to explain the significant differences in pear production. The results of the standard coefficient showed a significant difference in pear productivity, as the best standard variable showed in the soil water reserve (0.995), because it is closed to 1 (Fig. 5a), whereas, the standardized coefficient is negatively related to several factors, including average monthly temperature, and water deficit (-0.997 and -0.910) respectively, because the histogram is a negative (Fig. 5b, and c).

In the end, Pear can be grown from foothills to high hills (600-2700 ml) and experience 500-1500 chilling hours. It can withstand temperatures as low as -26°C when dormant and up to 45°C during the growth period. Spring frosts damage pear production and temperatures of 3.3°C or below kills the opened flower. A pear tree can thrive in average soil with a pH near 7, provided it is well-drained and free of standing water. However, maximum productivity is recorded in fertile sandy loam soils with a pH of 6 to 7. Many commercial apple and pear growers add lime to the soil before planting their trees, in order to stabilize the PH. We recommend that pears need a suitable soil for their cultivation, as pears grow best in deep, medium-textured, well-drained soil, which is available in Jerusalem, and a humid climate with moderate temperatures, as the best temperature for pear growth and production is 21 degrees Celsius (18 - 27 degrees Celsius).

4. CONCLUSION

The Jerusalem area was negatively affected by annual ombrothermic index, compensated thermicity index, water deficit, average monthly temperature, and precipitation, but it was positively affected by soil water reserves for pear production. The optimum temperature for pear production ranges between 18-24 degrees

Celsius, rainfall ranges between 600-1000 mm per year, simple continental thermicity index is 16-22, annual ombrothermic index is higher than 3, and the compensated thermicity index is about 250/400, with ecological areas in the central Mesomediterranean, to obtain high production pears. Also, the climatic requirements of pears determine its ability to adapt to the growing region, the extent of its response to climate changes, and increased productivity.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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