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Effect of Biology and Bioclimatology Applied Studies on Plant in the Area of Jerusalem in Palestine

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Abstract: *Apple tree (Malus domesticaL.Borkh) is one of the most important export crops in Palestine. We analyzed the mean annual temperature and precipitation using data from one weather station of the Palestine Meteorological Department, recorded in the period from 1993-2012 (19 years), with the same years plant production (rain-fed) from the Palestinian Central Bureau of Statistics (PCBS). Statistical tests included a bioclimatic analysis of Palestinian meteorological station for the period previous by using bioclimatic classification of the Earth of Rivas Martinez Salvador, with regard to simple continentaly index, compensated thermicity index, annual ombrothermic index, water deficit and soil water reserve. In concluded, when we applied a principal component analysis (PCA), observed that the Jerusalem type plots were located at the right of axis 1 during (1997-2002) affected by the climate factor as soil water reserve, and during (2007-2012) influenced by compensated thermicity index, deficit water and temperature, while type plots were located at the left axis 1 during (1993-1997) affected by precipitation, simple continentally index and annual ombrothermic index. With a large proportion of the variance explained by axes 1 (98.97 %) and axes 2 (0.74%). We indicated that the apple trees were adapted in dry to humid regions which are characterized by moderate summer with temperature between 18-28^{o} C, which had to obtain high quality of production, also the zero vegetation point for apple is 7^{o}C, above this level growth is active and reaches its optimum at about 18-28^{o}C, and the proper temperature range between 0-20 ^{o}C during the flowering period.*

Mediterranean and lower mesomediterranean environments, the optimum for the production of apple is achieved with values of simple thermicity index between 18-22, annual ombrothermic index between 2.5 - 4.5, and compensated thermicity index between 250-420 for the production of apricot in Jerusalem.

Keywords: *Palestine, Jerusalem, biology, bioclimatology and yield.*

1. INTRODUCTION

Apple tree (*Malus domestica Borkh*) is a deciduous tree in the rose family best known for its sweet, pomaceous fruit, the apple. It is cultivated worldwide as a fruit tree, and is the most widely grown species in the genus *Malus*. The tree originated in Central Asia, where its wild ancestor, Malus sieversii. About 80 million tons of apples were grown worldwide in 2013, and China produced almost half of this total [1]. Commercially popular apple cultivars are soft but crisp. Other desired qualities in modern commercial apple breeding are a colorful skin, absence of resetting, ease of shipping, lengthy storage ability, high yields, disease resistance, common apple shape, and developed flavor. Commercially, apples can be stored for some months in controlled-atmosphere chambers to delay ethylene-induced ripening.

There are more than 7,500 known cultivars of apples [2]. Apple orchard productivity varies greatly in different climates or different years in a one climate, but it is difficult to determine the critical factors over such a range of climatic conditions. Also, the large, perennial nature of apple trees limits classic growth analyses on cropping trees in the field, although some have been done [3, 4]. The lack of a great number of growth analyses in different climates reduces our ability to understand and predict climatic effects on productivity. Cultivars vary in their yield and the ultimate size of the tree, even when grown on the same rootstock. The original wild ancestor of *Malus domestica* was Malus sieversii, found growing wild in the mountains of Central Asia in southern Kazakhstan, Kyrgyzstan, Tajikistan, and Xinjiang, China.

Jerusalem is the capital of Palestine occupied by Israel since 1948, and so far, which is also one of the oldest cities in the world. Today, the status of Jerusalem remains one of the core issues in the Israeli–

Palestinian conflict. During the 1948 Arab–Israeli War, West Jerusalem was among the areas captured and later annexed by Israel while East Jerusalem, including the Old City, was captured and later annexed by Jordan. Israel captured East Jerusalem from Jordan during the 1967 Six-Day War and subsequently annexed it. During its long history, Jerusalem has been destroyed at least twice, besieged 23 times, attacked 52 times, and captured and recaptured 44 times.

The climate of Jerusalem is said to be ideal, with its relatively high altitude ensuring warm, dry summer weather with low humidity, and contrasting chilly, wet winters. Snow may fall in winter but is a rarity that is greeted as a novel experience by locals. Summer days are sunny and pleasant with temperatures averaging comfortably around 75°F (24°C). In the shoulder seasons of spring and autumn Jerusalem sometimes experiences the hot, dry desert wind known as the sharav or khamsin, traditionally believed to blow for 50 days out of the year.

Jerusalem today, however, seems to have a generally uniform climate and is in a specially favored location to experience an ideal climate. It is not too hot, not too cold, not too dry, not too wet. Bioclimatology is the discipline that studies the relationship between climates and living organisms. Jerusalem bioclimatic belt belongs to the inframediterranean and thermomediterranean of thermotype and arid to subhumid ombrotype [5, 6]. Recent studies [5-16] have highlighted the influence of bioclimatology and climatology applied on biology, yield, physiology and growth of plant.

Aim study the effect of climatic, biology and bioclimatology applied on apple (*Malus domestica L.* Borkh) to establish the variables that had the greatest influence on plant yield in the region of Jerusalem in Palestine.

2. MATERIALS AND METHODS

2.1. Study Area

Jerusalem is located in the middle of Palestine and between some of cities, where western of Jericho and Jordan river, east of Ramallah, the northern of Bethlehem and Hebron, south of Nablus and Jenin and others cities. in general, it is located between the Dead Sea of the western, Mediterranean Sea and the mountains Mediterranean Basin region, which include the Mount of Olives (East) and Mount Scopus (North East). The elevation of the Old City is approximately 760 m (2,490 ft) and with a Coordinates: 31°47′N 35°13′E, the whole of Jerusalem is surrounded by valleys and dry riverbeds (wadis).

2.2. Data Analysis

We indicated to data taken from the East Jerusalem (which occupied in 1967) with the knowledge that many of the areas have been taken over by Israel from 2000 and so far in Jerusalem. Data were used from the meteorological station in Jerusalem for the years 1993 to 2012, and for the same years for production of plant (**Table 1**) and (Fig. 1). The bioclimatology of the aforementioned station was studied, and the value of the bioclimatic indices as annual ombrothermic index (Io), simple continentally index (Ic), and compensated thermicity index (It/Itc) and the climatic factors were obtained according to Salvador Rivas-Martinez [17-21].

Fig1. *Location of Jerusalem of Palestine*

Table1. *Independents variables (Climate and bioclimate factors) and dependent factors (Plant production) from 1993-2012 in Jerusalem.*

Years	T	P	Df	R	It/Itc	Ic	Io	Production of Apple
1993-1997	20.9	549	576	413	422	17.4	2.26	388
1997-2002	21.9	511	618	444	475	16.1	1.89	320
2002-2007	20.1	577	566	398	390	18.9	2.48	455
2007-2012	22.3	533	586	408	433	18.6	2.32	366

Yield: *Kg. dunum.*

Moreover, we analyzed the relationship between the dependent variable as apple production; the independent variables consists of (climate factors) such as mean monthly temperature (T), precipitation (P), soil water reserves (R), and deficit water (Df), and (bioclimate factors) as annual ombrothermic index (Io), simple continentally index (Ic), and compensated thermicity index (It/Itc), in this study, the Shapiro-Wilk and Jarque-Bera normality tests were applied [22-25], and the p-value was obtained for the seven variables. We applied analysis of variance (ANOVA) linear regression analysis to each of the eight independent and dependent variables, the three bioclimatic variables and the four remaining physical variables (climate factors), and each of the dependent variable apple production, in order to obtain the Pearson's correlation matrix and the principal component analysis (PCA) were subsequently applied to determine the influence of independent variables on production. These statistical analyses were done using the XLSTAT software.

3. RESULTS AND DISCUSSION

Bioclimatic is study or relating to the relations of climate and living matter. Rivas Martinez methodology [17], determines a generic world-wide climate classification in five macrobioclimates (tropical, Mediterranean, temperate, boreal and polar) on the basis of bioclimatic indexes. However, we used the bioclimatic classification of earth to Salvador Rivas-Martinez to analyses of the climate factors and bioclimatic parameters (independent variables) to study the relationship between physical factors of climate and bioclimate, and plant production, the plant sustainability and increase the economy in the occupied Jerusalem, knowing that only study in East Jerusalem (occupied in the 1967 war and not in 1948 by Israel). After application of the Shapiro-Wilk normality test [24, 25], the p-value obtained from the variables studied tended to be below 0.05, a conventionally accepted value.

3.1. Principal Component Analysis

Principal component analysis (PCA) was used to help identify the variables different, using factor extraction with an eigenvalue > 1 after varimax rotation. The results of PCA, including the factor loadings with a varimax rotation as well as the eigenvalues, are tabulated in (Table 2). Three of the eigenvalues were found to be > 1 and the total variance for the three factors is about (98.974 %). Factor 1 was dominated by all climate and bioclimate factors as precipitation, simple continentally index, annual omrothermic index and accounts for (98.974 %) of the total variance. Factor 2 is a highly dominated by soil water reserve, while negatively to the rest of factors, and accounts for (0.735 %) of the total variance. This factor represents, effect, and interesting of soil water reserve on growth, production and sustainability of plant, therefore, its effect on the productivity of plant and increased economic in these area study, also choose a site with full sun, moderate fertility, and good air circulation and water drainage. Factor 3 is a highly dominated by simple continentally index (1.630), deficit water, while negatively to the rest of factors, and accounts for (0.290 %) of the total variance. Nevertheless, when we applied a principal component analysis (PCA), observed that the Jerusalem type plots were located at the right of axis 1 during (1997-2002) affected by the climate factor as soil water reserve, and during (2007-2012) influenced by compensated thermicity index, deficit water and temperature, while type plots were located at the left axis 1 during (1993-1997) affected by precipitation, simple continentally index and annual ombrothermic index. with a large proportion of the variance explained by axes 1 (98.97 %) and axes 2 (0.74%) (Fig. 2). Furthermore, the apple trees were adapted in dry to humid regions which are characterized by moderate summer with temperature between 18-28^{o} C, which had to obtain high quality of production and Mediterranean and lower mesomediterranean environments [16].

Table2. *Factors of eigenvectors and eigenvalue of the PCA and variables data (dependent and independent factors).*

Variables	F1	F2	F3
T	-0.565	-1.900	-1.226
P	0.613	-0.467	-1.511
Df	-0.530	-0.357	1.066
R	-0.623	1.516	-0.346
It/Itc	-1.111	-0.399	-0.071
Ic	0.727	-7.158	1.630
Io	1.315	-7.123	-2.058
Production of Apple	1.856	0.478	0.962
Eigenvalue	0.004	0.000	0.000
Inertia (%)	98.974	0.735	0.290
Variance %	98.974	99.710	100.000

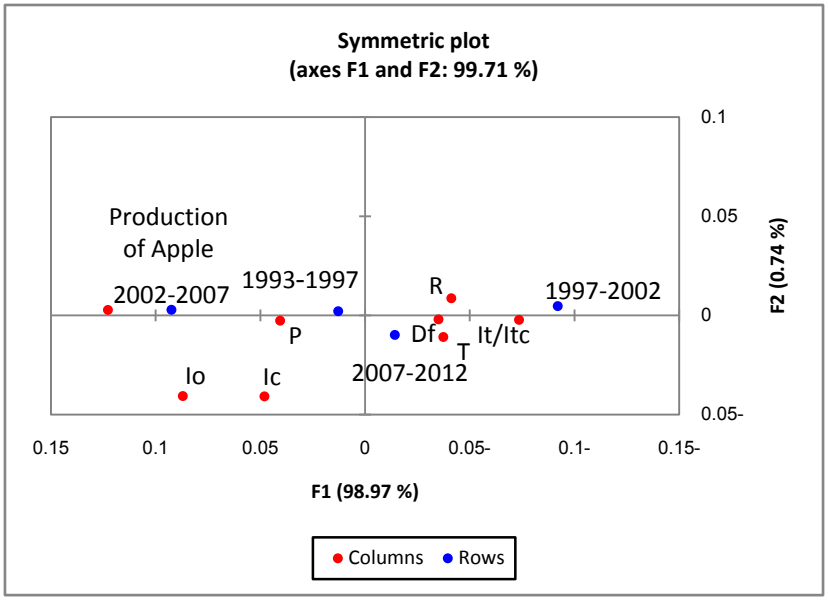

Fig2. *Graphic of principal component analysis to independent and independent variable*

3.2. Correlation Matrix

Table3. *Pearson's correlation matrix between the different variables*

Variables	**T**	**P**	**Df**	**R**	**It/Itc**	**Ic**	**Io**	**Production of Apple**
T	**1**	-0.999	0.998	0.985	0.997	0.986	-0.997	-0.978
P	-0.991	**1**	-0.994	-0.975	-0.993	-0.977	1.000	0.967
Df	0.999	-0.994	**1**	0.994	1.000	0.995	-0.993	-0.989
R	0.989	-0.975	0.994	**1**	0.995	1.000	-0.973	-0.999
It/Itc	0.997	-0.993	1.000	0.995	**1**	0.996	-0.991	-0.991
Ic	0.986	-0.977	0.995	1.000	0.996	**1**	-0.975	-0.999
Io	-0.998	1.000	-0.993	-0.973	-0.991	-0.975	**1**	0.964
Production of Apple	-0.977	**0.966**	-0.989	-0.999	-0.991	-0.999	**0.965**	**1**

Table 3 shows the correlation matrix between the characters studied, precipitation and ombrothermic index were positively correlated to yield and growth activates of plant. The effect of temperature, deficit water, soil water reserve, simple continentally index, and compensated thermicity index were negatively correlated between different variables, a high correlation negatively was observed between soil water reserve (-0.999), simple continentality index (-0.999), and compensated thermicity index (-0.991) and apple yield. Apple production systems are sensitive to temperature throughout the growth cycle therefore, we can confirm that in addition to temperature and other climatic, bioclimate factors are important in determining the production, growth and fruit quality of plants. Winter dormancy is an important adaptive mechanism for plant survival in temperate and cold climates. It is essential that the dormant condition is established within the plant well in advance of the cold season. This requires the timely sensing and physiological processing of a regular and reliable environmental seasonal signal. Moreover, growing apples in the warm winter

regions where the chilling requirement is not adequate, can cause the trees to develop a series of anomalies in the phenology referent to bud break, flowering, growth and development of both fruit and tree [26-31]. For apple production systems these impacts include effects of higher temperatures on flowering, fruit yield and fruit quality.

However, in the thermomediterranean to mesomomediterranean environments, the optimum for the production of apple is achieved with values of Io = 2.5-4.5 in Jerusalem and the rest of Palestine. Also, Jerusalem is located in the arid, semiarid, upper dry, and with a little sub humid territory [5, 6, 7, 8].

4. CONCLUSION

The apple tree (*Malus domesticaL.Bork*h) is one of the most important export crops in Palestine, when we applied a principal component analysis (PCA), observed that the Jerusalem type plots were located at the right of axis 1 during (1997-2002) affected by the climate factor as soil water reserve, and during (2007-2012) influenced by compensated thermicity index, deficit water and temperature, while type plots were located at the left axis 1 during (1993-1997) affected by precipitation, simple continentally index and annual ombrothermic index. with a large proportion of the variance explained by axes 1 (98.97 %) and axes 2 (0.74%). We indicated that the apple trees were adapted in dry to humid regions which are characterized by moderate summer with temperature between 18-28^{o} C, which had to obtain high quality of production, also the zero vegetation point for apple is 7^{o}C, above this level growth is active and reaches its optimum at about 18-28^{o}C, and the proper temperature range between 0-20 ºC during the flowering period. Apple production systems these impacts include effects of higher temperatures on flowering, fruit yield and fruit quality.

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