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Effect of Biology and Bioclimatology Applied on Plant in the Area of Jenin at the North of Palestine

***Jehad M. H. Ighbareyeh[1, 2], A. Cano-Ortiz, E. Cano Carmona, Mohammed M. H. Ighbareyeh, Asmaa A. A. Suliemieh**

[1]Department of Animal and Plant Biology and Ecology, Faculty of Experimental Sciences, University of Jaen, Jaen, Spain
[2]Department of Environmental Engineering Technology, College of Engineering, Palestine Polytechnic University, Hebron, Palestine.
**jehadighbareyeh@hotmail.com*

Abstract: *The 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 1993-2010 (17 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 Jenin (during 1993-2000) are affected by the bioclimate factors of Ic and It/Itc and climate factors as a temperature, deficit water, and soil water reserve, whereas affected by precipitation and annual omrothermic index during 2000-2005, and in the left axis 1 during (2005-2010) are affected by temperature. Nevertheless precipitation and annual ombrothermic index were positively correlated to yield, growth of plant, while negatively affecting by the rest of climate and bioclimate factors. 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 Jenin.*

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

1. INTRODUCTION

The apple tree (*Malus domesticaL.Bork*h) 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.There are more than 7,500 known cultivars of apples [1]. Cultivars vary in their yield and the ultimate size of the tree, even when grown on the same rootstock.About 63 million tons of apples were grown worldwide in 2012, with China producing almost half of this total. The United States is the second-leading producer, with more than 6% of world production. The largest exporters of apples in 2009 were China, U.S., Turkey, Poland, Italy, Iran, and India while the biggest importers in the same year were Russia, Germany, the UK and the Netherlands [2].

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 [3] Cultivation of the species, most likely beginning on the forested flanks of the Tian Shan mountains, progressed over a long period of time and permitted secondary introgression of genes from other species into the open-pollinated seeds. Significant exchange with *Malus sylvestris*, the crabapple, resulted in current populations of apples being more related to crabapples than to the more morphologically similar progenitor Malus sieversii. In strains without recent admixture the contribution of the latter predominates [4, 5].

Jenin site is the main and the biggest natural forest remaining in the West Bank that represents the Mediterranean bio-geographical ecosystem. Moreover this site is considered of high importance for wild genetic resources, in Palestine particularly the wild original species of barley, wheat, and fruit trees, it is locally well known for its vegetables, crops, fruits and other fruits. Jenin has a Mediterranean climate with mild and rainy winters, during the winter temperatures drop but remain

pleasant. Especially during autumn a lot of rain can be expected, while during spring temperatures rapidly rise and the entire summer temperatures are pleasantly warm to even hot.

Bioclimatology is the discipline that studies the relationship between climates and living organisms. Jenin bioclimatic belt belongs to the inframediterranean and thermomediterranean of thermotype and arid to subhumid ombrotype [6]. Recent studies [6-16] have highlighted the influence of bioclimatology and climatology applied on biology, yield and growth of plant.

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

2. MATERIALS AND METHODS

2.1. Study Area

Jenin is a Palestinian city in the northern West Bank, and is a major agricultural center for the surrounding towns and Palestine, Jenin overlooks the Jordan Valley to the east and the Jezreel Valley (known in Arabic as "Marj Ibn Amer") to the north, with coordinates 32° 27′ 40″ N, 35° 18′ 0″ E. its rises 178 above sea level, Jenin area alone to 21,000 acres (without its villages), making it the third largest Palestinian city in the West Bank after Hebron and Nablus, while the Jenin area 583 square kilometers which 9.7% of the total area of the West Bank.

2.2. Data Analysis

Data were used from the meteorological station in Jenin for the years 1993 to 2010 (17 years), (**Fig. 1**) and for the same years for production of plant (**Table 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].

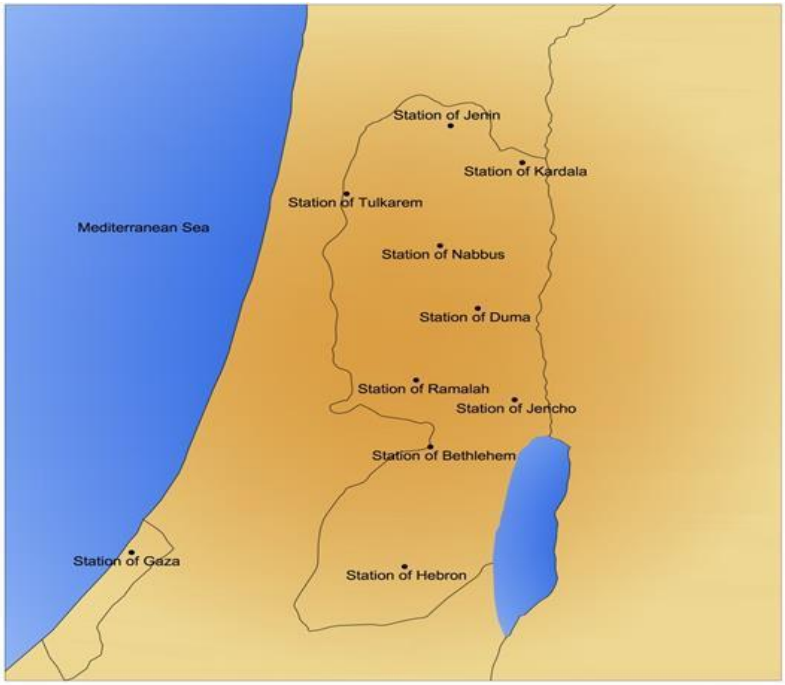

Fig1. *Location of the meteorological Palestinian stations.*

Table1. *Independents variables (Climate and bioclimate factors) and dependent factors (Plant production) from 1993-2010.*

Years	T	P	Df	R	It/Itc	Ic	Io	Production of Apple
1993-1996	20.6	485	790	430	460	17.6	1.88	600
1997-2000	21	470	811	444	480	17.8	1.7	372.5
2000-2005	20.5	494	780	420	440	17.4	1.9	750
2005-2010	20	504	750	386	420	17	2.1	1477

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 in order to determine the influence of independent variables on production. These statistical analyses were done using the XLSTAT software.

3. RESULTS AND DISCUSSION

The 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). 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

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). Two of the eigenvalues were found to be> 1 and the total variance for the two factors isabout 99.062%. Factor 1 was dominated by all climate and bioclimate factors except precipitation and accounts for 99.062% of the total variance. Factor 2 is highly dominated by temperature and deficit water, while negatively to the rest of factors, and accounts for 0.938% of the total variance. This factor represents, effect, and interesting of T and Df on growth, production and sustainability of plant, therefore, its effect on the productivity of plant and increased economic in these area study, in the other side, these environments factors were effected on yield, growth, biology of plant and biological resource management in Palestine [6-10].

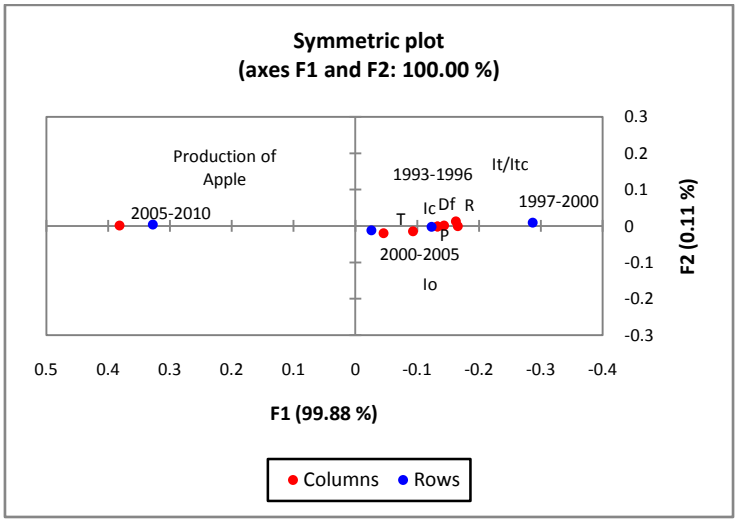

Fig2. *Graphic of principal component analysis to independent and independent variables.*

Nevertheless, when we applied a principal component analysis (PCA), observed that the Jenin type plots are located at the right of axis 1 during (1993-2000) affected by the bioclimate factors of Ic and It/Itc and climate factors as a temperature, deficit water, and soil water reserve, whereas affected by precipitation and annual omrothermic index during (2000-2005), with a large proportion of the variance explained by axes 1 and 2 (100%) (Fig. 2), while in the left axis 1 during (2005-2010) are affected by temperature. There are other factors that affect the production, reproduction, growth and fruit quality, including flowers, dormancy period, and metabolism process. Nevertheless apple trees have two distinct phases regarding their metabolism: the period of dormancy or vegetative phase, both are affected by climate conditions, mainly by temperature which leads to an alteration in the

phonological phases, including induction and flower differentiation. 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.

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	-0.998	-0.978
P	-0.999	**1**	-0.994	-0.975	-0.993	-0.977	1.000	0.967
Df	0.998	-0.994	**1**	0.994	1.000	0.995	-0.993	-0.989
R	0.985	-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	-0.978	**0.967**	-0.989	-0.999	-0.991	-0.999	**0.964**	**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 continentality 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. Also we indicated there are two phases that characterize the annual cycle of apple (*Malus domestica Borkh.*): hibernal period (dormancy) and shoot growth, temperature is the main factor related to dormancy, specifically low temperatures. The evolution of the apple phenological stages during the vegetative phase: induction and flower differentiation, budbreak, full bloom, fruit development and maturation, and yield and production quality, may be visually detected and are affected by climate conditions, mainly by temperature. 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 [26-32].For apple production systems these impacts include effects of higher temperatures on flowering, fruit yield and fruit quality. Apple production systems are sensitive to temperature throughout the growth cycle. These crops are dependent on a dormant period which requires accumulation of chill during the autumn and winter to promote bud burst and flowering. During the subsequent fruit growth phase, fruit size and quality are affected directly by climate, through temperature-driven impacts on growth processes, color development and sunburn damage.

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

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 Jenin (during 1993-2000) are affected by the bioclimate factors of Ic and It/Itc and climate factors as a temperature, deficit water, and soil water reserve, whereas affected by precipitation and annual omrothermic index during 2000-2005, and in the left axis 1 during (2005-2010) are affected by temperature. Precipitation and annual ombrothermic index were positively correlated to yield, growth of plant, while negatively affecting by the rest of climate and bioclimate factors. Apple production systems these impacts include effects of higher temperatures on flowering, fruit yield and fruit quality.

Mediterranean and lower mesomediterranean environments, the optimum for the production of apple is achieved with values of simple thermicity index between 18-22 and annual ombrothermic index between 2.5 - 4.5, and compensated thermicity index between 250-420 for the production of apricot in Jenin. Furthermore there are other factors that affect the growth, development, sustainable and production, biology, quality and quantity of the plant in addition to bioclimate and climate factors and the most important are varieties, type of soil, and breeding, age, abiotic factors, diseases, and phonological phase, period of dormancy and flowering of the plants.

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AUTHORS' BIOGRAPHY

Following the doctoral thesis at the University of Jaen-Spain by Dr. Jehad M. H. Ighbareyeh, doctoral thesis under the supervision of Dr. Eusebio Cano Carmona and Ana Cano Ortiz, we formed a research group between the two countries, Spain and occupied Palestine. This group works in Biology and Bioclimatology applied. So far work has been done in Palestine and Spain; several studies have been published in prestigious journals.