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Assessment of Biology and Bioclimatology of Plant to Increase Economic in Palestine

***Jehad M. H. Ighbareyeh, A. Cano-Ortiz, E. Cano Carmona**

Department of Animal and Plant Biology and Ecology
Faculty of Experimental Sciences University of Jaen, Jaen, Spain
**jehadighbareyeh@hotmail.com*

Mohammed M. H. Ighbareyeh, Asmaa A. A. Suliemieh

Faculty of Literature Quds Open University
Hebron, Palestine

Abstract: *Almonds (Prunusdulcis, Rosaceae, syn. P. amygdalus) grow wild throughout southwest and central Asia, Mediterranean basin and it is an economically important nut tree crop. We analyzed the mean annual temperature and precipitation using data from eight weather stations from the Palestine Meteorological Department, recorded in the period from 1993-2008 (15 years), with the same years plant production, in Jenin, Tulkarem, Nablus, Hebron, Jerusalem, Bethlehem, Ramallah and Gaza cities. Statistical tests included a bioclimatic analysis of Palestinian meteorological stations for the period previous by using bioclimatic classification of the Earth of Rivas Martinez Salvador, with regard to simple thermicity index, compensated thermicity index, annual ombrothermic index, water deficit and soil water reserve. In concluded, in the principal component analysis and the correspondence analysis, Nablus plots are more affected by the bioclimate factors of Ic and climate factors as a temperature, precipitation, soil water reserve; Bethlehem, Jerusalem, Hebron and Ramallah type plots reveal the influence of annual ombrothermic index in the case soft almond, whereas, Jenin and Tulkarem type plots are affected by the bioclimate factors of Itc and climate factors as a temperature and deficit water, in case of the hard almond production. However, the soft almond is a high production and quality in the area of Hebron, while the hard almond is in north of Palestine as Nablus, Jenin and Tulkarem areas, with adapted of value of annual ombrothermic index is 2-3.4, and simple continentality index is 16-24 to optimize almonds production and increased economic in these areas.*

Keywords: *Palestine, bioclimatology, production, economic, Plants.*

1. Introduction

The almond tree (*Prunusdulcis L.*) is a native to the Mediterranean climate region of the Middle East, and is among the most popular tree nuts on a worldwide basis and rank first in tree nut production. They belong to the family Rosaceae, which also includes apples, pears, prunes, and which also includes apples, pears, prunes, and raspberries [1] - [3]. It was spread into other regions of the world by humans, so that it is cultivated in Europe, Asia and Northern Africa, and more recently also in California. Italy, Spain, Morocco, France, Greece, and Iran are the main countries that produce almond. Although the exact origin of almonds has been difficult to determine, it has been suggested that almonds are native to the temperate, desert areas of western Asia, from which they gradually spread to other regions of the world. Domesticated almonds have been documented from Bronze Age sites in Greece and Cyprus and were common in Palestine by 1700 BC.A sub-tropical dry warm climate is optimal. Its growing range is quite wide, between 30°-45° laterals. Almonds do not like excess humidity; recent studies [4- 10] have highlighted the influence of bioclimatology on fruit tree yields as Olive, Fig, Date Palm and Grape; however this is the first time the bioclimatic characterization of the different varieties has been undertaken. Palestine produced 5390 ton of almonds in 2006-2007 according Palestinian Central Bureau of Statistics, and the world produced 2.00 million tons of almonds in 2011 according to Food and Agriculture Organization.

Aims study impact of climate and bioclimatic on the almond tree (*Prunusdulcis L.)* to establish the variables that had the greatest influence on plant production (hard and soft almond) to increase economic in Palestine, because it is a crop of economic importance in Palestine, Mediterranean and other region of the world.

2. Materials and Methods

2.1. Study Area

Palestine is located between longitudes 34˚15' and 35˚40' east and between latitudes 29˚30' and 33˚15' north. The geographic location of Palestine plays a major role in affecting the features of its climate and the climate diversity between the southern and northern parts.

2.2. Data Analysis and Targeting

The almond is grown and distributed in all cities and villages of Palestine, data were used from the meteorological stations in Palestine (Fig 1). Mean temperature, precipitation data from eight stations with records from 1993 to 2008 (15 years) and for the same years in plant production (from Palestinian Central Bureau of Statistics - State of Palestine) have been analyzed (Table 1), also we used two type of Almond tree (hard and soft almond) in this study. A bioclimatic analysis has been made of the data from the Palestinian meteorological stations of the same years ago, so we are dependent in the bioclimatic analysis about used temperature and rain full amount of data for Palestinian Meteorological Stations, elaboration the diagram bioclimatic according the professor Rivas Martinez Salvador in 1996 [11 - 14]. An analysis was made of the independent and independent variables, independent variable consist of biocliamte factors as compensated thermicity index (It/Itc), annual ombrothermic index (Io), simple continentality index (Ic), and climate factors as temperature (T), precipitation (P), soil water reserve (R) and water deficit (Df), while dependent variable is Almond production (table 1)

Standardized mean values were used to perform principal component (PCA) and correspondence analysis (CA) using XLSTAT software. The goal of PCA is to decompose a data table with correlated measurements into a new set of uncorrelated variables. The results of the analysis are presented with graphs plotting the projections of the units onto the components, and the loadings of the variables. Correlation between variables was evaluated using Pearson's correlation coefficient [15].

Fig1. *Location of the meteorological Palestinian stations*

Table1. *Independents variables (Climate and bioclimate factors) and dependent factors (Plant production) from 1993-2008*

Site	T	P	Df	R	Itc	Ic	Io	A. H. P.	A. S. P.
Jenin	20	500	761	400	450	17.3	1.9	1835	65.4
Tulkarem	22	620	830	442	477	17.2	2.4	2808	276
Nablus	17	683	614	474	350	19.1	3.2	1246	136
Ramallah	16.5	615	590	462	311	17.8	3.4	434	44
Jerusalem	17.4	570	580	413	370	17.4	2.9	63	48
Bethlehem	17	585	570	420	390	16.8	2.8	339	92
Hebron	16.6	596	583	471	297	18.1	3.4	939	1068
Gaza	20	400	500	250	455	13.2	1.8	108	20

P: Production, Yield: Kg. dunum. A. H. P.: Almond hard production, A. S. P.: Almond soft production.

3. RESULTS AND DISCUSSION

There are relationships between the factors of climate, bioclimate and plant production in Palestine; in this study 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 [16 - 19], the p-value obtained from the variables studied tended to be below 0.05, a conventionally accepted value.

3.1. Principal Component Analysis

The principal components are orthogonal because they are the eigenvectors of the covariance matrix, which is symmetric. 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 two factors is about 53.271%. Factor 1 was dominated by P, Io, Ic, and R, with a negatively productivity of hard almond (-0.092), these factors represents the effected on plant production especial precipitation, therefore production and profitability are highly dependent on irrigation supply [20], where positively productivity to soft almond (0.467), and accounts for 53.271 % of the total variance. Such domination may be caused by the effect of the variables (dependent and independent factors) on plant production (hard and soft almond); factor 2 is highly dominated by temperature and deficit water, and accounts for 33.422 % of the total variance. These factor represents, effect, and interesting of on plant production; factor 3 is dominated by temperature, and accounts for 9.961% of the total variance. This factor represents the effect of temperature in almond production and its sustainability; factor 4 is dominated by temperature, compensated thermicity index, precipitation and annual ombrothermic index and accounts for 9.961% of the total variance; factor 5 is dominated by compensated thermicity index, precipitation and simple continentality index and accounts for 0.747 % of the total variance; factor 6 is dominated by temperature and simple continentality index, with a negatively productivity of soft almond (-0.039)and accounts for 0.440% of the total variance; and factor 7 is dominated by temperature, precipitation and annual ombrothermic index and simple continentality index, with a negatively productivity of hard almond and accounts for 0.221 % of the total variance. We indicated that the plant is influenced by temperature dramatically and the amount of precipitation as climate factors and Ic, Itc, and Io as bioclimate factors, in the other side, these environments factors were effected on plant biology and ecology in Palestine [6], [9],also we show that the hard almond affected by compensated thermicity index, temperature and deficit water, the examined cultivated almonds, in response to the increase in climatic deficit water, tended to arrange their stomatal structures like those of wild almonds, a species more suited to arid environments and a probable ancestor of cultivated almonds, while the soft almond affected by precipitation and annual ombrothermic index, soil water reserve and simple continentally index (Fig 2).

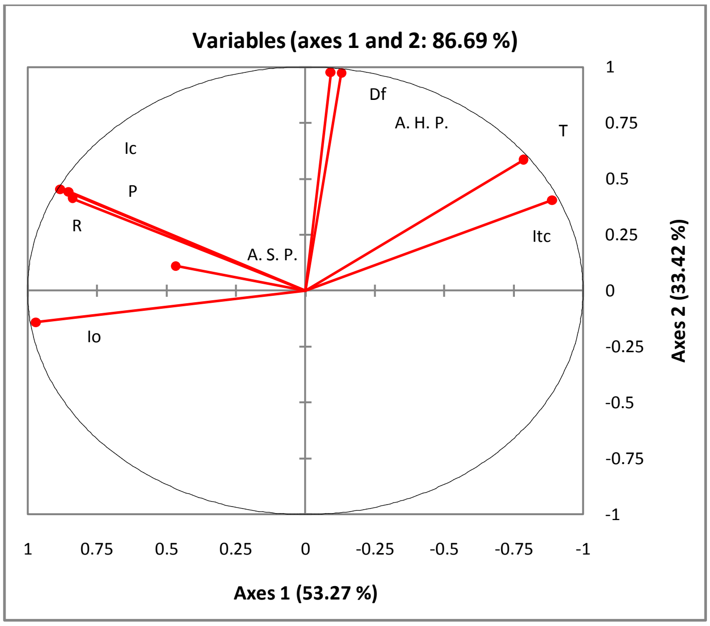

Fig2. *Correlations between variables and factors*

Nevertheless, when we applied a principal component analysis (PCA), observed that the Nablus, Tulkarem, Bethlehem, Jerusalem, Hebron and Ramallah type plots are located at the left of axis 2, Nablus plots are more affected by the bioclimate factors of Ic and climate factors as a temperature, precipitation, soil water reserve, Bethlehem, Jerusalem, Hebron and Ramallah type plots reveal the influence of annual ombrothermic index in the case soft almond; with a large proportion of the variance explained by axes1 and 2 (86.69 %) (Fig. 3).Whereas, Jenin and Tulkarem type plots are located at the right of axis 2, affected by the bioclimate factors of Itc and climate factors as a temperature and deficit water, in case of the hard almond production, with a proportion of the variance explained by axes 2 (33.42 %) (Fig. 3).Based upon, Tulkarem and Jenin are considered in particular and the area north of Palestine in general from more areas for the production of almonds in addition to Hebron because of the fertility of soil, climate and bioclimate as a part of Mediterranean basin.

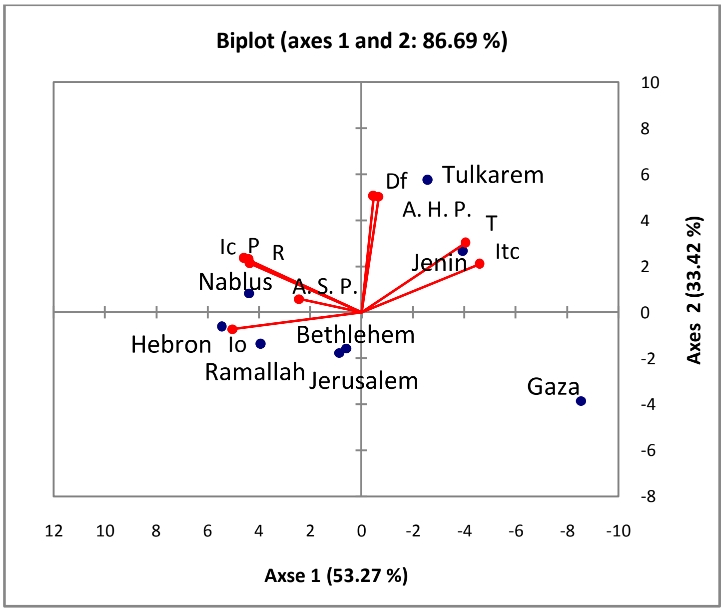

Fig3. *Graphic representation of PCA between the almond production and independent variables*

However, we indicated that almonds are adapted in arid, semiarid and dry regions, the optimal temperature for their growth is between 15 and 28°C, which had to obtain high quality of production, also the zero vegetation point for date palm is 7^{o}C, above this level growth is active and reaches its optimum at about 18-24^{o}C; almonds can be grown without irrigation with a low yield. It is an accepted policy to add supplementary irrigation, where annual rainfall is less than

500 mm. Almonds require less cold units than other deciduous trees, but varies from one variety to the other; most varieties require 300-500 cold units, cold conditions are a serious problem for almonds, which blossom in early spring. Blossoms suffer damage at -2 °C, and vegetative buds at -4 to -6 °C.

Table2. *Factor loadings for varimax rotated PCA of variables data (dependent and independent factors).*

Variables	F1	F2	F3	F4	F5	F6	F7
T	-0.785	0.583	0.103	0.142	-0.081	0.018	0.079
P	0.838	0.411	-0.238	0.253	0.085	-0.007	0.003
Df	-0.130	0.974	-0.042	-0.128	-0.108	-0.067	-0.001
R	0.882	0.453	-0.077	-0.050	-0.034	-0.075	-0.047
Itc	-0.890	0.405	-0.106	0.083	0.124	-0.103	-0.003
Ic	0.851	0.442	-0.165	-0.191	0.094	0.033	0.081
Io	0.969	-0.142	-0.007	0.166	-0.115	-0.013	0.019
A. H. P.	-0.092	0.976	0.134	0.035	0.020	0.125	-0.059
A. S. P.	0.467	0.111	0.875	0.011	0.053	-0.039	0.011
Eigenvalue	4.794	3.008	0.897	0.175	0.067	0.040	0.019
Variability (%)	53.271	33.422	9.961	1.948	0.747	0.440	0.211
Cumulative %	53.271	86.692	96.654	98.602	99.349	99.789	100.000

3.2. Correlation Matrix

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

Variables	T	P	Df	R	Itc	Ic	Io
T	-0.785	0.583	0.103	0.142	-0.081	0.018	0.079
P	0.838	0.411	-0.238	0.253	0.085	-0.007	0.003
Df	-0.130	0.974	-0.042	-0.128	-0.108	-0.067	-0.001
R	0.882	0.453	-0.077	-0.050	-0.034	-0.075	-0.047
Itc	-0.890	0.405	-0.106	0.083	0.124	-0.103	-0.003
Ic	0.851	0.442	-0.165	-0.191	0.094	0.033	0.081
Io	0.969	-0.142	-0.007	0.166	-0.115	-0.013	0.019
A. H. P.	-0.092	0.976	0.134	0.035	0.020	0.125	-0.059
A. S. P.	0.467	0.111	0.875	0.011	0.053	-0.039	0.011

Table 3 shows the correlation matrix between the characters studied.

We observed that precipitation and compensated thermicity index, soil water reserve and deficit water were positively correlated to plant production. The effect of Precipitation, Df, R and Itc were positively correlated between different variables, while simple continentality index was negatively to soft almond production but positively in hard almond, also annual omrothermic index was negatively to hard almond production but positively in soft almond. A high correlation was also observed between precipitation and hard almond production and between deficit water and soft almond production, for almonds, a water deficit is generally applied impact on almond productivity [21] and [22]. Generally, thus highlighting the high correlation between almond production and physical parameters as precipitation and compensated thermicity index, we indicated that in some cases there is effect and antagonism between environmental factors, economic and productivity[5].Also, Play temperature and rainfed in addition to other climatic and bioclimate factors role in the increased productivity and growth of almonds in Palestine, addition to growth and productivity can be greatly reduced by aridity [23, 24], therefore the importance of water shortage cannot be overemphasized for the rain-fed production systems in the semi-arid tropical regions [25]. In the other side, the effect of reduced precipitation could result in reducing annual groundwater recharge in the West Bank by 30% of existing value [26].

3.3. Correspondence Analyses

When we analyzed correspondence analysis is applied to each of the dependent variables and the seven physical parameters (independent variables), significant differences ($P < 0.05$) can once again be observed in all cases. These differences are lower in the case of almond production in Gaza and Jerusalem (soft almond), again in this case the value of R^2 obtained the correlation coefficient is (0.472 and 0.389) respectively. In view of the linear correlation obtained, we applied a correspondence analysis (CA) [27, 28]. This was done by comparing the dependent variables almond production with the total independent variables and the three bioclimatic parameters Io, Ic and It/Itc. In the first place it was observed that Nablus, Bethlehem, Jerusalem, Gaza and Ramallah type plots are located at the left of axis 2, and affected by the bioclimate factors of It/Itc, Io, and Ic, and climate factor as temperature, deficit water and soil water reserve while the Tulkarem, and Jenin type plots are located at the right, with a large proportion of the variance explained by axis 2 (43.34 %), and axis 1 (53.52 %) (Fig.4). In the case of (Fig. 4), there is confirmation that the Nablus, Bethlehem, Jerusalem, Gaza and Ramallah type plots are conditioned by the compensated thermicity index, annual ombrothermic index, simple continentality index, deficit water, precipitation and temperature, this is probably due to the lack of rainfall, human activities, plant disease, the type of soil, soil quality is an important indicator to agricultural and environmental sustainability [29, 30], and salinity, optimal pH is 7.0-8.5, almonds grow in all types of soil, including chalky and shallow soils.

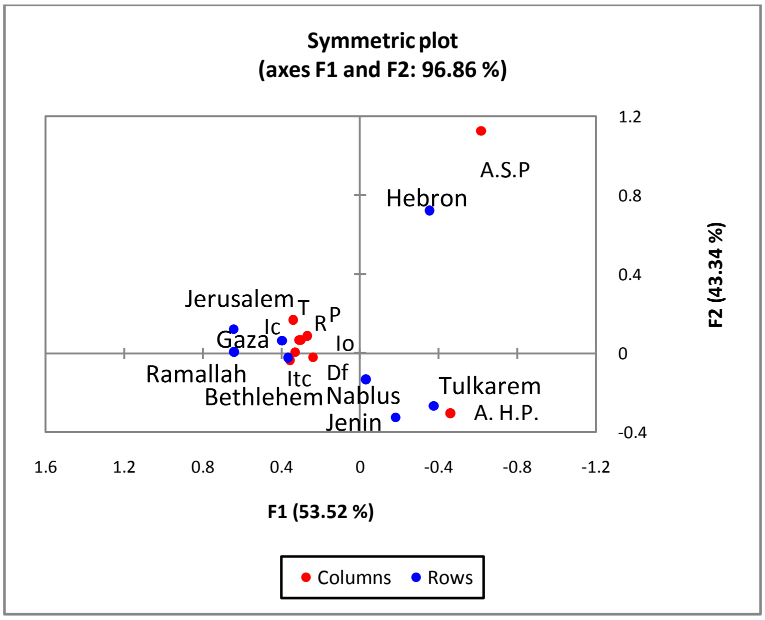

Fig6. *Graphic representation of correspondence analysis between the almond production and independent variables.*

However, cultivated almond is subjected to drought during the annual cycle; such conditions greatly influence growth and productivity [31]. Almond, however, is considered a drought-tolerant fruit crop [32, 33]] and [34], as in the inframediterranean to thermomediterranean environments; the optimum for the production of almond is achieved with values of Io □ 2.5, and Ic value between 17-24. Furthermore, almonds have an interesting price in the local market, especially when the fruits are sold as green-unripened, allowing the farmer to get income earlier.

4. Conclusion

The almond (*P. dulcis L.)* is an economically important nut tree crop, with an apparent origin as an edible crop in southwest Asia and the eastern Mediterranean; we proposed that almond (soft and hard) can be adapted in area arid, semiarid, dry and sub-humid ombrotype, and belong to upper inframediterranean to thermomediterranean thermo type to optimize production and increased of the economic. Also, the soft almond is a high production and quality in the area of Hebron, while the hard almond is in north of Palestine as Nablus, Jenin and Tulkarem areas, with adapted of value of Io is 2-3.4, and Ic is 16-24.

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