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Biology and Bioclimatology Applied on Plant in Palestine

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Abstract: *Palestine is a geographic region in Western Asia between the Mediterranean Sea and the Jordan River.We analyzed the mean annual temperature and precipitation using data from two weather stations from the Palestine Meteorological Department, recorded in the period from 1993-2008 (15 years), with the same years plant production (rainfed), in Palestine. 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, when we applied the principal component analysis observed that Hebron, Bethlehem and Ramallah were affected by the climate factors as a temperature and precipitation, while when we applied correspondence analysis observed that the Tulkarem, Hebron, Bethlehem, Jerusalem, Salfit, Nablus and Ramallah were affected by the all climate and bioclimate factors excepted simple continentally index, also Tubas, Jenin and Qalqilia were affected by bioclimate factors as simple continentally index.Palestine has a climate and bioclimate plays a big role in the development, growth, the production and biology of plant. We indicated that in the upper inframediterranean to mesomediterranean environments, the optimum for the production of tomatoes is achieved with value of annual ombrothermic index 2.5, simple continentality index value between 16-23, compensated thermicity index value between 300-450, the temperature between 15-25^{0}C, with annual rainfall between 400-800 millimeters, and with the dry to humid of ombrotype. Northern districts including Jenin and Tubas, Qalqilia, Nablus were highest tomato production and they occupy about 50% of the total tomato production in the West Bank part of Palestine.*

Keywords: *Palestine, bioclimate, biology, economic, variables.*

1. INTRODUCTION

Palestine has a Mediterranean climate characterized by long, hot, dry summers and short, cool, rainy winters, as modified locally by altitude and latitude. Like many other developing countries, Palestine has an important agricultural sector, which has been considered the backbone of its economy. This was particularly true in the years after instituting its autonomy with the establishment of the National Palestinian Authority in 1994. Tomato (Solanumlycopersicum) is one of the most important vegetable plants in the world; also it belongs to the extremely large family Solanaceae and is closely related to many commercially important plants. It originated in western South America, and the exact date of domestication is unknown: by 500 BC, it was already being cultivated in southern Mexico and probably other areas [1]. The cultivated tomato and its wild relatives form a small clade of 13 closely related species, comprising *Solanum sect. Lycopersicon*, formerly recognized as the genus *Lycopersicon* [2]. In comparison to domesticated tomato, wild tomato species span a vast range of climatic, biogeographic, and environmental variation, from temperate deserts to wet tropical rainforests [2].

Tomatoes are considered of economic importance in Palestine, where are grown in greenhouses, and open field (rain fed) including tomato table as (Izmir, 1123, and 593), cluster, and cherry tomatoes.Because of its importance as food; tomato has been bred to improve productivity, fruit quality, and resistance to biotic and abiotic stresses. Like many other developing countries, Palestine has an important agricultural sector, which has been considered the backbone of its economy. Vegetables are the most important crops grown in the country, occupying 18734.4

hectares, with an annual production of 645157 metric tons. More than 31% of those vegetables are tomatoes, and the remainder includes thirty-five other vegetable crops, of which cucumbers are the most important. Tomato production in Palestine, however, has not yet reached its full potential due to many factors related to climate and poor management, and above all, due to the high level of pests and diseases [3].

Analysis of climate trends in tomato-growing locations suggests that temperatures are rising and the severity and frequency of above-optimal temperature episodes will increase in the coming decades [4].Bioclimatology is a scientific subject connecting the climatology, meteorology with ecology. Bioclimatology studies the effects of climatology, meteorology conditions on the living organism in different ecosystems. Recent studies [5-12] have highlighted the influence of bioclimatology on plant yields; however this is the first time the bioclimatic characterization of the different varieties has been under taken. Palestine is belonging to the inframediterranean to mesomediterranean of bioclimatic belts; and arid, semiarid, dry, sub-humid and humid of ombrotype [5].

Aims study impact of bioclimatology and climatology on Tomato (*Solanumlycopersicum L.*) to establish the variables that had the greatest influence on plant production to increase economic in the region of Palestine, because tomatoes are one of the most important vegetable in Palestine.

2. MATERIALS AND METHODS

2.1. Study Area

Palestine is located between longitudes 34º15´ and 35º40´ east and between latitudes 29º 30´ and 33º15´ 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

Data were used from the meteorological stations in Palestine (Table 1) and (Fig 1). Mean temperature, precipitation data from ten stations with records from 1993 to 2008 (15 years) and for the same years in plant production (rainfed), have been analyzed in this study. A bioclimatic and climate analyses have 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 rainfall amount of data for Palestinian Meteorological Stations, elaboration the diagram bioclimatic according the professor Rivas Martinez Salvador in 1996 [13-16]. 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 mean monthly temperature (T), precipitation (P), soil water reserve (R) and water dificit (Df), while dependent variable is tomatoes production (table 1).

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	Production of tomatoes
Jenin	20.3	488	761	400	450	17.3	1.9	1300
Tulkarem	22.4	601	830	442	477	17.2	2.4	150
Nablus	17.8	683	614	474	350	19.1	3.2	428
Tubas	18.8	405	730	444	498	61.2	2.7	1070
Ramallah	17.1	615	590	462	311	17.8	3.1	385
Jerusalem	17.4	549	580	413	370	17.4	2.9	450
Bethlehem	17.9	548	570	420	390	16.8	2.8	421
Hebron	16.6	595	583	471	297	18.1	3.2	327
Salfit	20	611	612	449	480	17.9	2.2	388
Qalqilia	21	621	700	470	466	17.6	2.5	942

P: Production, Yield: Kg. dunum.

We applied the principal component (PCA), correlation matrix (Pearson (n) 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 [17].

3. RESULTS AND DISCUSSION

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 [18-21], the p-value obtained from the variables studied tended to be below 0.05, a conventionally accepted value.

3.1. Principal Component Analysis

Moreover, principal components analysis, correspondence analysis creates orthogonal components and, for each item in a table, a set of scores (sometimes called factor scores. 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 tabulatedin Table 2. Eight of the eigenvalues were found to be 1 and the total variance for the two factors isabout 55.197 %. Factor 1 was dominated by P, Io, Ic, and R, and accounts for 55.197% of the totalvariance. Such domination may be caused by theeffect of the variables (dependent and independent factors) on plant production. Factor 2 is highly dominated by all climate and bioclimate factors except of Io is negatively (-0.098), and accounts for 24.828 % of the total variance. This factor represents, effect, and interesting of all climatology and bioclimatology factors on plant production. Factor 3 is dominated by Ic, and R conductivity, and accounts for 10.929 % of the total variance. This factor represents the effect of Ic and R, on tomatoes production and its sustainability.

Factor 4 is dominated by T, Df, R, and Io, and accounts for 4.594 % of the total variance. Factor 5 is dominated by Ic, and Df conductivity, and accounts for 3.166 % of the total variance. Factor 6 is dominated by T, P, Io, Itc, while the factors of Df, Ic, and R were negatively, and accounts for 1.116 % of the total variance. Factor 7 is dominated by P, and Df as climate factors, and accounts for 0.170 % of the total variance. Factor 8 is dominated by Ic, Io, and T conductivity, and accounts for 0.001 % of the total variance and (Fig. 2), therefore, abiotic factors effected on the productivity of plant and increased economic in Palestine, addition to, these environments factors were effected on plant biology and resource management [5, 6]. We observed through analysis and study that temperature effects on plant production as f 2, f 4, f 6 and f 8. Nevertheless, vegetative and reproductive processes in tomatoes are strongly modified by temperature alone or in conjunction with other environmental factors [22]. High temperatures can cause significant losses in tomato productivity due to reduced fruit set, and smaller and lower quality fruits [23].

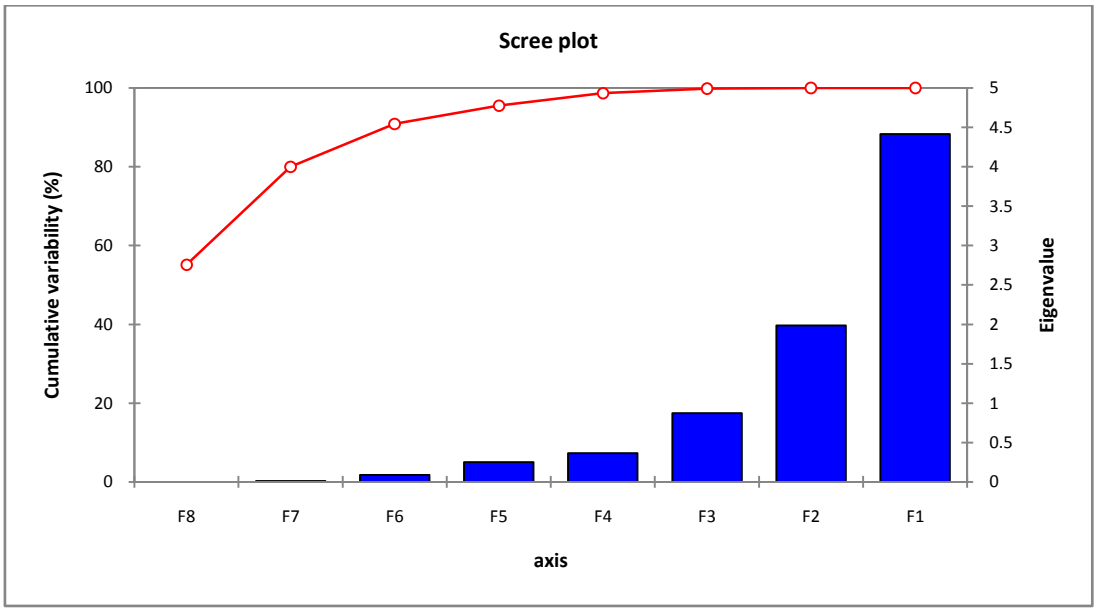

Fig2. *Factors of the cumulative and eigenvalue PCA of variables data (dependent and independent factors).*

Nevertheless, when we applied a principal component analysis (PCA), observed that the Tulkarem, Jenin, Salfit, Jerusalem and Qalqilia type plots are located at the right of axis 2, and affected by the factors Ic, P and R , excepted Jenin and Jerusalem were affected by bioclimate factor as ombrothermic index, with a proportion of the variance explained by axes 1 ((55.20 %). Hebron, Bethlehem and Ramallah plots are more affected by the climate factors as a temperature; therefore lower the temperature in these areas affects the productivity, growth, development and biology of plants, also the temperature is below 12°C almost no growth is expected for tomato. In comparison, increasing the temperature for short periods during the growing season increased yield in the week following the increase in temperature, but had no influence on the overall yield [24]. This is probably due to the effect of temperature accelerating fruit ripening, while other fruits are unaffected, leading to a lower yield in the following weeks, while Tubas and Nablus type plots reveal the influence of Itc and Df, and represents supplementary productivity in graph, with a large proportion of the variance explained by axes 1 and 2 ((80.02 %) (Fig.3). However, we indicated that tomatoes are adapted in dry to humid regions which are characterized by hot summers with temperature between 12- 32^{o}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 25^{o}C.

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

Variables	F1	F2	F3	F4	F5	F6	F7	F8
T	-0.376	0.423	-0.142	0.051	-0.080	0.129	-0.112	0.789
P	0.314	0.516	-0.041	-0.172	-0.063	0.453	0.617	-0.116
Df	-0.351	0.344	-0.040	0.755	0.202	-0.005	0.051	-0.379
R	0.320	0.463	0.094	0.067	-0.590	-0.513	-0.225	-0.091
Itc	-0.398	0.305	-0.101	-0.516	-0.014	0.240	-0.465	-0.445
Ic	0.323	0.329	0.487	-0.078	0.672	-0.100	-0.263	0.117
Io	0.447	-0.098	-0.124	0.342	-0.153	0.608	-0.514	0.033
P. of Tomatoes	-0.269	-0.107	0.839	0.062	-0.356	0.278	0.060	0.003
Eigenvalue	4.416	1.986	0.874	0.367	0.253	0.089	0.014	0.000
Variance %	55.197	24.828	10.929	4.594	3.166	1.116	0.170	0.001
Cumulative %	55.197	80.025	90.954	95.548	98.714	99.829	99.999	100.000

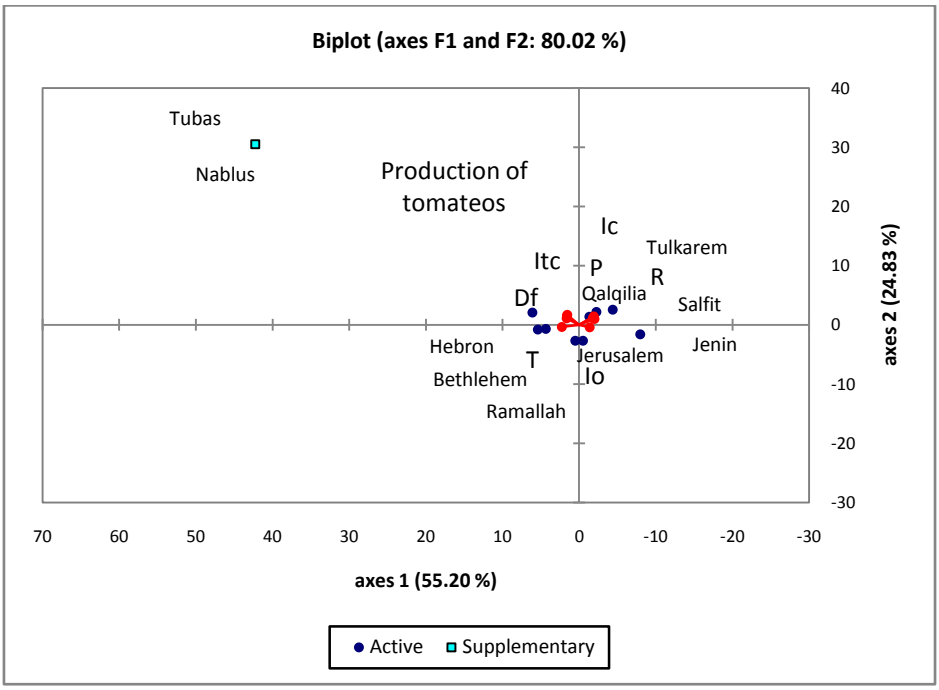

Fig3. *Graphic of principal component analysis to independent and independent variables*

3.2.Correlation Matrix (Pearson (N)

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

Variables	T	P	Df	R	Itc	Ic	Io	Production of tomatoes
T	**1**	-0.079	0.886	-0.147	0.923	-0.335	-0.791	0.264
P	-0.079	**1**	-0.182	0.897	-0.197	0.754	0.524	-0.5
Df	0.886	-0.182	**1**	-0.194	0.685	-0.279	-0.668	0.314
R	-0.147	0.897	-0.194	**1**	-0.311	0.701	0.537	-0.369
Itc	0.923	-0.197	0.685	-0.311	**1**	-0.399	-0.882	0.33
Ic	-0.335	0.754	-0.279	0.701	-0.399	**1**	0.48	-0.161
Io	-0.791	0.524	-0.668	0.537	-0.882	0.48	**1**	-0.566
Production of tomatoes	**0.264**	**-0.5**	**0.314**	**-0.369**	**0.33**	**-0.161**	**-0.566**	**1**

The correlation matrix can be seen as the covariance matrix of the standardized random variables, table 3 shows the correlation matrix between the characters studied. Temperature (T), water deficit and compensated thermicity index were positively correlated to plant production. In this case, temperature has a large influence on growth and development in tomato. In young, vegetative tomato plants growth is reduced because the plants produce thicker leaves. In mature plants this aspect can be neglected as most of the light is intercepted anyway. Early yield is affected by temperature because less assimilate goes to fruits at lower temperatures, due to lower fruit and truss development rates early in the season [25]. The effects of climate and bioclimate factors were positively correlated between different variables. A high correlation was also observed between precipitation (0.500), soil water reserve (0.369), compensated thermicity index conductivity (0.330), and tomatoes production. That means the quality and yield of tomatoes were affected by the precipitation, soil water reserve and compensated thermicity index more than other factors of the climatic and bioclimatic in Palestine.

3.3. Correspondence Analysis

Correspondence analysis is performed on a contingency table. Also, correspondence analysis (CA) is a multivariate statistical technique proposed [26] by Hirschfeld [27] and later developed by Jean-Paul Benzécri. [28] It is conceptually similar to principal component analysis, but applies

to categorical rather than continuous data, when we analyzed correspondence analysis is applied to each of the dependent variables and the seven physical parameters (independent variables), significant differences ($P < 0.05$). These differences are lower in the case of tomatoes production in Tulkarem and Hebron because the production is decreased.

Generally, by Ighbareyeh et al. [7], indicated that in some cases there is effect and antagonism between environmental factors, economic and productivity for the plant in Palestine. In view of the linear correlation obtained, in this analysis was done by comparing the dependent variables tomatoes production with the total independent variables and the three bioclimatic parameters Io, Ic and It/Itc. In the first place it was observed that the Tulkarem, Hebron, Bethlehem, Jerusalem, Salfit, Nablus and Ramallah type plots are located at the right of axis 2, with a proportion of the variance explained by axes 2 (7.86 %) and affected by the all climate and bioclimate factors excepted simple continentally index, while the Tubas, Jenin and Qalqilia type plots are located at the left of axes 1, with large a proportion of the variance explained by axes 1 (87.19 %) and axes 2 (95.05 %) and affected by bioclimate factors as simple continentally index (Fig.4).

However, tomatoes production in the Hebron, Tulkarem, Salfit were decreased because the precipitation and others factors decreased and conditioned by annual ombrothermic index, water deficit, soil water reserve and compensated thermicity index, this is probably due to the lack of rainfall in general for these areas, because he tomatoes prefers subtropical climate, with rainfall between 400 and 600 millimeters and annual [29], the effect of reduced precipitation could result in reducing annual groundwater recharge in the West Bank by 30% of existing value [30]; the type of soil, therefore, storm water runoff are affected by soil types and local variations [31, 32] However, soils must be permeable since the plants are not tolerant to water-logging [33]. Therefore, they grow naturally on soils with a pH of 5 to 8.5; and salinity, in Palestinian Territories Occupied, salinity is a major constrain in farming, where tomato production is adversely affected by moderate to high saline content in the soil [33], We indicated that in the upper inframediterranean to mesomediterranean environments, the optimum for the production of tomatoes is achieved with value of annual ombrothermic index more than 2.5, simple continentality index value between 16-22, compensated thermicity index value between 290-450, and the temperature between 12-25^{0}C, with annual rainfall between 400-800 millimeters.

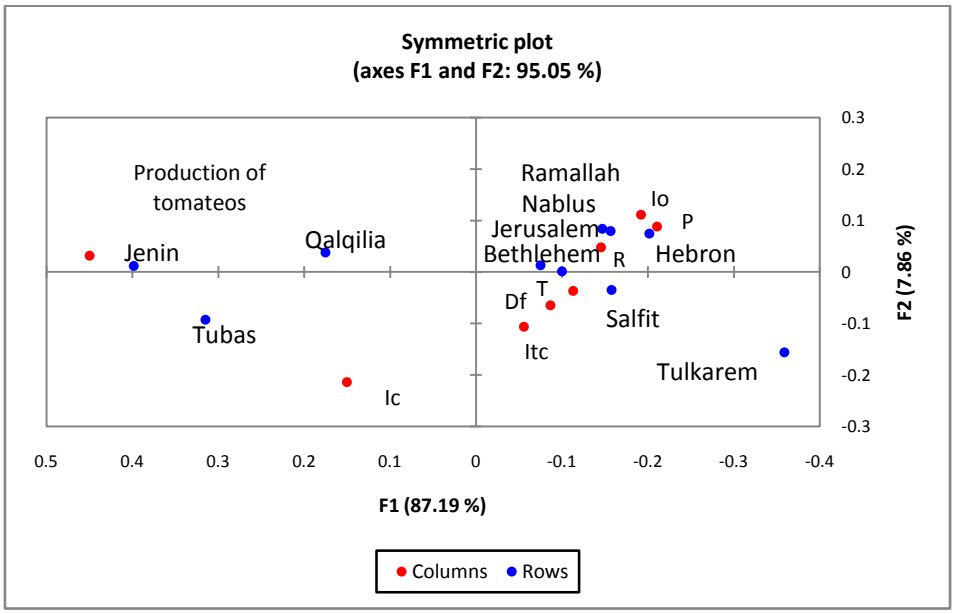

Fig4. *Graphic representation of correspondence analysis between the tomatoes production and independent variables.*

4. CONCLUSION

Tomato (*Solanumlycopersicum L.*) is an important horticultural crop in most parts of the world. Tomatoes are generally sensitive to environmental extremes, and thus high temperatures and limited soil moisture are the major causes of low yields in the tropics and will be further magnified by climate change. Palestine has a climate and bioclimate plays a big role in the

development, growth, the production and biology of plant. We indicated that in the upper inframediterranean to mesomediterranean environments, the optimum for the production of tomatoes is achieved with value of annual ombrothermic index 2.5,simple continentality index value between 16-23, compensated thermicity index value between 300-450, the temperature between 15-25^{0}C, with annual rainfall between 400-800 millimeters, and with the dry to humid of ombrotype. Northern districts including Jenin and Tubas, Qalqilia, Nablus were highest tomato production and they occupy about 50% of the total tomato production in the West Bank part of Palestine, because these regions were affected by the climatology and bioclimatology factors as temperature, precipitation, water deficit, soil water reserve, and simple contenintality index; topography and geography features; soil type as rosary soil, sandy loam soil, like soil that has a pH of 5.5 - 8, is fertile, deep, well-drained, and that is rich in organic matter. Moreover, when we applied a principal component analysis (PCA), observed that Hebron, Bethlehem and Ramallah were affected by the climate factors as a temperature and precipitation, while when we applied correspondence analysis observed that the Tulkarem, Hebron, Bethlehem, Jerusalem, Salfit, Nablus and Ramallah were affected by the all climate and bioclimate factors excepted simple continentally index, also Tubas, Jenin and Qalqilia were affected by bioclimate factors as simple continentally index.

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