International Journal of Research Studies in Biosciences (IJRSB)
Volume 3, Issue 1, January 2015, PP 90-97
ISSN 2349-0357 (Print) & ISSN 2349-0365 (Online)
www.arcjournals.org

Study of Biology and Bioclimatology of Date Palm (*Phoenix Dactylifera L.*) To Optimize Yield and Increase Economic in Jericho and Gaza Cities of Palestine

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Abstract: *We analyzed the mean annual temperature and precipitation using data from two weather stations from the Palestine Meteorological Department, recorded in the period from 1993-2010 (17 years), with the same years plant production, in Jericho 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, Jericho whose production depends on the bioclimate and climate factors as a temperature, compensated thermicity index and simple continentality index, while Gaza type plots reveal the influence of annual ombrothermic index, precipitation, soil water reserve and water deficit. However, Jericho and Gaza were located in the arid, semiarid and dry ombrotype of the area where mean temperature is higher than 20^{o}C for eight months of the year during which the annual ombrothermic value is>2.5, with suitable soil water reserve and little deficit water to optimize Date Palm production and increased economic in these areas.*

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

1. INTRODUCTION

Date palms are widely cultivated in arid Mediterranean regions and require large quantities of water, and climate, bioclimatic suitable to produce commercial yields. Despite its economic and symbolic importance in the arid regions of the Middle East little is still known about the early cultivation of the date palm (*Phoenix dactylifera L.*). Date palms and culture are depicted in ancient Assyrian and Babylonian tablets, including the famous Code of Hammurabi, which contained laws pertaining to date culture and sales. References relating to date palms are also found in ancient Egyptian, Syrian, Libyan, and Palestinian writings [1] [2]. Date is one of the oldest known fruit crops and has been cultivated in North Africa and the Middle East for at least 5000 years [3].

Date palms have been effective for the control of desertification and land reclamation in the Arabian Peninsula, especially in UAE. Feral date trees in southern Australia are sometimes considered invasive species [4].

The local consumption of dates in Palestine is close to the international average of about 0.9 kg/year/person and the local production was about 175 tons in 2004 which represented only 7.1% of the national consumption [5]. Most of the seedlings distributed to farmers were of Medjoul and DegletNour varieties as these have high market value. Although there are many cultivars of dates, some have become preeminent in the world market [6, 7, 1].

Date palms have been traditionally grown in the Jordan valley area from antiquity, after the 1967 Israeli occupation of the West Bank and Gaza strip, however, considerable areas of the Jordan

valley were confiscated by Israel and new high quality varieties of date palm trees, mainly Medjoul, were introduced [5]. The adaptability of the new varieties and the use of advanced techniques for propagation and cultivation such as tissue culture and localized irrigation systems produced crops of excellent quality and yield to supply the local and international markets [8]. The development of date palm cultivation in the Jericho, Gaza strip and Jordan valley areas of Palestine are below expectations due to several constraints facing its progress including high investment costs, weak marketing, and unfair competition from Israeli products. Date palms are cultivated in arid and semi-arid regions which are characterized by long and hot summers, no or low rainfall and very low relative humidity during the ripening period. Exceptional high temperatures (56^{o}C) are well endured by date palm for several days under irrigation. During winters, temperatures below 0^{o}C are also endured; also it can survive within a wide temperature range, and grow in almost any type of soil [9, 10].

However, Jericho and Gaza are considered industrial activities remains importance's to the areas, and the cities are an exporter of trees, vegetables, crops, salts, minerals, and gas and petroleum in the future, as well as an important commercial shipping center.

Aims study effect of climate and bioclimatic on Date Palm (*Phoenix dactylifera L.)* to establish the variables that had the greatest influence on plant production to increase economic in the regions of Jericho and Gaza cities, because it is a crop of economic importance in Palestine and all of Arabian Gulf.

2. MATERIALS AND METHODS

2.1. Study Area

Jericho is a city located near the Jordan River in the West Bank, and has been held under Israeli occupation since 1967; It is believed to be one of the oldest inhabited cities in the world [11, 12], also the first of which dates back 11,000 years (9000 BCE) [13], almost to the very beginning of the Holocene epoch of the Earth's history.

Jericho is located 260 meters below sea level in an oasis in WadiQelt in the Jordan Valley [14, 11], and coordinates between 31°51′N and 35°27′E. Annual rainfall is 166 mm, mostly concentrated between November and February. The average temperature is 15°C (59 °F) in January and 31°C (88 °F) in August. The constant sunshine, rich alluvial soil, and abundant water from the spring have always made Jericho an attractive place for settlement.

Gaza city is a Palestinian city in the Gaza Strip, its history of habitation dates back 5,000 years, making it one of the oldest cities in the world. Located on the Mediterranean coastal route between North Africa and the Levant, and coordinates between longitude 31°31′N and 34°27′E, also it is situated on a low-lying and round hill with an elevation of 14 meters above sea level.

2.2. Data Analysis

Data were used from the meteorological stations in Palestine (Table 1) and (Fig 1). Mean temperature, precipitation data from two stations with records from 1993 to 2010 (17 years) and for the same years in plant production have been analyzed 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 [15 - 17] and [18]. 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 dificit (Df), while dependent variable is Date Palm production (table 1)

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

Site and years	T	P	Df	R	It/Itc	Ic	Io	P of Date
Gaza 1993-2000	20	400	500	250	455	13.5	1.8	84
Gaza 2000-2010	21	390	520	280	470	13.2	1.7	110
Jericho 1993-2000	24	166	100	50	550	12.9	0.8	1671
Jericho 2000-2010	25	161	120	80	620	12.4	0.6	1316

P: Production, Yield: Kg. dunum.

Fig1. *Location of the meteorological Palestinian stations*

Standardized traits 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 [19].

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 [20 - 23], 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. Three of the eigenvalues were found to be□1 and the total variance for the two factors is about 94.48%. Factor 1 was dominated by P, Io, Ic, Df and R, and accounts for 94.48% of the total variance. Such domination may be caused by the effect of the variables (dependent and independent factors) on plant production. Factor 2 is highly dominated by Ic, Io, and accounts for 5.180% of the total variance. This factor represents, effect, and interesting of Icon plant production. Factor 3 is highly dominated by Itc, Ic, and P conductivity, and accounts for 0.333% of the total variance. This factor represents the effect of It/Itc, Ic and P, in Date palm production and its sustainability, therefore, its effect on the productivity of plant and increased economic in these areas studies, in the other side, these environments factors were effected on plant biology and resource management in Palestine [24, 25], and Date Palm has unique biological and developmental characteristics that necessitate special propagation, culture, and management techniques [26].

Nevertheless, when we applied a principal component analysis (PCA), observed that the Gaza type plots are located at the left of axis 2, Jericho plots are more affected by the bioclimate factors

of Ic and It/Itc and climate factors as a temperature, Gaza type plots reveal the influence of annual ombrothermic index, temperature, water deficit and precipitation and soil water reserve, with a large proportion of the variance explained by axes1 and 2((100%) (Fig. 2). However, we indicated that Date Palms are adapted in arid, semi-arid and dry regions which are characterized by long and hot summers with temperature between 28-40^{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 32^{o}C; the growth will continue at a stable rate until the temperature reaches 38–40^{o}C when it will start decreasing again [27].

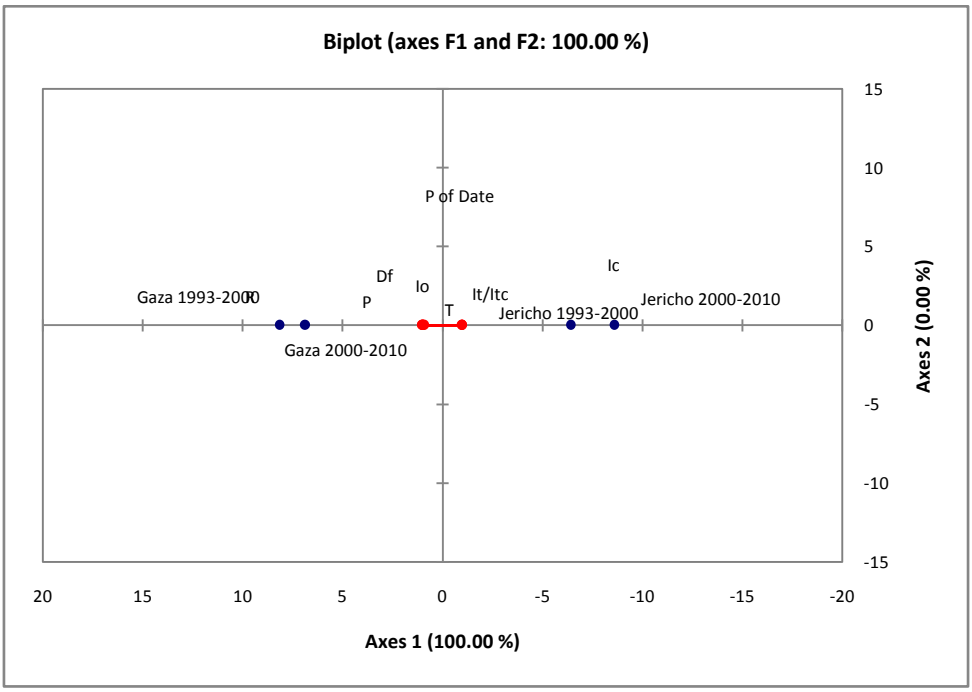

Fig2. *Graphic of principal component analysis to independent and independent variables*

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

	F1	F2	F3
T	-0.361	-0.173	-0.437
P	0.362	-0.142	0.055
Df	0.359	-0.255	-0.181
R	0.351	-0.396	-0.387
It/Itc	-0.349	-0.405	0.588
Ic	0.333	0.621	0.264
Io	0.364	0.048	-0.048
P of Date	-0.349	0.420	-0.454
Eigenvalue	7.559	0.414	0.027
Variance (%)	94.487	5.180	0.333
Cumulative %	94.487	99.667	100.000

3.2 Correlation matrix and correspondence analysis

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

Variables	T	P	Df	R	It/Itc	Ic	Io	P of Date
T	**1**	-0.977	-0.957	-0.923	0.974	-0.955	-0.994	0.927
P	-0.977	**1**	0.997	0.984	-0.932	0.876	0.992	-0.981
Df	-0.957	0.997	**1**	0.995	-0.907	0.836	0.981	-0.989
R	-0.923	0.984	0.995	**1**	-0.866	0.779	0.957	-0.990
It/Itc	0.974	-0.932	-0.907	-0.866	**1**	-0.980	-0.969	0.845
Ic	-0.955	0.876	0.836	0.779	-0.980	**1**	0.927	-0.774
Io	-0.994	0.992	0.981	0.957	-0.969	0.927	**1**	-0.950
P of Date	0.927	-0.981	-0.989	-0.990	0.845	-0.774	-0.950	**1**

Table 3 shows the correlation matrix between the characters studied. Temperature (T) and Itc were positively correlated to plant production. The effect of Precipitation, Df, R, Io and Ic were

positively correlated between different variables, while negatively to plant production in general. A high correlation was also observed between temperature and Date Palm production.

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 Date Palm production in Gaza; again in this case the value of R^2 obtained the correlation coefficient is 0.8629.Thus highlighting the high correlation between Date Palm production and physical parameters as temperature and compensated thermicity index. Generally, by Ighbareyeh et al. [28], indicated that in some cases there is effect and antagonism between environmental factors, economic and productivity for the other plant in Palestine.

In view of the linear correlation obtained, we applied a correspondence analysis (CA). This was done by comparing the dependent variables Date Palm 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 Jericho type plots are located at the right of axis 2, while the Gaza type plots are at the left. Jericho plots are more affected by the bioclimate factors of It/Itc, and climate factor as temperature during 2000- 2010,Gaza type plots reveal the influence of water deficit, annualombrothermic index and precipitation during year 1993-2000, Ic and soil water reserve during year 2000-2010, with a large proportion of the variance explained by axis 1 (99.39%), and axis 2 (0.52%) (Fig.3). In the case of (Fig. 3), there is confirmation that the Jericho type plots are maintained at the right of axis 1, and are conditioned by the compensated thermicity index and temperature, underlining the fact that Date production in these plots depends on previous factors, whereas Date production is less influenced by annual ombrothermic index, precipitation, water deficit, and soil water reserve.

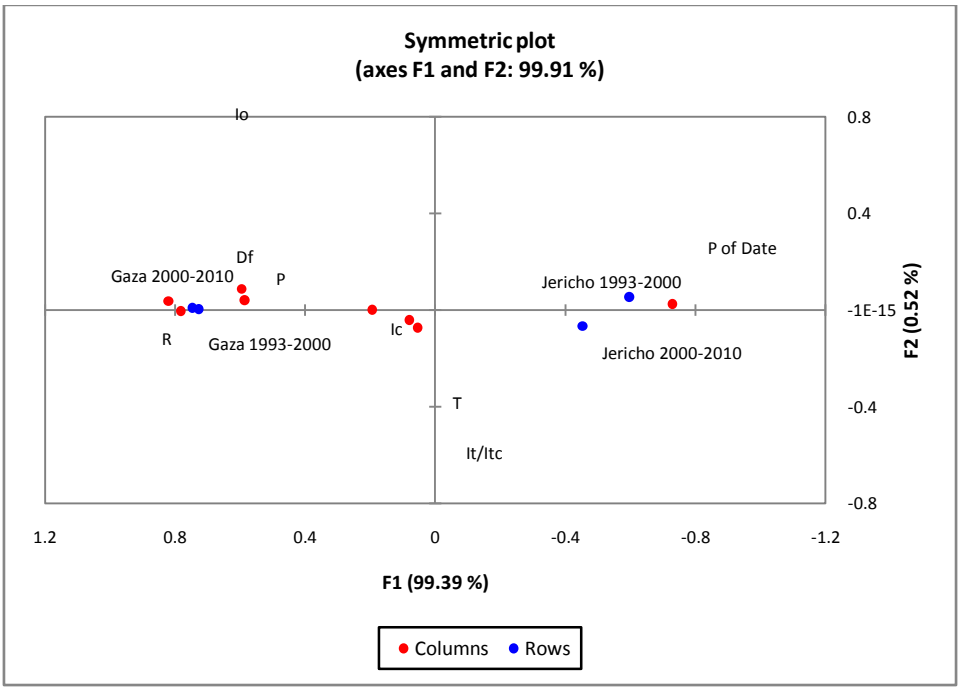

Fig3. *Graphic representation of correspondence analysis between the Date Palm production and independent variables*

However, Date production in the Gaza type plots are located at the left axis 2 and conditioned by annual ombrothermic index, water deficit, soil water reserve and precipitation, this is probably due to the lack of rainfall in general for these areas, the type of soil, and salinity, therefore, storm water runoff are affected by soil types and local variations [29, 30]. Due to the lower amount of precipitation in this area, irrigation is essential to achieve plant and Date production. As in the inframediterranean to thermomediterranean environments, the optimum for the production of Date Palm is achieved with values of Io = 0.6-2.0. Also, Jericho and Gaza are located in the area arid,

semiarid and upper dry [31], addition to growth and productivity can be greatly reduced by aridity [32, 33] and some of the areas and the Palestinian territories fall within the arid and semi-arid, therefore the importance of water shortage cannot be overemphasized for the rain-fed production systems in the semi-arid tropical regions [34]. 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 [35], and pollution and high demand for water have reduced the productive capacity of farms in the Gaza Strip [36].

4. CONCLUSION

In concluded, Jericho and Gaza were located in the arid nature of the area where mean temperature is higher than 20^{o}C for eight months of the year during which the annual ombrothermic value between 0.6 to 2.5, with a little water deficit and increased soil water reserve to optimize Date Palm production and increased economic in these areas. Groves of date palms are important environmental for local wildlife and play a central role in the desert ecological system. We proposed that Date Palm can be adapted in area arid, semiarid and dry ombrotype, and belong to upper inframediterranean to thermomediterranean thermo type to optimize production. Also, The Jericho Agro-Industrial Park is a public-private enterprise being developed in the Jericho area.

In the case of principal component analysis, Jericho type plots are conditioned by the compensated thermicity index and temperature, therefore, Date Palm production in these plots depends on previous factors, whereas it is less influenced by annual ombrothermic index and others factors. The correspondence analysis in all cases separates two types of plots: Jericho whose production depends on the bioclimate and climate factors as a temperature and compensated thermicity index, while Gaza type plots reveal the influence of temperature, annual ombrothermic index and precipitation, and soil water reserve and water deficit.

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