Vol III Issue VII April 2014 ISSN No : 2249-894X

Monthly Multidisciplinary Research Journal

Review Of Research Journal

Welcome to Review Of Research

RNI MAHMUL/2011/38595 **ISSN No.2249-894X**

Review Of Research Journal is a multidisciplinary research journal, published monthly in English, Hindi & Marathi Language. All research papers submitted to the journal will be double - blind peer reviewed referred by members of the editorial Board readers will include investigator in universities, research institutes government and industry with research interest in the general subjects.

Advisory Board

Address:-Ashok Yakkaldevi 258/34, Raviwar Peth, Solapur - 413 005 Maharashtra, India
Cell : 9595 359 435, Ph No: 02172372010 Email: ayisrj@yahoo.in Website: www.ror.isrj.net

Review Of Research
Vol. 3 | Issue. 7 | April. 2014
Impact Factor : 2.1002 (UIF)
ISSN:-2249-894X

DOI : 10.9780/2249-894X/372014/688
Available online at www.ror.isrj.net

ORIGINAL ARTICLE

CLIMATE CHANGE AND ITS EFFECTS ON OLIVE TREE PHYSIOLOGY IN PALESTINE

Rezq Basheer-salimia and Joy K. Ward

Department of Plant Production and Protection, Faculty of Agriculture, Hebron University,Palestine .
Department of Ecology and Evolutionary Biology, University of Kansas, Lawrence,USA.

Abstract:

Over the last several decades, there has been a sharp decrease in rainfall in the Middle East in general, including Palestine in particular. Indeed, marked increases in the number of droughts, particularly in the southern and eastern slopes of the West-Bank have been noted. Unfortunately, there are projections of a further decline in rainfall in Palestine in the future, which is predicted to be particularly devastating to crop production, including native species. In this study, we sampled leaves of olive trees from 11 different regions of Palestinethat vary in water availability. We conducted leaf stable carbon isotope analysis on these treesacross their native range in order to better understand the variation in physiological responses that include stomatal conductance and photosynthetic capacity that together determine ci/ca(inter-cellular leaf [CO_2]/atmospheric [CO_2]). The carbon isotope ratios of olive trees showed a range of values that differed by approximately 6‰(ranging from -23.6 to -29.2‰). However, the correlation between carbon isotope ratios and precipitation did not reflect the expected trend for response to water availability, and may be due to strong adaptations for water-use efficiency, as well as responses of leaves during formation to past years that differ from the collection year. In addition, the oldest tree (possibly greater than 3,000 years old) had carbon isotope ratio values that were different from all of the other younger trees. More specifically, this tree had an isotope value near -29.0%that likely reflects higher stomatal conductance and higher ci/ca values. This study provides a foundation for beginning to determinethe degree to which olive responds to water availability and may allow us to choose the most appropriate genetic sources for continued success of olive production in the face of a rapidly changing climate in Palestine.

KEYWORDS:

Carbon isotopes; climate change; drought; Olea europeaL.; water availability; Palestine.

INTRODUCTION :

It is clear that many nations are facing increasing problems with agriculture production as a result of climate change, with Palestine being no exception. Over the last several decades, there has been a sharp decrease in rainfall in the Middle East in general (Zhang et al., 2005), including Palestine in particular. Rainfall is not evenly distributed throughout the winter season in Palestine, but rather the vast majority comes duringshort and intense periods of time, which further exacerbates the problem of water availability for crop production. Additionally, marked increases in the number of droughts, particularly in the southern and eastern slopes of the West-Bank have been noted.

Reasons for the observed changes in regional rainfall are obviously complex, but are clearly linked to global and regional environmental changes, likely involving increasing CO_2 and temperature(IPCC, 2007).Unfortunately, there are projections of a further decline in rainfall in the Middle East and Palestine in the future, which will be particularly devastating to crop production, including native species. According to a realistic emissions scenario for the region, the IPCC predicts that warming over the 21st century will be larger than global annual mean warming – ranging between 2.2-5.1ºC. Furthermore, annual precipitation rates are expected to decrease by 10% by 2020, and are expected to decline by 20% by 2050 – with an increased risk of summer droughtsin the region (IPCC,2012).

Palestine has a great variety of landscapes with a diversified relief (Basheer-Salimia et al., 2012). It has a range of mountains forming a spine in the West Bank, varying between +1100 and -400 m in height. The mountainous areas serve as the main rainfall collection and replenishment zones for the underground water aquifers of the region (Lautzeand Kirshen, 2009; Feitelson et al.,2012). However, during the last few years, current extraction from groundwater is exceeding recharge and ground water levels are decreasing rapidly.The area is characterized by a high degree of aridity and pronounced rainfall variability across its territories and is therefore highly vulnerable to drought. As a result, this region willlikely experience declines in water availability atlarge population centers as well as declining crop production. The consequences of this decline in water availability is poorly understood, and therefore we strive to understand the effects of variation in water availability on olive tree physiology in Palestine, which involves both a native species and one that is critical for agriculture in Palestine.

The agricultural sector in Palestine accounts for 11-20% of the Palestinian economy, employing approximately 15% of the formal workforce and up to 39% of the informal workforce, and accounts for about 20% of exports (FAO, 2009). Because approximately 95% of Palestinian crops are dependent solely on local rainfall (irrigation is rarely available), and because crop production is of substantial economic and social importance in Palestine (PCBS, 2010), this situation poses an important challenge to the Palestinian community.

Among those crops, olive trees (*Oleaeuropea*L.) areconsidered to be the most important crop in Palestinian agriculture in terms of area covered, and withrespect to economic returns (Basheer-Salimia et al., 2009). Olive covers about 100,000 hectares distributed all over the West Bank and Gaza strip and it is distinguished as the major tree in rain fed areas, covering about 51% of the total cultivated area in the West Bank. In addition, this tree contributes to about 40% of total gross product of fruit production and compromisesmore than 20% of the overall national agricultural output (MOA, 2011). Additionally, the olive sector contributedapproximately 6.3% of the Palestinian GDP in 2011 and it plays a critical role in providing income to poor households and promotes food securityin the region (PCBS, 2011).Thus, it is absolutely critical that we have a full understanding of the effects of climate change on this critical tree species, as both a native species and a major agricultural resource.

The main goal of this study is to make progress in understanding the physiological responses of olive trees to variation in water availability using stable carbon isotopetechniques across olive trees in their native range.

MATERIALS AND METHODS

Fully developed olive leaf samples (in full sun) from the middle region of the annual shoots were collected from trees in 11 different regions of Palestine (Table 1,Figure 1). Based on farmer knowledge, samples were collected from the most dominant cultivar known asRomithat belongs to the Roman Period (63 BC to 638 AC). The majority of the trees samples were between 1370 and 1950 years of age (although one sample which was collected from ArRjoom near Idnawas likely greater than 3,000 years old).

At the laboratories of Hebron University, leaves were oven-dried immediately after collection (70°C for at least 48 hr) and all leaves from within the same tree were combined and ground with liquid nitrogen to a fine powder for stable carbon isotope analysis.

Isotopemeasurements were performed at the Keck Paleo-environmental and Environmental Stable Isotope Laboratory (KPESIL) at the University of Kansas, Lawrence, KS USA. $\delta^{13}C$ was measured on leaf tissue using an elemental analyzer (Costech 4010) coupled to a Thermo Finnigan MAT 253 IRMS isotope mass spectrometer. $\delta^{13}C$ values were calculated using the following formula:

$$(\delta = (R_{sample}/R_{standard} - 1)*1000:$$

where R is the ratio of ^{13}C to ^{12}C, using belemnite carbonate from the Pee Dee Formation, Hemingway, SC (PDB) as the standard. Data were converted to 'per mil' (‰) notation by multiplying δ values by 1000.

This technique is highly beneficial for understanding the stomatal regulation of plants over an integrated time scale encompassing a period over which plant tissue is produced (leaves in this case). Carbon isotopes are indicative of plant ci/ca (inter-cellular [CO_2]/atmospheric [CO_2]) ratios, which are driven by stomatal regulation (usually the primary factor), as well as leaf photosynthetic capacity (Farquhar et al., 1989).

RESULTS AND DISCUSSION

Olive is one of the oldest known cultivated trees worldwide and the Mediterranean region is considered its center of origin. The archaeological findings demonstrate that the Syrian-Palestinian region was the center of origin of olive cultivation (Zohary and Hopf, 1994; Remesal-Rodriguez, 1996; Basheer-Salimia, 2004). Among this entire history of major climate change, olive trees still survive and have high functioning, even under drought conditions. In fact, olive might achieve this result via various morphological and physiological mechanisms that reduce water loss under severe drought conditions (Ayerza and Sibbett, 2001; Bacelar et al., 2009; Boughalleb and Hajlaoui, 2011), while allowing for high water uptake and increased growth rates during periods when water is plentiful.

In this study, we make progress in understanding the physiological responses of olive trees to variation in water availabilityusing stable carbon isotope technique on these trees. Stable carbon isotope ratios of leaves are mainly driven by levels of stomatal conductance (the amount of opening of stomatal pores on the leaf surface), as well as effects from photosynthetic capacity that together determine ci/ca(inter-cellular leaf [CO_2]/atmospheric [CO_2]). In addition, this measurement allows for integration of the regulation of stomata across the developmental timing of the tissue being measured. Such work will allow us to determine the degree to which olive responds to water availability and may allow us to choose the most appropriate genetic sources for continued success of olive production in the face of a rapidly changing climate in the region.

The carbon isotope ratios of olive trees collected from throughout different regions of Palestine (Table 1, Figure 1) showed a range of values (Table 2)that differed by approximately 6‰ and ranged from -23.6 to -29.2‰. Olive in its native range is known to be a drought-tolerant species, and these relatively high (less negative) isotope values indicate that the species is indeed highly water-use efficient in general. We also found variation for carbon isotopes among regions with similar precipitation, particularly for mid-level precipitation regions (Figure 2). This finding suggests that there is some level of variation in physiology that could be utilized for breeding purposes and for response to rapid climate change. At this stage of sampling, we find that approximately one-fourth of the variation in carbon isotope ratiosis correlated with local levels of precipitation (Table 2,R^2 = 0.27; Figure 2). However, this is not in the direction that we would have predicted, since somewhat lower carbon isotope ratios (more negative) are occurring in drier regions, implying that stomatal conductance is higher in these drier regions (and this is counter-intuitive). We also did notobserve marked differences in C/N ratios among these trees frommore drier regions, and thus differences in photosynthetic capacity are not likely to be driving these responses, and therefore this offers no further explanation on the unexpected correlation between precipitation and carbon isotope ratios. This response may simply be because this species is highly drought-tolerant and water-use efficient and exhibits little response to differences in water availability. It is also possible that since olive leaves are long-lived (usually lived for 18 months), this response is reflecting earlier precipitation events that correspond with the timing of when leaves were formed, which may vary from more recent and long-term precipitation conditions.That is particularly possible since these trees depend on precipitation events, and rarely use groundwater sources since they have shallow roots(Therios, 2009), and are not irrigated. It is also important to point out that although we see a 6‰ range in carbon isotopes among all sampled trees, this was mainly driven by one outlier. Other trees (that are younger in age) occur within a more restricted range of physiological response, indicating that widespread sampling would be needed to enhance the degree of physiological variation for trees in the region.

We found that the oldest tree (possibly greater than 3,000 years old) hada carbon isotope ratio value that was different from all of the younger trees, possibly reflecting adaptations to a past climate that no longer exists in the region (this tree was not included in the graph shown in the manuscript since it is much older than the rest). More specifically, this tree (Olive-4) had an isotope value near -29.0‰ that likely reflects higher stomatal conductance and higher ci/ca values. This value was more negative than what would be predicted from water availability alone, and may therefore be reflective of adaptations to past conditions that may have been wetter. All trees used in this study would have evolved under periods of lower atmospheric [CO_2] during pre-industrial periods that differ from modern conditions (270-290 ppm in the past versus 400 ppm today(Gerhart and Ward,2010).However, tree Olive-4 may have also been adapted to much earlier climate conditions, in addition to lower atmospheric [CO_2] (including water availability). It is also possible that the change in carbon isotopes represents a response of advanced age rather than an adaptation to previous environments (or possibly both).

In general, this study allows us to gain increased understanding of the level of variation in the physiological response of olive trees to regional differences in precipitation. We can also begin to use this data as a baseline for olive physiological functioning in the current climate in order to better understand how climate change is continuing to impact the physiology of this tree in the near future as climate change advances in Palestine.

REFERENCES

1.Ayerza, R. and Sibbett, G. 2001, Thermal adaptability of olive (OleaeuropaeaL.) to the Arid Chaco of Argentina. Agricultural Ecosystem and Environment 84: 277-285.
2.Bacelar, E.A.Moutinho-Pereira, J.M. Gonçalves, B.C. Lopes, J.I. and Correia, C.M. (2009). Physiological responses of different olive genotypes to drought conditions.-ActaPhysiologiaePlantarum 31 (3): 611-621.
3.Basheer-Salimia, R.Awad, M. and Kalaitzis, P. 2009,Genetic Fingerprinting of Palestinian Olive (Oleaeuropea L.) Cultivars Using SNP Markers. Jordan Journal of Agricultural Sciences 5 (3): 282-294.
4.Basheer-Salimia, R.Awad, M. and Ward, J. 2012,Assessments of biodiversity based on molecular markers and morphological traits among West-Bank, Palestine fig genotypes (FicuscaricaL.). American JournalofAgricultural Sciences 3: 1241-1251.
5.Basheer-Salimia R. 2004,Morphological, anatomical, physiological and biochemical markers describing the phase changes phenomena of juvenility-maturity in olive tree (OleaeurpoaeaL.). Ph.D. Thesis. School of Agriculture, Aristotalian University of Thessaloniki, Thessaloniki, Greece.
6.Boughalleb, F. and Hajlaoui, H. 2011,Physiological and anatomical changes induced by drought in two olive cultivars (cvZalmati and Chemlawi). ActaPhysiologiaePlantarum 33 (1): 53-65.
7.FAO, 2009, Database of the Food and Agricultural Organization (FAO) of the United Nations. Available at [http//www.fao.org]. Rome, Italy.
8.Farquhar, G.D.Ehleringer, J.R. and Hubick, K.T. 1989,Carbon isotope discrimination and photosynthesis. Rev. Plant Physiology. Plant Molecular Biology 40: 503-537.
9.Feitelson, E.Tamimi, A. and Rosenthal, G. 2012,Climate change and security in the Israeli- Palestinian context.Journal of Peace Research 49: 241-257.
10.Gerhart, L.M. and Ward, J.K. 2010,Plant responses to low [CO2] of the past. Tansley Review. New Phytologist 188: 674-695.
11.Gonzalez-Meler, M.A., Blanc-Betes, E. Flower, C.E.Ward, J.K. and Gomez-Casanovas, N. 2009,Plastic and adaptive responses of plant respiration to changes in atmospheric CO2 concentration. PhysiologiaPlantarum137: 473-484.
12.IPCC, 2007,Climate Change "Synthesis Report (the physical science basis. Summary for policymakers". Contribution of Working Group I to the Fourth Assessment Report of the Inter-governmental Panel on Climate Change). Geneva (www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf).
13.IPCC, 2012,Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B. Barros, V. Stocker, T.F. Qin, D. Dokken, D.J. Ebi, K.L. Mastrandrea, M.D. Mach, K.J. Plattner, G.K. Allen, S.K. Tignor, M.and Midgley,P.M. (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp582.
14.Lautze, J. and Kirshen, P. 2009,Water allocation, climate change, and sustainable water use in Israel/Palestine: The Palestinian position. Water International 34 (2): 189–203.
15.MOA, 2011, Database of the Palestinian Ministry of Agriculture (MOA). Available at [http//www.moa.gov.ps]. Ramallah, Palestine.
16.PCBS, 2010, Database of the Palestinian Central Bureau of Statistics. Available at [http//www.pcbs.gov.ps].
17.PCBS, 2011, Database of the Palestinian Central Bureau of Statistics. Available at [http//www.pcbs.gov.ps].
18.Remesal-Rodriguez, J. 1996,Economiaoleicola: En la antiguedad. In: 'EnciclopediadelOlivo'. ConsejoOleicolaInternacional (ed). Plaza &JanesEditores SA., Bacelona, Spain, 47-58.
19.Therios, I. 2009, Olives. Biddles Ltd. King's Lynn, UK.

20.Zhang, X. Aguilar, E.Sensoy, S.Melkonyan, H.Tagiyeva, U.Ahmed, N.Kutaladze, N.Rahimzadeh, F.Taghipour, A.Hantosh, T.Albert, P.Semawi, M.Ali, M.Al-Shabibi, M.Al-Oulan, Z.Zatari, T.Khelet, I.Hamoud, S.Sagir, R.Demircan, M.Eken, M. Adiguzel, M.Alexander, L.Peterson, T.and Wallis, T. 2005,Trends in Middle East climate extreme indices from 1950 to 2003. Journal of Geophysical Research 110, D22104, doi:10.1029/2005JD006181.
21.Zohary, D.and Hopf, M. 1994, Domestication of plants in the Old World (2nded). Clarendon Press, Oxford, UK.

Figure 1.This map shows the sites of collection of olive from different regions of the West-Bank, Palestine (sites are shown in purple).

Figure 2.Correlation between carbon isotope ratios and annual precipitation.Note that outlier Olive-4 (a very old tree) was not included in this correlation, although it is discussed in the text.

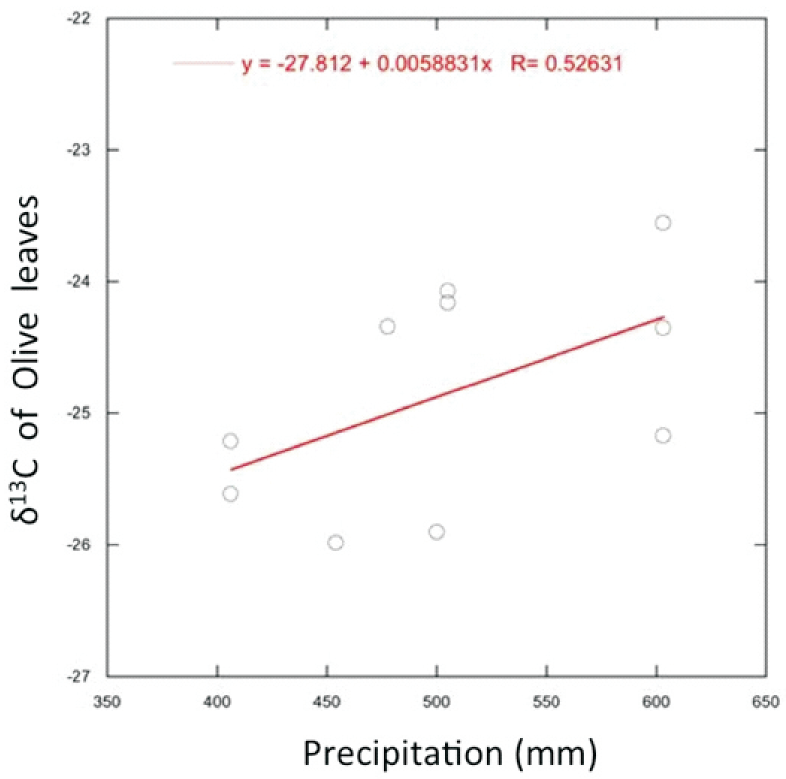

Table1.Elevation (m), rainfall in the 2011/2012 collection season, andlong-term average rainfall (mm)forthe 11 collection sitesin Palestine. The percent rainfall of the 2011/2012 season versus the long-term average is shown in the % column.

			2011/2012		
#	Collection Site	Height (m)	Rainfall mm	Average Rainfall	%
Olive-1	Hebron - Univ. Campus	960	603	596	101
Olive-2	Hebron - Univ. Campus	960	603	596	101
Olive-3	Hebron - Univ. Campus	960	603	596	101
Olive-4	ArRjoom - Idna	280	478	473	101
Olive-5	Jenin- Birqin-Near Kanan Comp.	255	500	515	97
Olive-6	Jenin- Near the Center	155	454	468	97
Olive-7	Samouh -Near the Center	725	406	420	97
Olive-8	Samouh- border	700	406	420	97
Olive-9	Idhna	490	478	473	101
Olive-10	Yatta - Near the center	790	505	389	130
Olive-11	Yatta	700	505	389	130

Table2.Carbon isotope values of olive leaves collected from the 11 sites across Palestine, as well as leaf %N, %C, and C/N ratios.

Identifier	$\delta^{13}C$ VPDB	%N	%C	C/N
Olive-1	-23.55	2.23	47.9	21.5
Olive-2	-24.35	1.41	38.7	27.5
Olive-3	-25.17	1.82	44.4	24.5
Olive-4	-29.28	1.49	38.6	25.9
Olive-5	-25.90	1.06	28.8	27.1
Olive-6	-25.98	1.30	30.1	23.1
Olive-7	-25.61	1.68	38.4	22.8
Olive-8	-25.21	1.12	33.4	29.9
Olive-9	-24.34	2.08	47.5	22.9
Olive-10	-24.16	1.98	47.7	24.1
Olive-11	-24.07	1.30	43.8	33.8