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EFFECTS OF CLIMATE CHANGE ON OLIVE CULTIVATION AND TABLE OLIVE AND OLIVE OIL QUALITY

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Abstract

Climate change is undoubtedly the most imminent environmental issue the world is facing today. Climate changes could heavily affect olive oil producing areas, especially in the Mediterranean basin. Olive trees are tougher than vines and can thrive on many different terrains and under various climate conditions. Researchers reported that a key area of Spanish olive oil production in Catalonia may become unviable within 20 years due to these increasing temperatures and water shortages. Extreme temperatures pose risks for olive production. The Mediterranean basin region, where more than 90% of the world's olive oil is produced is expected to be exposed to higher temperatures in the future due to global climate changes, which caused unfavorable growing conditions and showed negative effects on oil production and quality. According to result of studies there is an urgent need for approaches to estimate the consequence of climate change and its effects on olive quantity and quality of olive oil and table olive. This research was aimed to present result of studies which focused on effects of climate change on olive growing and production and also quality of table olive and olive oil products.

Key words: *global warming, olive industry, table olive, olive oil.*

INTRODUCTION

Climate change is undoubtedly the most imminent environmental issue the world is facing today. The rise in climate temperature will have certain major effects on ecosystems, wildlife, food chains and eventually human life (Appels et al., 2011). According to result of studies, in less than forty years, three-quarters of the wine producing areas on earth will not be suitable for vine farming due to the effects of climate change. Soon enough those vineyards will move to other territories that will have the conditions to grow the grapes, like northern Europe, northwestern America and areas of central China (Hannah et al., 2013; Vasilopoulos, 2013). Similarly, the climate changes could heavily affect olive oil producing areas, especially in the Mediterranean basin (Vasilopoulos, 2013). Climate change alters both average and extreme temperatures and precipitation patterns which in turn influence crop yields, pest and weed ranges and introduction and the length of the growing season (Anon., 2008). Olive trees are tougher than vines and can thrive on many different terrains and under various climate conditions. They give olive oil with little effort and care throughout the year, often without much watering. This is why countries like India, Libya and Australia are planting more olive trees; it is relatively easy to grow them and they can yield a profit (Vasilopoulos, 2013). According to result of studies climate chage have caused effects on olive cultivation and alteration on quality of table olive and olive oil (Ponti et al., 2014; Dag et al., 2014; Tupper 2012). This review aimed to present these effects and alterations on olive cultivation and olive product quality.

EFFECTS OF GLOBAL WARMING ON OLIVE CULTIVATION

Climate change threatens agro-ecosystems of olive which is an ancient drought-tolerant crop of considerable ecological and socioeconomic importance in the Mediterranean Basin (Ponti et al., 2014). Researchers reported that a key area of Spanish olive oil production in Catalonia may become unviable within 20 years due to these increasing temperatures and water shortages. Spain is thought to be highly susceptible to climate change. Studies have shown that the flowering period of olive trees is highly dependent on the yearly spring temperatures, which are rising steadily over time (Tupper, 2012).

The most immediate issue for the olive cultivation is rainfall which is highly affected by climate change. 2013 has been reported as the driest year on record since dating back over 150 years for California (Moran, 2014). Less rainfall means low olive oil production, with few options for farmers when water prices remain high (Moran, 2014; Tupper, 2012). This pertains to the bulk of American olive oil production, considering that 90 percent of olives grown domestically come from California (Moran, 2014). If Spain is to continue its supremacy as an olive oil producing nation, new and innovative irrigation alternatives will have to be created to combat the constantly changing climate. This is no easy task however, as increasing irrigation can have negative effects on water supplies for the area, leading to desert like areas and water shortages for other purposes, as has previously been seen in Greece, Italy and Portugal when irrigation demands increased (Tupper, 2012).

When the weather becoming warmer, olive groves on high hills or slopes will probably suffer less, but groves located on low altitude areas or plains could become totally unproductive. There are already signs of the oncoming change, with this year's harvest in Spain crippled by the drought and the phenomenal weather variations (Vasilopoulos, 2013). Water scarcity affects every continent and countries such as Greece and Italy have already suffered the devastating effects of drought, with olives dying at high temperatures and from lack of water. In addition to the direct effects of a changing climate on the olive population, variations in weather can also cause changes in other environmental factors such as insects and disease. These may then influence the olive tree population, as an indirect effect of changing climates (Tupper, 2012).

Extreme temperatures, pose risks for olive production. In 1998, severe cold temperatures caused significant losses for olives in California. Olive trees can normally handle brief cold snaps, but sub- freezing temperatures that last longer than a few hours will damage new and small branches and may prevent fruit production (Moran, 2014).

Olive phenology has been reported as a good indicator of future climatic change (Osborne et al., 2000). This could be explained by the fact that photoperiod would also affect the start of flowering in the late spring flower species. Moreover, one of the most expected consequences of climate change will be the increase in minimum temperatures, especially in winter and early spring (Ahmad, 2001).

The variability in chilling hours, which garner less attention than frost, are equally important to overall olive vitality. Accumulated winter chill hours are declining in the growing regions of California, which affects a range of crops from olives to almonds. A substantial amount of chilling hours (32-45^{o}F) are necessary for olive flower bud development, which facilitate the plant's movement out of its vegetative state so fruit can be produced (Moran, 2014).

Inability to determine reliably the direction and magnitude of change in natural and agro-ecosystems due to climate change poses considerable challenge to their management. This level of climate warming will have varying impact on olive yield and fly infestation levels across the Mediterranean Basin, and result in economic winners and losers (Ponti et al., 2014).

Mild temperatures in summer are reported as a reason for increased olive fly infestations in the region without stretches of summer heat to reduce the fly population. Together, these effects create a complex web of changing climate and olive oil production, whose future will require further scientific research, careful monitoring (Moran, 2014; Marshall et al., 2011). Recycling to soil olive mill waste has the potential to improve soil fertility, thus reducing CO_2 emission associated to global warming (Altieri and Esposito, 2010).

Climate change will impact the interactions of olive and the obligate olive fruit fly (*Bactrocera oleae*) and alter the economics of olive culture across the Mediterranean Basin. The effects of climate change on the dynamics and interaction of olive and the fly using physiologically were estimated based on demographic models in a geographic information system context as driven by daily climate change scenario weather (Ponti et al 2014).

Climate does not only affect olive trees directly, but changing temperatures also influences insect diversity and frequency for a given area. Rising carbon dioxide levels will exacerbate most insect and pest problems. This is particularly relevant to the olive fly, olive's most notorious and costly pest, but studies show that this effect may actually operate in a counter intuitive way (Moran 2014).

Decreased level of production may become common place if continued scarcity of water and increased temperatures start to effect groves in Spain. While high temperatures are optimal for growth and development of olives, heavy rain is also necessary to complete the ripening process (Tupper 2012). Irrigation of olives with saline water will inevitably increase in the future in the Mediterranean due to negative effects of population growth and climate change on the availability and quality of existing fresh water supplies. As a consequence, the risk land salinisation will exacerbate threading the agricultural production particularly in countries with a semi-arid or arid climate (Chartzoulakis 2005).

Spanish olive oil production has doubled in the last ten years, but ongoing drought and climate change may mean a setback for the global leader in olive oil production. Spain may fall to the same fate as fellow olive oil producing power houses Greece and Italy due to the effects of climate change. Italy has seen a drop of 50 % in production since 2001 and Greece has also seen its annual production levels decline by half with climate change thought to be an important factor (Tupper 2012).

EFFECTS OF GLOBAL WARMING ON TABLE OLIVE AND OLIVE OIL PRODUCTION AND QUALITY

Climate warming will affect olive yield and oil quality across the Mediterranean Basin, resulting in economic winners and losers at the local and regional scales. At the local scale, profitability of small olive farms in many marginal areas of Europe and elsewhere in the Mediterranean Basin will decrease, leading to increased abandonment (Ponti et al., 2014).

Emerging players of the olive industry like China and India with vast lands for cultivating olive trees could challenge European producers. Because of rapid changing weather, reduction of olive oil production is on the way for traditional olive oil powerhouses such as Spain, Italy and Greece (Vasilopoulos, 2013).

Decline of olive oil production in Italy and Greece has had a temporarily positive effect on Spain, which is now producing twice the joint production of Greece and Italy. Current harvest in Spain will be a poor one, with a 40 % drop in production due to drought, leading to a huge leap in market prices for olive oil (Tupper, 2012).

More than 90% of the world's olive oil is produced in the Mediterranean basin where is expected to be exposed to higher temperatures in the future due to global climate changes which caused unfavorable growing conditions and showed negative effects on oil production and quality (Dag et al., 2014). Early harvest (relatively low ripening index) is reported as one of the major findings to prevent from those climate changes (Dag et al., 2014; Vasilopoulos, 2013,).

Determination of the optimal fruit ripening stage for the production of olive oil represents a critical choice based on the best combination of oil quantity and quality (Dag et al., 2014). As olive ripening proceeds, fruit characters such as weight, pulp to stone ratio, color, oil content, enzymatic activities and profiles of various phytochemicals, including fatty acids and total polar phenol content, are constantly changing. These changes in fluence fruit firmness, olive oil chemical composition and sensory qualities (Beltrán et al., 2004). Climate has a major in fluence on the ripening process and hence on oil accumulation and its chemical composition (Aparicio and Luna, 2002).

As well as the quantity of fruit, the qualitative components of olive oil produced can be influenced by the environmental conditions of the growing year (Lombardo et al., 2008). This relates to the absolute variations in fatty acids and the relationships between these individual components such as the oleic acid/linoleic fatty-acid ratio, and the ratio between oleic acid and the sum of palmitic and linoleic acids (D'Imperio et al., 2007). Getting a high quality olive oil requires several different factors which are healtly trees, appropriate climate and proper farming. Also the ground morphology and the moisture levels of the area play an important role in shaping the oil characteristics. European olive oils in fifty years from now could be very different in terms of their qualities and organoleptic characteristics (Vasilopoulos, 2013).

One of the most important aspects is the use of irrigation while monitoring for potential water stress caused by water deficit in the summer months. Thus, greater attention needs to be paid on the part of the olive growers for evaluation of the vegetative–productive state of the trees and their reproductive cycle, and of the hydro-pedological conditions of the terrain that vary with the seasonal meteorological trends (Orlandi et al., 2012).

A water deficit during initial development of the fruit (in June in the northern hemisphere) can result in a decrease in the size of the cells of the mesocarp that cannot be recovered, except, at least in part, if the plants are regularly irrigated in the following stages (Servili et al., 2004). Water deficit affects fruit maturation, which occurs earlier and more rapidly, and can result in more intense pre-harvest fruit fall (Inglese et al., 1996). However, a number of studies have shown that the water state of the plant has marginal, if any, effects on free acidity and peroxide value of the olive oil produced (Servili et al., 2007). A direct relationship connects the water stress to the levels of linoleic and linolenic acids, where higher stress corresponds to high levels of these fatty acids. This therefore provides further support for the concept of qualitative irrigation (Servili et al., 2004).

The phase of maturation of the olive fruit influences not only its acid composition, but also the composition of its minor constituents, and particularly its phenolic and volatile compounds. Thus, factors that affect the evolution of maturation of the drupe can also affect the qualitative characteristics of the resulting olive oil (Fiorino and Nizzi Griffi, 1991).

Variability in acid composition has been correlated to the temperature sum of the period from fruit setting to fruit maturation. The high temperatures during this phase that arise in hot seasons and environments can result in decreased oleic acid content, which is accompanied by increased palmitic and/or linoleic acids (Lombardo et al., 2008). A very high temperature sum also tends to reduce total polyphenol content (Ripa et al., 2008). Similarly, in cooler areas, a positive correlation has been shown between the temperature sum from August to October and the total polyphenol content of olive oil (Tura et al., 2008).

The water state of the plant also has marked effects on concentrations of volatile compounds in the oil. Thus, oil from plants grown without irrigation, as opposed to those with, can be more bitter and biting to the taste (Servili et al., 2007). Plants grown under conditions of water stress therefore tend to produce oils that are more full bodied and strong in their taste, with strong bitter and biting notes, but that are relatively less aromatic (Orlandi et al., 2012).

CONCLUSIONS

According to result of these mentioned studies there is a urgent need for approaches to estimate the consequence of climate change and its effects on olive quantity and quality of olive oil and table olive. Water uses for irrigation should be good planned for olive orchard to reach maximum olive yield and olive oil or table olive quality with minimum water consumption. Global warming and rising carbon dioxide levels will increase the most of the insect and pest populations and change their life cycle. So that olive orchard should be kept under constant observation to determine the time and use the type and amount of pesticide and insecticide uses. According to climatic changes, harvest time of olives should be redefined which should be provide a balance between for high yield and final product quality. New breeding studies should be focused on the behavior of olive genotypes with respect to climate change. Water stres and diseases resistance of olive trees and olive oil quaity or table olive quality under increased temperatures and water stres should be use as a dominant advanced selection criteria for new olive cultivar candidates.

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