Adaptation of Date Palms to Climate Changes

Sayed Ashour Ahmed

Department of Plant Protection, Faculty of Agriculture, Assiut University, Egypt.

Abstract

The problem of climate change is one of the most serious environmental challenges facing the world today, and its significance lies in the various devastating effects it has on ecosystems and agriculture. Most of the global warming observed in the past 50 years has been attributed to an increase in "greenhouse gases", primarily resulting from human activities. This paper reviews the negative effects of climate change on fruit trees in general and on date palms in particular. It also examines the adaptive capabilities of various fruit trees, including figs, olives, grapes, pomegranates, mulberries, and palm trees, in response to these changes. Specifically, the paper discusses the tolerance of date palms to high temperatures and the potential impacts of climate change on their flowering and productivity. It explores the variability among palm varieties in their tolerance to humidity and rainfall, categorizing them based on their susceptibility to rain damage and high humidity. Additionally, the paper addresses the effects of environmental factors such as wind and soil salinity on pollination, fruit ripening, and overall palm productivity.

Keywords: Climate change, date palm, environmental challenges, global warming, adaptive capabilities.

***Corresponding author:** s.ashour@gmail.com

1. Climate changes and date palms

One of the negative effects of climate change is the deterioration of productivity in some types of fruit trees. Those fruit trees that can adapt to the consequences of climate change resulting from global warming typically possess specific characteristics, such as low cold requirements and a robust, deep taproot system. This root system allows them to access sufficient moisture, withstand high temperatures and drought, and regulate water balance by shedding some leaves during periods of extreme heat. A variety of fruit trees exhibit these characteristics and thrive under rain-fed agricultural conditions in the Mediterranean Basin's temperate climate. These include figs, olives, grapes, pomegranates, almonds, mulberries, pistachios, quinces, and palm trees, among others. Such drought-resistant trees are biologically better equipped to endure extreme weather conditions, pests, and plant diseases. For example, the palm tree has deep taproots, making it highly tolerant of drought and soil salinity. Similarly, the pomegranate is well-adapted to drought and intense sunlight, thriving in various soil types due to its strong, diverse, and deep root system that can extend several meters into the ground (Hammoud, 2011).

1.1. High temperatures

Palm trees tolerate high temperatures without significant damage, even reaching up to 50 degrees Celsius. In fact, high temperatures positively impact the success of domesticated date palm varieties and enhance the natural and chemical characteristics of their fruits. While palm trees can grow under varying temperatures, they only flower in areas where shaded temperatures reach at least 18 degrees Celsius, and they do not bear fruit unless temperatures exceed 25 degrees Celsius. In general, date palms require a limited amount of heat units to undergo the necessary physiological changes. Research indicates that dry and semi-dry varieties need heat units ranging from 1,980 to 2,600, while early soft varieties require around 1,150 heat units (Rural Knowledge Network, 2012).

1.2. Air humidity and rain

Palm cultivation thrives in dry areas, particularly during the flowering, growth, and ripening stages of the fruit, as well as before harvesting and marketing. Increased relative humidity during the flowering period can lead to a higher incidence of diseases affecting flower inflorescences. Studies have confirmed that disease outbreaks are more common in seasons characterized by increased rainfall and high humidity, as these conditions promote the growth and development of pathogens. Rainfall during the pollination period hinders the completion of this process; if rain occurs, pollination often fails and must be repeated. Fruits, especially in the later stages of maturity (Rutab and dates), can be affected by various diseases if exposed to rain or high humidity. This includes issues like top blackening disease and damage from rot, fermentation, and acidification. Rainfall prior to harvesting can cause significant damage, hindering the collection process and leading to fruit rotting and fermentation. Consequently, many palm growers worldwide must harvest their crops before the rainy season, sometimes even during the Khalal or Rutab stages, and artificially ripen the fruits (Rural Knowledge Network, 2012).

Palm varieties differ in their tolerance to moisture and rain damage, categorized as follows:

- **High-tolerance varieties**: Al-Dairi, Al-Khastawi, Al-Khadrawi, Al-Halawi, and Al-Sayer.
- **Medium-tolerance varieties**: Zahdi, Khalas, and Barhi.
- **Low-tolerance varieties**: Deglet Nour, Al-Hayani, and Al-Ghars.

In general, the best dates, in both quantity and quality, are those produced in areas that do not receive rain during the pollination and fruit ripening periods.

1.3. Wind

In general, wind is not considered a significant factor in the success of palm cultivation compared to other fruit trees, due to the anatomical characteristics of

the palm tree. Its flexible trunk and strong attachment of the fronds help it withstand strong winds. However, winds can negatively impact palm productivity in several ways:

- **Pollination hindrance**: Strong winds can disrupt the pollination process, particularly during mechanical pollination.
- **Risk of toppling**: Towering palms may fall, especially if they are infested with borers or termites.
- **Dust and sand damage**: Winds can carry dust or sand, causing significant damage to the fruits, negatively affecting both the quality of dates and the overall yield. If winds occur during the ripening period, they can cause large quantities of fruit to drop.
- **Moisture loss**: Dry winds can lead to a high percentage of moisture loss in the fruits.
- **Sand burial**: In palm oases, such as those in Algeria, Libya, Morocco, and the Arabian Peninsula, winds carrying heavy sand can bury, cover, or destroy palm trees.

1.4. Salinity

Salts affect water relations in the soil, and increasing their concentration leads to a decrease in the osmotic potential of the soil solution. This, in turn, reduces the forces driving the roots to absorb water. Salts also impact soil properties and the movement of water within it. Soil salinity can originate from various sources, with irrigation water being one of the most significant contributors (Marschner, 1998; Waisel, 1972). This issue is particularly pronounced in agricultural areas, especially arid and semi-arid regions, where high evaporation rates and insufficient rainfall limit the washing away of accumulated salts from plant roots (Carter, 1975). Salinity may result in nutrient imbalances for plants, significantly affecting essential nutrients such as calcium, potassium, phosphorus, and nitrogen. The toxicity of sodium salts can manifest as a decrease in calcium content or a high sodium-to-calcium ratio. While salinity affects the physiological processes in plants to varying degrees (Maas *et al*., 1972), its primary effect is to hinder the natural growth of the plant. Research has shown that the concentration and composition of salts in the soil can influence plant growth through osmotic effects (Mass & Nieman, 1978), direct ion effects, or nutritional imbalances (West, 1986). Fruit trees exhibit varying levels of resistance and tolerance to salinity. Studies have found that date palms tolerate salinity to a greater extent than other fruit trees, followed by pomegranates and figs. In contrast, avocados and citrus fruits show lower tolerance. Despite the differences in salinity tolerance among date palm varieties, all varieties are adversely affected when sodium chloride concentrations exceed 300 mmol. Notably, varieties such as Khalas and Umm Rahim have shown

greater tolerance to high salinity within certain limits compared to many other varieties (Al Khatib *et al*., 2002).

Conclusion

In summary, the successful cultivation of date palms is influenced by several environmental factors, including temperature, humidity, wind, and salinity. Date palms exhibit remarkable tolerance to high temperatures, thriving in arid conditions that enhance their fruit quality. However, flowering and fruiting require specific temperature ranges to ensure successful yields. Humidity and rainfall can pose challenges, particularly during pollination and fruit ripening, leading to increased disease susceptibility and fruit drop. Wind, while generally not detrimental due to the anatomical resilience of palm trees, can disrupt pollination and contribute to fruit damage. Salinity is a significant concern, particularly in arid and semi-arid regions where irrigation practices can lead to salt accumulation. Although date palms demonstrate a higher tolerance to salinity compared to many other fruit trees, excessive sodium chloride concentrations can adversely affect their growth and nutrient uptake. Understanding these factors is crucial for optimizing cultivation practices and enhancing the productivity of date palms. By managing environmental conditions and implementing appropriate agricultural techniques, growers can mitigate the challenges posed by these factors, ensuring sustainable and fruitful palm cultivation.

References

Al Khatib, A. A., Al-Khatib, S. A., & Dinar, H. M. (2002). A comparative study of the resistance of palm varieties to salinity at the level of callus tissue. Project follow-up report. Palm and Date Research Center and College of Agricultural and Food Sciences, King Faisal University, Al-Ahsa, Kingdom of Saudi Arabia.

Carter, D. L. (1975). Problems of salinity in agriculture. In A. Poljakoff-Mayber & J. Gale (Eds.), *Plants in saline environments* (pp. 25-35). Berlin: Springer-Verlag.

Hammoud, H. (2011). How do we avoid the effects of negative climate fluctuations on our fruit trees? *Army Magazine*, (309), 1–6. http://www.lebarmy.gov.lb/article.asp?ln=ar&id=27576

Maas, E. V., & Nieman, R. H. (1978). Crop tolerance to suboptimal land conditions. In M. Stelly (Ed.), *Physiology of plant tolerance to salinity* (pp. 276-299). New York: John Wiley & Sons.

Maas, E. V., Ogato, G., & Garber, M. I. (1972). Influence of salinity on uptake of Fe, Mn, and Zn by plants. *Agronomy Journal*, *64*(5), 793-795.

Marschner, H. (1998). Mineral nutrition of higher plants. London: Academic Press.

Rural Knowledge Network. (2012). Palm tree. http://www.reefnet.gov.sy/reef/index.php?option=com_content&view=article&id=361:2008-06-18-10-27-03&catid=49:farms&Itemid=150

Waisel, Y. (1972). Biology of halophytes. New York: Academic Press.

West, D. W. (1986). Stress physiology in trees—salinity. *Acta Horticulturae*, *175*, 123-135.

تأقلم نخيل التمر مع التغيرات المناخية

سيد عاشور أحمد
قسم وقاية النبات كلية الزراعة- جامعة أسيوط، مصر

الملخص العربي

إن مشكلة تغير المناخ تعد من أخطر التحديات البيئية التي تواجه العالم اليوم، وتكمن أهميتها في التأثيرات المدمرة المتعددة التي تخلفها على النظم البيئية والزراعة. وقد نسبت معظم ظاهرة الاحتباس الحراري التي شهدها العالم خلال الخمسين عاماً الماضية إلى زيادة في "غازات الاحتباس الحراري"، والتي نتجت في المقام الأول عن الأنشطة البشرية. وتستعرض هذه الورقة الآثار السلبية لتغير المناخ على أشجار الفاكهة بشكل عام وعلى أشجار النخيل بشكل خاص. كما تدرس القدرات التكيفية لأشجار الفاكهة المختلفة، بما في ذلك التين والزيتون والعنب والرمان والتوت وأشجار النخيل، استجابة لهذه التغيرات. وتناقش الورقة على وجه التحديد مدى تحمل أشجار النخيل لدرجات الحرارة المرتفعة والتأثيرات المحتملة لتغير المناخ على إزهارها وإنتاجيتها. وتستكشف الورقة التباين بين أصناف النخيل في تحملها للرطوبة وهطول الأمطار، وتصنفها على أساس قابليتها للتلف بسبب الأمطار والرطوبة العالية. بالإضافة إلى ذلك، تتناول الورقة آثار العوامل البيئية مثل الرياح وملوحة التربة على التلقيح ونضج الثمار والإنتاجية الإجمالية للنخيل.

الكلمات الدالة: تغير المناخ، نخيل التمر، التحديات البيئية، الاحتباس الحراري والقدرات التكيفية.