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EVALUATION THE IMPACT OF ATMOSPHERIC THERMAL STRESS ON VEGETATIVE GROWTH OF TREES IN NINEVEH GOVERNORATE/ IRAQ

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Abstract

In the Iraqi governorate of Nineveh, especially, occurred serious military operations accompanied by much explosions, which caused the burning of 19 oil wells and sulfur fields for several months, which reflected in the area's atmosphere in a negatively form , which caused the heat to be lifted all Months in general, especially during the months of July and August, where many hours of afternoon has reached 50-60 ° C. High temperatures cause a rise in the rate of the physiological process. that negatively affected on vegetative growth of trees; where heightened the evaporation, transpiration and respiration which caused the drought and fall down of leaves. High thermal which is expected with climate change and the potential for more extreme temperature events will affect on physiological processes of trees: like; Hill-reaction (photosynthesis), which is one of the most sensitive for extreme temperatures during the vegetative growth stage, then affecting on phosphorus oxidation process. The major impact of high temperatures was during the vegetative growth stage, that caused to leaves drought and in all cases significantly reduced the growth by falling down the leaves from 80-90%. Found the trees have optimal growth conditions in the temperature range 21-29 ° C. A thermal death thresh hold is reached at 45 ° C. As a general rule, each temperature stop, starting at 1 ° C and continuing to 11,25,35,45 and 54 ° C.Each allows doubling breathing and water loss. Gross photosynthesis generally doubles up to 35 ° C and then rapidly fall-off. Classified in this study the kind of degraded trees as follows; Excessive degraded trees (A); Pomegranate, Grape, Aromas tree, Common figs, Peach, Apricot, Balsam, Bitter orange, Sweet Cherry, Black Thorn. Low degraded trees (B); King Mandarin, Grapefruit, Kumquats, Eureka Lemon, Blood orange, Sweet orange. Lime, Bitter orange, Tangelo, Key lime, Orange .Non degraded trees (C); Nectarine, Quince, Eucalyptus, Apple, Persimmon, Castor, Date Palm, Wallace Mulberry, Olive. Conclusion that the physiological changes resulted from temperature rise, the rate of transpiration is more than absorption rate, leading to a severe shortage of water content of tissues, which also leads to the dryness of leaves, temperature rise leads to disturbances in cellular food transitions by increasing the rate of catabolism more than the rate of metabolism, vegetative growth becomes eventually damage, high temperature leads to damage in cellular structure, as well as cell composition, also has a deterioration of the function of plasma membranes . The variance in the degradation of the trees infected due to thermal stress can be explained by the differences between the trees in the absorption of nutrient elements in quantity and quality from the soil and their translocation to leaves for the purpose of photosynthesis, where each element receives thermal optical photons through the leaves by a different amount from the other, this depending on the quality and quantity of the element in the cellular solution of leaves. This implies that direct thermal radiation is impacted on the vegetative growth of trees .We observed all trees in the shadow and in the opposite side of the sun not influenced.

Keywords - Thermal stress , Vegetative growth, Trees ,Nineveh Governorate, Iraq.

INTRODUCTION

The fruit trees are one of the ecosystems which achieves the biodiversity and keep the natural balance within the biosphere. Temperature is one of the most essential environmental factors controlling physiological processes in trees [1,2,3]. Temperatures rising are expected to have severe consequences for the effectiveness of all living organisms, like fruit trees. Improved knowledge of the impact of temperature on vegetations, including trees, is particularly important as trees contribute to the sustainability of the biological diversity, weather stability and mitigate global warming [4] furthermore, vegetation cover and trees has essential biogeochemical, hydrological and biophysical interactions with the ecosystem and its responses therefore have an effect on both local and global weather [5,6]. In particular, it is paramount to understand the responses of plant physiological processes to climate change in order to project lithosphere feedbacks on the carbon cycle along with the potential of the biosphere to be mitigate the further global warming [7]. Extreme heat events can affect a wide variety of tree functions. At the leaf level, photosynthesis is reduced, photo oxidative stress increases, leaves abscise and the growth rate of remaining leaves decreases. In some species, stomata conductivity increases at high temperatures, which may be a mechanism for leaf cooling. At the whole plant level, heat stress can reduce the growth and shift biomass allocation. When drought stress accompanies heat waves, the negative effects of heat stress are exacerbated and can lead to tree mortality. However, some species exhibit remarkable tolerance to thermal stress[. Responses include changes that minimize stress in photosynthesis and reductions in dark respiration. There is evidence of the in-species genetic variation in thermal tolerance, which could be important for use in production trees and forestry systems. Understanding the mechanisms of differing tree responses to extreme temperature events may be critical to understanding how climate change will affect tree species [8]. In global vegetation models, the photosynthesis of terrestrial plants is modeled using a well-established biochemistry model of photosynthesis [9,10,11,12]. This pattern requires parameters of some photosynthetic capacities; the most carboxylation average of ribulose-1,5-bisphosphate carboxylase/oxygenase and the most rate of electron transmission , important to regenerate ribulose-1,5-bisphosphate. The maximum average of photosynthetic carboxylation and electron transmission rely upon a couple of factors, of which the most essential was light[13,14]. that extraordinary processes in trees ecosystems and their interaction with climate variability is complicated, because of extraordinary response of physical, biological, and chemical procedures, that an increase of CO_2 concentrations in atmosphere lead to limit the stomata opening which required to permit a given amount of CO_2 to enter into in the leaves that might lessen transpiration of the trees. which effect on utilize of water efficiency [15]. Trees are enable to adaptation with hot climate, although the reaction anticipated from species are variable according to trees type and the impact on photo inhibition and photorespiration are extra difficult in general. [16]. Thermal stress often is defined as wherein temperatures are warm enough for sufficient time that they events irreversible harm for vegetative properties of trees. further, high temperatures can rise the average of reproductive improvement, which shortens the time for photosynthesis to make a contribution to fruit reproduction . will also consider this as a warmness-pressure impact despite the fact that it is able to motive permanent harm to improvement because the acceleration does considerably lessen fruit yield . The average to which warmth strain occurs in particular climatic zones is a complex issue . Trees can be damaged in variable ways by means of either high day or high night temperatures and by both high air or high soil temperatures. additionally, trees species and cultivars vary of their sensitivity to high temperatures. cold season annual species are extra sensitive to hot climate than annual heat season [17]. Range of thermal stress that may arise in a specific climatic zone depends on the probability of excessive temperatures happening and their period throughout the day or night time. in status of occurring global weather change not be possible to predication well to these probabilities but only can depending on historical records for specific sites . thermal stress is a complicated characteristic includes; temperature intensity ,duration and average of height in temperature. The rate of thermal stress hastily will increase as temperature rising above a threshold level and complex adaptation effects can arise that rely upon temperature and different environmental elements. Trough vegetative stage , high temperatures in day can reason damage to compositions of leaf photosynthesis, decreasing carbon dioxide assimilation averages compared with environments having extra most temperatures. photosynthesis sensitivity to heat particularly can be due to damage to components of photosynthesis regime located within the membranes of the chloroplast and membrane traits [18]. possible assess thermo stability for membrane by measuring electrolyte leakage from leaf disks subjected to maximum temperatures [19]. membranes which stable at much form that clear lower electrolyte leakage. that are hot season species suited to higher temperatures [20]. extreme thermal can cause early death of plants. consider the annual winter plants will be very sensitive to high day temperatures with death of the plant when temperatures reaches approximately 35°C in summer time for sufficient length, while summer season plants are resistant to high heat , in particular in the stage of vegetative growing. for warm season annuals, can produce giant biomass when developing in one of the hottest plant production environments on the planet (most day-time air temperatures in a climate station refuge of approximately 50°C), even though its vegetative improvement may also show off abnormalities consisting of leaf fasciations. For monocotyledons, together with both cool-season and warm-season annuals, excessive daytime temperatures can motive leaf firing which involves necrosis of the leaf pointers and this symptom also can be as a result of drought [21]. The rate to which excessive-temperature harm to photosynthesis or reproductive development affect fruit trees likely relies upon on the volume to which the photosynthetic source are proscribing of fruit trees , and this may differ among species and varieties . Surface and inner tissues of citrus fruit may be harmed with the aid of the aggregate of high temperatures and severe sun radiation. excessive thermal of tissue temperatures also can damage cambium layers for exposed stems and branches.

MATERIALS AND METHODS

This study was conducted in Mosul city in the Nineveh governorate of Iraq country, located in the northwestern part of Iraq in the semi-arid region between longitudes (41˚-25) (44˚-25) and latitudes (34˚ -55) (37˚ - 03). The Mosul city is located 1640 m above sea level and is not surrounded by vegetation in all directions which occupy an area of 7323 km^2 affected by the climate of the Mediterranean Sea. It was dominated by the cold weather in the winter and the low temperature below freezing in most days with snowfall in most areas and survival for a long period. But its climate was changed now to intensive heat .. In Iraq during this year 2017, there was an intense hot wave during the two months of

July and August, causing severe damage to the trees. This brought our attention to the preparation of this study, in order to find out the negative effects on tree vegetative growth in biology aspects by conducting a survey in Mosul city on affected tree types in order to classify trees according degradation degree due to the heat stress that affected on trees , also to give a scientific explanation for the physiological processes that have been affected by thermal stress including; photosynthesis, respiration, transpiration, evaporation-transpiration, and their negative effects on the vegetative growth of many types of fruit trees. which were affected by the thermal which reflected in negative form on the vegetative growth of trees.

RESULTS AND DISCUSSION

In current increased ecological crisis where have been occurred of global climate changes in scary form, mainly increased temperatures by rising of atmospheric carbon dioxide as well as lower in precipitation and their replicationو where increased severity of intense climatic caused globally warming and drought , have been danger impacted on the vegetation that includes; herbs, forests and trees [22].Due to military actions and bombs explosion in Iraq from 1980- 2003 and terrorism continuation to 2017, so weather changed negatively . In general form , the climate of Iraq is desert in the centre and the south with normal winters and extremely hot summers but the north region distinguish by semi-arid within Nineveh Governorate, with rather cold winter, even as in the northern mountains, the weather is cold relatively in winter and rainy and some times snowy in winter ,hot and sunny in summer, however with cooler nights by the reason of excessive altitude of earth surface, in the northern belt the weather is semi-arid but cold in winter, occur in some months atmospheric depressions where bring moderate rainfall. Mosul town located ed at the northern most part on the banks of the Tigris River, wintry weather is mild ,however certainly it isn't tropical. The January temperature rate is 7 °C . It rains from December to March for 7-10 day/ month, and sunny days change with volatile unstable climate .At night it often gets cold, some times the temperature drop a few degrees below freezing(0 °C) Summer is very hot in Mosul city , with relentless sun and with daytime rate temperature of 43 °C in July and August ,but reaches some days to 48/50 °C ,however,air humidity is low. The annual precipitation was 365 mm of rainfall, they are not many ,but thy are concentrated between November and April , with very few rains in May and October, while between June and September almost never rains , also in summer season the light period in Mosul city between 15-16 hour with thermal stress rise between 50 - 60 °C in some days through July and August months. The table (1) explain the Mosul annual average temperature in 2017 and table(2)explain the Mosul annual average precipitation in 2017(Source of Iraqi Meteorological in Baghdad).

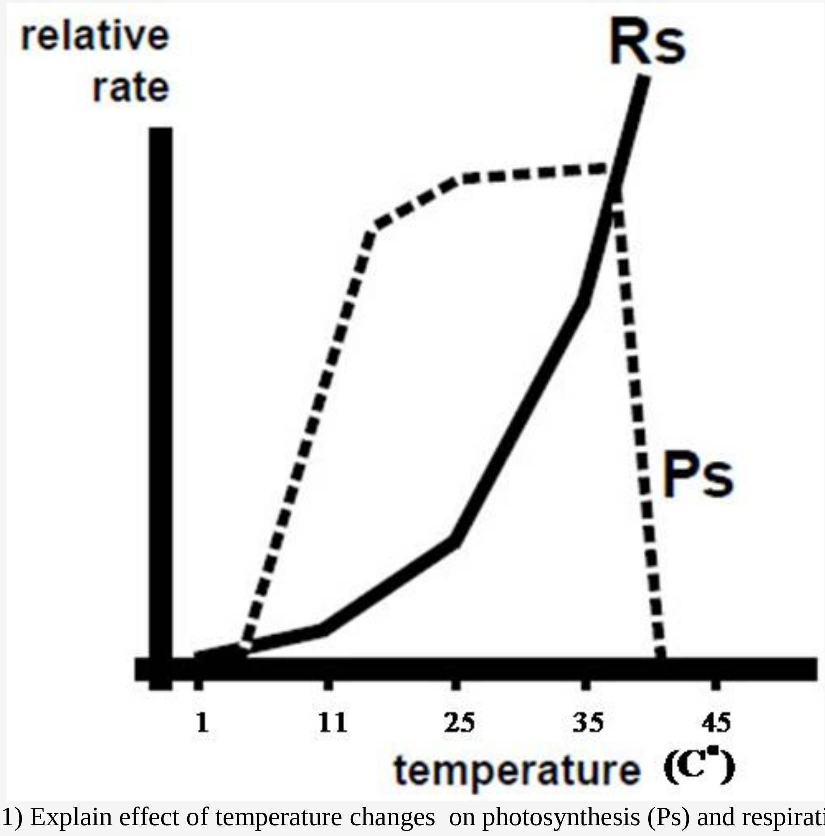
Table(1) Mosul annual average temperatures in 2017

Tem. / Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min (°C)	2	3	7	11	16	21	25	24	19	14	7	4
Max (°C)	12	15	19	25	33	39	43	43	38	31	21	14
Min (°F)	36	37	45	52	61	70	77	75	66	57	45	39
Max (°F)	54	59	66	77	91	102	109	109	100	88	70	57

Table(2)Mosul annual average precipitation in 2017

Pricip./ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Prec. (mm)	60	65	65	45	15	1	0	0	0	10	45	60	365
Prec.(in)	2.4	2.6	2.6	1.8	0.6	0	0	0	0	0.4	1.8	2.4	14.4
Days	11	11	12	9	6	0	0	0	0	5	7	10	71

High temperature (HT) is a chief ecological stress that prevents vegetations growth, metabolism, and productivity . Trees growth and their development includes several biochemical reactions that are sensitive to heat . Trees reactions with HT differs according length of temporal period of thermal stress and their sorts. In current the HT is a wide concern for growing of trees and approaches for conserve vegetative growth and high productivity of trees under HT pressure that are essential agrarian goals. Trees possess some of adaptive, avoidance mechanisms to reacts with HT status. therefore, a chief tolerance mechanisms that utilize ion converts, proteins, osmo-protectants, antioxidants, and other factors involved in signaling cascades and transcriptional control are activated to offset stress-induced biochemical and physiological alterations. Trees survival under HT stress depends on the ability to perceive the HT stimulus, generate and transmit the signal, and initiate appropriate physiological and biochemical changes. HT induced gene expression and metabolite synthesis also substantially improve tolerance. The physiological and biochemical responses to thermal stress are active research areas, and the molecular approaches are being adopted for developing HT tolerance in trees [34,35]. Therefore, the trees adaptation for high temperatures and the methods underlying the development of thermal-resistant, require to be better knowledge for important trees . The responses of trees to thermal stress have been studied in recent years; However, a full understanding of the mechanisms trees tolerance for heat is still elusive. The large thermal variation between season and other, between night and day which still complicates situation, that response to different the heat stress is limited by a trees capability to adaptation to variance of climate systems. Tree responses to heat stress also vary according species and different growing stages under thermal stress conditions, trees accumulate variance metabolites (such as antioxidants, osmoprotectants, heat shock proteins [HSPs], etc.) and different metabolic processes are activated this is consistent with [23,24]. At the field level, managing agricultural practices, such as the date and methods for transplantation the seedlings , irrigation management, and choosing of species, can also considerably reduce the negative effects of thermal stress. exogenous applications of protections such as osmoprotectants, phytohormones, signaling molecules, micro elements, etc. have clear beneficial effects on tree growing under HT, due to the growth promoting and antioxidant activities of these compounds this is consistent with [25,26,27].The rate of growth and development of trees depends on the temperature surrounding them, and each species has a certain temperature range, represented by the minimum, maximum and optimal. That expected changes in temperature over the next 30-50 years will be in the range of 2-3 ° C .That daily minimum temperatures will rise more fast than daily maximum temperatures this leading to the increase in the daily average temperatures and a greater probability of thermal stress events and these changes could have detrimental effects on growing and yield of trees. The major impact of HT was during the vegetative growth stage by caused leaves drought and in all cases was significantly reduced the growth by fall down leaves 80−90% from a normal temperature regime Found the summer trees have optimal growth conditions in the temperature range 21-29 ° C . A thermal death thresh hold is reached 45° C . As a general rule ,each temperature stop , beginning at 1° C and continuing to 11,25,35,45 and 54° C.Each allow doubling of respiration and water loss. Gross photosynthesis generally doubles up to 35° C and then rapidly fall-off figure(1).



Figure(1) Explain effect of temperature changes on photosynthesis (Ps) and respiration (Rs)

Found in this study the kind of degraded trees as follows;. Excessive degraded trees(A) ; Pomegranate, Grape, Aromas tree, Common figs, Peach, Apricot, Balsam, Bitter orange, Sweet cherry , Black thorn. Low degraded (B); King Mandarin, Grapefruit, Kumquats, Eureka lemon, Blood orange, Sweet orange. Lime,Bitterorange,Tangelo,Keylime,Orange.Nondegraded(C);Nectarine,Quince,Eucalyptus, Apple , Persimmon , Castor , Date palm, Wallace Mulberry, Olive .Conclusion that physiological changes resulting from high temperature rise, the higher of temperature causes higher the rate of transpiration than the absorption rate leading to severe shortage of water content of tissues, which also leads to the drought of leaves, temperature rising leads to disturbances in cellular food transitions by increasing the rate of catabolism than the rate of metabolism, the trees becomes eventually damage, high temperature leads to damage in cellular structure as well as the composition of the organs in the cell also has a deterioration in the function of the plasma membranes and also a change in gene expression, biochemical changes resulting from thermal stress. The variances in the degradation infected between trees due to thermal stress can be explained by the differences between trees in the absorption of nutrient elements in quantity and quality from the soil and their translocation to the leaves for the purpose of photosynthesis, where each element receives the thermal optical photons through the leaves by a different amount from the other this depending on the quality and quantity of the element in the cellular solution of leaves. We noticed all trees in shadow and in opposite side of sun not influenced, this indicates that the direct thermal radiation impacted on the vegetative growth of trees. High temperature effects are increased the physiological process photosynthesis, respiration, transpiration, evaporation-transpiration ,effects on vegetative growth, and their negative effects on vegetative growth where happen drought and fall down the leaves, which table(3) clears the thermal stress on trees types .

Table(3)Explain degradation degree of trees due to thermal stress in Mosul city.

English name	Scientific name	Family	Degradation degree
Pomegranate	*Tunica granatum*	*Lythraceae*	A
Grape	Vitis vinifera	Vitidaceae	A
Aromas tree	*Vachellia aroma*	*Fabaceae*	A
Common Fig	*Ficus carica*	*Moraceaea*	A
Peach	*Prunus persica*	*Rosaceae*	A
Apricot	*Prunus armeniaca*	*Rosaceae*	A
Loquat	Eriobotrya japonica،	*Rosaceae*	A
Sweet cherry	*Prunus avium*	*Rosaceae*	A
Blackthorn	*Prunus spinosas*	*Rosaceae*	A
Mandarin orange	*Ctrus reticulata*	*Rutaceae*	B
Grapefruit	*Citrus paradisi*	*Rutaceae*	B
Kumquats	*Citrus japonica*	*Rutaceae*	B
Lime	*Citrus aurantiifolia*	*Rutaceae*	B
Eureka lemon	*Citrus limon*	*Rutaceae*	B
Blood orange	*Prunus domestics*	*Rosaceae*	B
Sweet orange	*Citrus sinensis*	*Rutaceae*	B
Citron	*Citrus medica*	*Rutaceae*	B
Bitter orange	*Citrus aurantinum*	*Rutaceae*	B
Tangelo	*Citrus tangelo*	*Rutaceae*	B
Key lime	*Ctrus aurantifoli*	*Rutaceae*	B
Nectarine	*Prunus **persica***	*Rosaceae*	C
Quince	*Cydonia ablonga*	*Rosaceae*	C
Eucalyptus	*Eucalyptus olbigua*	*Myrtaceae*	C
Apple	*Malus pumila*	*Rosaceae*	C
Persimmon	*Diospyros kaki*	*Ebenaceae*	C
Castor bean	*Ricinus communis*	*Euphorbiaceae*	C
Date palm	*Phoenix dactylifera*	*Arecaceae*	C
Myrtle	*Myrtus communis*	*Myrtaceae*	C
Mulberry	*Morus alba*	*Moraceae*	C
Olive	Olea europaea	*Oleaceae*	C
walnut	*Juglans regia*	*juglandaceae*	C
Oleander	*Nerium oleander*	*Apocyanceae*	C

Therefore ,the differences between trees to resistance heat loads revolve around enzyme capability and membrane validity. The strength enzymes and membranes can be protected from heat impacts, the most effective the tree will be in dealing with great heat loads. Preservation of enzyme systems in trees are impacted by pH, levels of solute in cells, protein concentrations, and protection mechanisms. The ability of the tree to continue functioning demonstrates the mechanisms of tolerance, which are mostly genetically controlled, although all individual usually has a large range of responses to thermal stress. Internal changes within the living tree as heat loading impacts increase as follows ; Decrease in photosynthesis (Ps) and increase in respiration (Rs). Closing down of Ps (turn-over point for Ps and Rs = 35° C). Closed stomata stop CO2 capture and nutriment production. More slowing of transpiration (loss of heat dissipation, increase of internal temperature, and transportation / absorption problems). Increasing cell membrane damage. Continued physical water loss and dehydration. Cell division and expansion inhibited, growth regulation disrupted. Tree starvation through rapid use of nutriment reserves, inefficient nutriment use, increased photo-respiration, and inability to call on reserves when and where needed. Toxins generated (cell membrane releases and respiration problems) and deficiencies of elements and metabolites occur. Membrane integrity loss and protein breakdown. Local cell death, tissue lesions, and tissue death.

RECOMMENDATIONS

For the purpose of protecting trees from heat stress in the summer we recommend following ;Spraying the trees for the period between15 July to 15August with water for reducing the effects of heat stress, planting of severe degradation trees and low degradation behind non degraded trees to protect them from heat stress, when establishing the orchard must consider the cultivation of tolerant green belts to protective the trees from thermal stress. Constructing the plantation of the trees in the residential area to protect them from thermal stress. Below the procedures process for protecting trees from heat waves:

.Partial shading to reduce total incoming radiation but not filter photosynthetically active radiation.

. Watering, sprinkling, and misting for improved water supply, reduction of tissue temperature, and lessening of the water vapor pressure deficit.

. Reflection and dissipation of radiation heat using colorants and surface treatments around landscapes and on trees.

. Block or channel adverted heat away from trees and soils.

. Use of low-density, organic, surface covers, mulches or composted materials which minimize water loss, do not add to heat loading on-site, and do not prevent oxygen movement to roots.

. Cessation of any nitrogen fertilizer applications in or around trees, and resumption only after full leaf expansion in the next growing season.

. Prevent or minimize any soil active / osmotically active soil additions which increase salt index or utilize soil water for dilution or activation.

. Be cautious of pesticide applications (active ingredients, carriers, wetting agents, and surface adherence) performance under hot temperatures and with damaged trees.

. Minimize green-wood pruning (trade-offs between wounding responses, transpiration loads, and food storage reserve availability).

. Utilization of well-designed and constructed active shade structures in the landscape like arbors and trellises.

. Establish better tree-literate design and maintenance practices which deal with heat problems and monitor other stresses. (treat causes not symptoms!).

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