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Effects on Plant Morphology of drought in olive

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Abstract

In recent years, with the increasing effect of global warming, the impact of drought on plants has been also increasing. The effects of drought degree vary according to species and varieties of plants. The olive tree is one of the least damaged plants from drought. While all the other plants are faced with heavy damage by drought in a much shorter period, olive tree, relatively more resistant, can protect itself by activating internal defence mechanisms against drought stress. Although olive trees are partly drought-resistant, with drought constantly, when it can't find the water, demand of the olive tree, it is unavoidable to effect as physiological and morphological from drought. As a result, the development of the olive trees and the product quality is negatively affected. In this study, the morphological responses in the face of drought of olive were examined.

Keywords: Olive, drought, plant morphology

Kuraklığın Zeytinde Bitki Morfolojisi Üzerine Etkileri

Özet

Küresel ısınmanın etkilerini artırdığı son yıllarda, kuraklığın bitkiler üzerindeki etkileri de artmaktadır. Kuraklığın etki derecesi bitkinin tür ve çeşidine göre farklılık göstermektedir. Zeytin ağacı kuraklıklardan en az zarar gören bitkilerden biridir. Diğer tüm bitkiler kuraklık ve susuzluktan çok daha kısa sürede ağır tahribata uğrarken, göreceli olarak daha dayanıklı olan zeytin, kuraklık stresine karşı içsel savunma mekanizmalarını kısa sürede etkinleştirerek kendini koruyabilmektedir. Zeytin bitkisi kısmen kuraklığa dayanıklı olsa da sürekli seyreden kuraklıkla birlikte, ihtiyacı olan suyu karşılayamadığında fizyolojik ve morfolojik olarak kuraklıktan etkilenmesi kaçınılmaz olmakta ve sonuç olarak zeytin ağacının gelişimi ve ürün kalitesi de olumsuz etkilenmektedir. Bu çalışmada zeytinin kuraklık karşısında gösterdiği morfolojik tepkiler incelenmiştir.

Anahtar Kelimeler: Zeytin, kuraklık, bitki morfolojisi

Introductıon

Although olive's internal defence mechanism is very effective, this mechanism is effective for plants that grow in their natural environment. In modern culture, effectiveness of internal defence mechanisms decreases. In addition, "olive does not want water" belief which belongs to period of more abundant and regular rainfall, in a similar manner, in products like figs that are subject to traditional farming, is one of the biggest barriers to be overcome now. If the olive does not find the necessary water during periods that it needs, it will be in trouble in a certain period, as a result growth delay, the quality and yield loss will show. Some of these negativities causing loss of yield and quality in plant can be listed as reduction of flower bud formation and fruit set, increase in alternate, depending on the decrease in cell division, reduction of fruit size and the oil content even quality. The water needs of olive tree and effects of water stress on the growth period are seen in Table 1.

Olive has been widely grown around the Mediterranean Basin for around 5000 years. In this area where rainfall is low or variable, productivity and survival of this long-lived evergreen tree depend on physiological characteristics but also on management. Olive tree controls water loss by transpiration effectively and can also withstand intense internal water deficit. Critical aspects of management that maintain, albeit limited, transpiration and metabolic activity during hot dry summer months, are directed at both crop and understorey. Strategic decisions are selection of cultivar, tree density, and canopy size, together with surface management as tilled soil or as cover crop of selected species. Tactical adjustments are seen in extra pruning of olives and timing of tillage, or of grazing, mowing, or herbicides to restrict growth and water use of the understorey, especially following dry winters and during dry summers (Connor, 2005).

Table 1. The effects of water stress on the development stages of the olive tree (Beede and Goldhamer, 1994; Fereres, 1995)

Phenological event	Period	Effect of water stress
Shoot growth	Late winter-early summer	Shoot growth decreases.
flower bud formation	February-April	Flower bud is reduced.
blooming	April-May	Abortive flowers occur.
Fruit set	May-June	Fruit set is reduced, periodicity increases.
ruit growth	June-July	Cell division decreases, fruit volume becomes smaller.
Fruit enlargement	August-harvest	Cell elongation is reduced, smaller fruits occur.
Fat accumulation	September-harvest	Fruit oil ratio decreases.

There is no irrigation at 85% of the olive fields on the World. 1000-2000 kg / ha yield loss occurs in these non-irrigted areas and olive growing generally depends on rainfall (Touzani, 2001).

Some morphological changes in olive trees under drought conditions

In olive cultivation depending on rainfall, as well as the amount of annual rainfall, rainfall distribution is also important in the process of vegetation. Although olive is one of the most tolerant fruit species to drought and it uses water in the soil more effective than the others, if drought continues longer, some problems depending on water stress occur (Xiloyannis, C., Dichio et al., 1999).

When plants meet drought conditions, they take functional measures to reduce the loss of water by transpiration and to protect appropriate water content in tissues. Plants provide this case changing their physiological and morphological structure.

If plant leaf surface area is large, the loss of water increases from the plant. During drought, plant may response to water stress by reducing leaf area, curling and in some cases by shedding their leaves. Even short-term dry periods may cause slow development of the leaves.

The increase of the leaf surface area of plants increases water loss. Slowdown, stopping, of leaf growth or shedding of leaves occurring in water deficiency in the plant have been considered as an adaptation mechanisms developed by plant to reduce transpiration of the plant against water deficits (Smart and Coombe, 1983).

Bacelar et al. (2004), in their study, investigated morphological changes of five olive cultivars leaves grown under drought conditions. Researchers have reported that genotypes grown in temperate regions generally tend to form smaller leaves than ones in arid regions. In their study, they have found that Blanquita (7.69 cm^2) variety has the largest leaf while Arbequina (3.51cm^2) has the smallest leaf and Cobranços (4.54 cm^2), Negrinha (5.14 cm^2) and Manzanilla (4.41 cm^2) take place among these varieties.

Aktepe Tangu (2012) has determined reduction in leaf area of varieties in parallel the decline in leaf water potential. Linear decline in Gemlik, Ayvalık, Kilis varieties was quite significant except Domat. In this study, Domat was found to have the largest leaves.

During the drought stress, decolourization is seen in leaves because leaves lose their chlorophyll and leaves change their connection angle to the branch to make easy reflection. Decolourization in Domat and Ayvalık varieties under drought stress is seen in figure 1.

With restricted water stress, changes depending on varieties in the morphology of olive leaves are observed. Different varieties respond to stress in different ways. Under the drought and restricted water stress, as a response to the situation, leaf area decreases to reduce the effect of sunlight, (figure 3) and shrinkage of connection angle of leaves to the branch and curling of the leaves are seen. As a response to restricted water stress, curling in leaves of Gemlik olive variety watered at 25% of field capacity in figure 2, reduced in leaf area determined in Ayvalık variety in Figure 3 and the status of connection angles on the branches observed the field capacity level (a), in 50% of field capacity (b) and 25% of field capacity (c) in Figure 4 is shown (Aktepe Tangu, 2012).

Dichio et al., (2002), have determined in 'Corotina' olive variety, that the root and leaf dry weight ratio of non-irrigated plants is bigger than that of irrigated plants. In the study, researchers emphasized that crown growth in plants irrigated increased much more than those of non-irrigated plants, not only root growth but crown growth, in response to water deficit, is substantially reduced and as a result, larger root / shoot ratio is caused.

Figure 1. Decolourization in leaves of Domat (left) and Ayvalik varieties (right) under restricted water stress

Figure 2. Curling in the leaves of the olive tree under drought and restricted water stress Gemlik variety)

Figure 3. Reduction occurring in leaf area in Ayvalik variety under restricted water stress

While leaf palisade mesophyll tissues develop well under drought stress, spongy mesophyll tissues grow weak. Intercellular spaces in the leaves decrease.

Figure 4. The status of the connection angles of leaves on shoots in plant irrigated at field capacity (a), 50% of field capacity (b) and 25% of field capacity (c) in Ayvalik variety.

Figure 5. Development of plants irrigated at field capacity (left), 50% (middle) and 25% (right) of field capacity in Domat olive variety

The effects of drought on several major morphological and anatomical features of leaves were investigated in an attempt to explain the origin of the difference in drought resistance between two olive (*Olea europaea* L.) cultivars, ('Chemlali' and 'Meski') previously demonstrated to be drought-resistant and drought-sensitive, respectively. In the present study, cultivar-dependent differences in leaf morphoanatomical adaptations to drought stress were found. When subjected to water stress, the leaves of 'Chemlali' increased the thickness of their upper palisade and spongy parenchyma by 17% and 22%, respectively, compared with only 9% and 13% in the case of 'Meski'. Stomatal density in 'Chemlali' leaves increased by 25% (*vs.* 7% for 'Meski' leaves) during drought treatment. Other morpho-structural traits implicated in the control of water loss were enhanced more in 'Chemlali' than in 'Meski' leaves. Under conditions of lower water availability, leaf size decreased by 24% in 'Chemlali' (*vs.* 15% in 'Meski'), trichome density increased by 25% (while remaining unchanged in 'Meski'), and the thickness of the upper and lower epidermis increased by 32% and 25%, respectively (while remaining unchanged in 'Meski'). The above morpho-anatomical adaptations should improve the water-use efficiency of the tree. These differential changes in leaf morphology and anatomy can explain, at least in part, the difference in drought resistance between the two cultivars. In particular, the upper palisade parenchyma, the spongy parenchyma, stomatal density, and trichome density could be considered key structural features of leaves that govern the ability of a tree to withstand water stress. They could therefore be used as criteria to select olive cultivars that are more resistant to drought (Ennajeh, et al., 2010).

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