

# Evaluation of Leaf Properties of Eight Cherry Cultivars Grafted onto Maxma 14 Rootstock

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## Abstract

The study was conducted in order to assess the leaf properties of different sweet cherry varieties grafted onto MaxMa 14 rootstock. The experiment was arranged in a randomized plot desing with three replicates of five plants per replication. The soil analyses showed that the soil properties of experiment site were found as moderate alkaline, low amount of organic material, N, P, Zn and Mn. The soil characteristics may be sub-optimum for cherry growing. According to our results, Kordia had the highest SPAD value (37.86) among the cultivars. Samba, Regina, Kordia and 0900 Ziraat cultivars had the highest anthocyanin contents. The highest stomatal conductance was in 0900 Ziraat cv followed by Sweetheart. Samba had greater leaf area (53.25 cm<sup>2</sup>) compared to other cultivars. The highest LRWC was obtained with Lorry Bloom. Epicuticular was content of Regina leaves was higher among the cultivars. The results of the present study provide useful informations about how the cherry scions grafted onto MaxMa 14 response to environmental challenges in nature. The identified leaf properties are valuable targets for physiological studies related with environmental stresses.

**Keywords:** cherry, leaf properties, MaxMa 14, scion, variety

## 1. Introduction

Sweet cherry (*Prunus avium* L.) is one of the most economically important fruit worldwide

growing in temperate climate zones. Sweet cherry production in world increased from 1.9 to 2.32 million tons over the last 16 years (Blando and Oomah, 2019). Establishing a cherry orchard represents a 20-25-year economic value. Cultivar and rootstock selections are pivotal factors affecting orchard profitability. Several different rootstocks are used in cherry orchards. This is mainly due to the environmental stress factors adversely affect plant growth. Many studies reveal that the use of stress tolerant rootstocks can help scion to survive under stress conditions (Aras and Eşitken, 2018, 2019b; Li et al., 2019). Scions are also important due to affecting stress tolerance, fruit quality and yield and consequently, the property of economy. Therefore, the choice of a cultivar by growers is other important key decision in the economy of the region.

Canopy of cultivars affects light distribution and consequently photosynthesis. Tree vigor depending on scion-rootstock interactions influences fruit yield, precocity and tree management costs (Lordan *et al.*, 2017). In addition, scion-rootstock interactions modify the tolerance to many environmental stresses. Plant leaves can be used as an indicator of stress damage (Wahome *et al.*, 2001) and also affect photosynthesis (Wu *et al.*, 2019). Increase in photosynthesis leads to improve in fruit yield and quality. Many physiological and biochemical responses occur in the leaves during vegetation. Leaves reflect plant status under different environmental conditions. Chlorophyll content of the leaves is key component of the photosynthesis (Mehta *et al.*, 2010). Leaf water content is also a determiner of photosynthesis (Garriga *et al.* 2015). The epicuticular wax other important leaf characteristic is an effective barrier to water loss. Moreover, the waxes repel bacterial and fungal pathogens and prevent excess UV radiation (Jenks *et al.*, 1994; Krauss *et al.*, 1997). In a previous study, two plum cultivars budded on some rootstocks were evaluated under Mediterranean conditions. Many leaf properties such as chlorophyll and leaf mineral content changed depending on cultivar and rootstock interaction (Reig *et al.*, 2018). Nikolopoulos *et al.* (2002) stated that alterations in leaf anatomy and morphology of cherry contribute to photosynthetic capacity. Furthermore, it has been reported that morpho-anatomy, chemical composition, gas exchange and water status of sweet cherry leaves varied under different growth habits such as open and dense canopy conditions (Gonçalves *et al.*, 2008).

To improve adaptability to environmental challenges, different cultivars can be used. Most of the studies evaluated the rootstock ability to environmental conditions, however few studies offer the choice of cultivar. The main objective of this study was to evaluate some leaf properties of eight of the most popular sweet cherries grafted onto MaxMa 14 rootstock.

## **2. Materials and Methods**

### *2.1 Plant material, Site Description and Experimental Design*

The study was carried out during two growing season of 2018-2019 at the Yozgat Bozok University Experiment Orchard. Six year old sweet cherry cultivars Samba, Regina, Kordia, Karina, Early Lory, 0900 Ziraat, Sweetheart and Lorry Bloom grafted onto MaxMa 14 rootstock were compared. The rootstock was chosen because it is semi-dwarfing (Moreno *et al.*, 2001) and common rootstock for sweet cherry in Turkey. Starks Gold was planted in the orchard as pollinator. The experiment was arranged in a randomized plot design with three replicates of five

plants per replication. Tree spacing was 4m x 5m. Trees were irrigated through drip lines as needed. Average annual precipitation for the region was 554 mm. Tree training was based on encouraging development of the leader. Soil properties are shown in Table 1.

Table 1. Soil properties of experiment site (Balcı and Yakupoğlu, 2018)

Property	Amount	Property	Amount
pH	7.91	Ca, $\mu\text{g g}^{-1}$	7561
Salt, %	0.021	Mg, $\mu\text{g g}^{-1}$	167
CaCO <sub>3</sub> , %	5.36	Fe, $\mu\text{g g}^{-1}$	2.05
Organic material, %	0.99	Cu, $\mu\text{g g}^{-1}$	0.42
Total N, %	0.05	Zn, $\mu\text{g g}^{-1}$	0.29
P, $\mu\text{g g}^{-1}$	5.76	Mn, $\mu\text{g g}^{-1}$	4.44
K, $\mu\text{g g}^{-1}$	215		

## 2.2 Leaf Properties

Relative chlorophyll value (SPAD) was measured with a Minolta SPAD-502 chlorophyll meter (Minolta Camera Co, Ltd, Osaka, Japan). Relative anthocyanin content of the leaves was measured with an Anthocyanin Content Meter (ACM-200 plus). Stomatal conductivity and leaf temperature were measured with a leaf porometer (Li-COR). Measurement of leaf area was performed with a leaf area meter.

Leaf relative water content (LRWC) was determined by the procedure of Smart and Bingham (1974). Fresh weights (FW) of leaves were determined and then leaves were placed in distilled water to rehydrate. After 5 hours, turgid weights (TW) were determined. Afterward, leaves were oven-dried and dry weights (DW) were determined. LRWC was calculated using the equation as:

$$\text{LRWC (\%)} = [(\text{FW}-\text{DW})/(\text{TW}-\text{DW})] \times 100$$

To determine epicuticular wax content, total leaf area of leaf samples was determined with a leaf area meter and the leaves were weighed. Wax removal was done by dipping 50 leaves in chloroform (CHCl<sub>3</sub>) for 30 s. After removing the wax, leaves were weighed and total wax concentration calculated on a leaf area basis ( $\mu\text{g}/\text{cm}^2$ ) (Alcerito *et al.*, 2002).

SPSS software (20.0) was used to perform the statistical analyses. Average of the data belonging two consecutive years was analyzed. Significance was determined at the 5% level by the Duncan's test.

### 3. Results

Leaf properties were significantly affected by cultivar. Table 2 and 3 represents the mean value of the leaf properties affected by MaxMa 14 rootstock evaluated in the current work over two years (2018-2019).

Kordia had the highest SPAD value (37.86) among the cultivars. Samba, Regina, Kordia and 0900 Ziraat cultivars had the highest anthocyanin contents. Stomatal conductance varied from 106.56 to 168.96  $\text{mmol m}^{-2} \text{s}^{-1}$  and the highest value was in 0900 Ziraat cv followed by Sweetheart. Leaf temperature was not significantly different among cultivars.

Table 2. SPAD, anthocyanin, stomatal conductance and leaf temperature values of cultivars

Cultivars	SPAD	Anthocyanin	Stomatal conductance ( $\text{mmol m}^{-2} \text{s}^{-1}$ )	Leaf temperature (°C)
Samba	35.63 abc	4.90 a	145.83 ab	30.06 <sup>NS</sup>
Regina	33.53 bcd	4.90 a	135.10 ab	30.36
Kordia	37.86 a	4.63 a	117.33 ab	31.40
Karina	30.23 e	4.00 b	125.06 ab	28.76
Early Lory	32.50 de	3.73 b	106.56 b	30.10
0900 Ziraat	35.93 ab	4.70 a	168.96 a	31.50
Sweetheart	33.03 cd	4.00 b	160.46 a	31.46
Lorry Bloom	30.33 e	3.83 b	151.93 ab	31.70

Means separation within the columns and line by Duncan's multiple range test ( $P < 0.05$ ).  
NS-Non-Significant

Samba had greater leaf area ( $53.25 \text{ cm}^2$ ) compared to other cultivars. The highest LRWC was obtained with Lorry Bloom. Epicuticular was content of Regina leaves was higher among the cultivars (Table 3).

Table 3. Leaf area, LRWC and epicuticular wax content values of cultivars

Cultivars	Leaf area (cm <sup>2</sup> )	LRWC (%)	Epicuticular wax content (µg/cm <sup>2</sup> )
Samba	53.25 a	80.27 b	434.29 ab
Regina	36.46 b	79.48 bc	556.61 a
Kordia	39.00 b	76.68 bc	479.17 ab
Karina	41.95 b	79.24 bc	431.38 ab
Early Lory	34.96 b	75.74 c	283.54 b
0900 Ziraat	39.08 b	76.73 bc	402.34 ab
Sweetheart	36.50 b	77.48 bc	299.47 b
Lorry Bloom	36.96 b	84.28 a	456.48 ab

Means separation within the columns and line by Duncan's multiple range test ( $P < 0.05$ ). NS-Non-Significant

#### 4. Discussion

Plants are exposed to many environmental challenges such as drought, low temperature and salinity. In the current study we corroborated the leaf properties of six-year old sweet cherry cultivars grafted onto MaxMa 14 rootstock. Leaves reflect plant status under different environment conditions. Therefore, we measured and compared many properties of leaves in order to determine the status of sweet cherry plants in temperate zone. Moreover, the soil analyses showed that the soil properties of experiment site were found as moderate alkaline, low amount of organic material, N, P, Zn and Mn. The soil characteristics may be sub-optimum for cherry growing.

SPAD value indicates relative chlorophyll content and chlorophyll takes central role in the photosynthesis. Chlorophyll reduction due to the environmental stresses has been stated for several species (Aras and Eşitken, 2019a, b; Civelek and Yıldırım, 2019). Kordia had the highest SPAD value observed as more greenness of leaves among varieties while Karina and Lorry Bloom had the lowest value. Reig et al. (2018) evaluated two plum cultivars under Mediterranean conditions and SPAD value of the cultivars grafted onto two different rootstock ranged from 30.9 to 34.2. Anthocyanins, as well as chlorophyll, are pigments responsible in photosynthesis and red coloration of leaves. Plants accumulate anthocyanins as an adaptive response to capture more light (Gould *et al.* 1995). Moreover, anthocyanins can protect plants from stress factors (Gitelson *et al.*, 2001). In our experiment Samba, Regina,

Kordia and 0900 Ziraat had higher anthocyanin content.

Stomata take a pivotal role in the CO<sub>2</sub> and O<sub>2</sub> exchange and regulate leaf water status (Arbona *et al.*, 2005). Lower stomatal conductance represents decrease in photosynthesis related with gas exchange and indicates avoiding water loss through stomatal closure. This phenomenon is likely related to less leaf transpiration via stomata. Many experiments demonstrated that plants close stomatal gaps in order to decrease water loss under stresses (García-Legaz *et al.*, 2008; Aras and Eşitken, 2018). 0900 Ziraat and Sweetheart tended to have higher stomatal conductance. In a study of Gonçalves *et al.* (2008), stomatal conductances of Burlat, Summit and Van sweet cherry cultivars grafted onto Edabriz were 119, 157 and 176 mmol m<sup>-2</sup> s<sup>-1</sup>, respectively.

Leaf, a plant part, captures solar energy for photosynthesis. Therefore, plant productivity depends on the leaf area (Turner and Begg, 1981). Plants adjust leaf size as an adaptive mechanism to drought conditions (Liu and Stützel, 2004). Thus, leaf area depends on the environmental conditions. In our work, Samba had higher leaf area compared to other cultivars. In other work, it was found leaf area of Burlat, Summit and Van sweet cherry cultivars ranged from 52.6 to 75.7 cm<sup>2</sup> (Gonçalves *et al.*, 2008).

Leaf water content influences photosynthesis and plants exhibit some protective ways to avoid water loss. Stomata closure and epicuticular wax formation are defense mechanisms to save water in the leaves against environmental challenges. In the current study in Early Lory had the lowest LRWC, while this variety had the lowest stomatal conductance. Decrease in LRWC despite stomatal closure may be due to possessing lower epicuticular waxes on the leaf surface. Leaves contain wax layer in epicuticula. Environmental conditions affect epicuticular wax content (Maiti *et al.*, 2016). Epicuticular wax reduces radiation and cuticular transpiration as an adaptation to stress conditions (Mohammadian *et al.*, 2007). Many studies showed that epicuticular wax decreases water loss from leaves and thus contribute drought tolerance (Figueiredo *et al.*, 2015; Medeiros *et al.*, 2017). We determined wax content of eight cherry cultivars and Regina had the highest wax content while the lowest values were found in Early Lorry and Sweetheart. Furthermore, Early Lorry and Sweetheart had lower LRWC among the cultivars that may be a result of low epicuticular wax content.

## 5. Conclusion

We determined the leaf properties of the different sweet cherry varieties grafted onto MaxMa 14 rootstock under sub-optimum soil characteristics. The results of the present study provide useful information about how the cherry scions grafted onto MaxMa 14 response to environmental challenges in nature. The choice of an appropriate scion is an effective way to overwhelm environmental stresses. The findings of this study could be beneficial for plant physiologists working on abiotic stresses. In terms of stomatal conductance, Early Lory adapted well under the soil and climate conditions. Under drought and water limited conditions, Early Lory should be recommend to growers due to lower stomatal conductance as an adaptive mechanism to environmental challenges.

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