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Araştırma Makalesi

Effect of Berry Heterogeneity and Water Deficit in Organic and Conventional Vineyards on Grape Berry Characteristics[¥]

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ABSTRACT

In a two-part experiment, the first parcel is certified organic vineyard and, consisting of Cabernet Sauvignon cv. vines grafted onto the 1103P rootstock. The second parcel is conventional vineyard, with cv. Cabernet Sauvignon vines grafted onto the 5BB rootstock. Using Split-Plot Design based on stress levels, the experiment is set up with three repetitions, with two main plots representing Organic and Conventional vineyard, each split into two sub-plots. Predawn leaf water potential values were measured, and vines with values below -0.8 MPa and above -0.8 MPa were grouped into Dryland-Shallow Soil and Bottomland-Deep Soil, respectively, based on soil type (six groups, namely Control, Stress 1, and Stress 2). Berry characteristics were studied during harvest, and berries were classified into four groups based on their diameter (10mm-12mm, 12mm-14mm, 14mm-16mm, 16mm-18mm). The results showed that the 10mm-12mm berry size group had the desired berry characteristics, Dryland-Shallow Soil produced smaller berries, and Stress 2 increased berry skin area and berry skin area/berry volume values.

Keywords: Cabernet Sauvignon cv., Organic viticulture, Heterogeneity, Grape quality

Organik ve Konvansiyonel Bağda Tane Heterojenitesinin Tane Özelliklerine Etkisi

ÖZ

İki parselden oluşan denemede; birinci parsel organik tarım sertifikalı ve Cabernet Sauvignon/1103P aşı kombinasyonuna sahip omcalardan oluşmuştur. Diğer parselde konvansiyonel yetiştiricilik yapılmaktadır ve bu parselde Cabernet Sauvignon/5BB aşı kombinasyonundaki omcalar bulunmaktadır. Stres düzeylerine göre Bölünmüş Parseller Deneme Desenine göre 3 tekerrürlü olarak kurulmuş olan deneme, Organik ve Konvansiyonel olmak üzere iki ana ve ikişer alt parsele ayrılmıştır. Şafak öncesi yaprak su potansiyeli değerleri; -0,8 MPa'dan düşük olan ve -0,8 MPa'dan büyük olan omcalar belirlenip arazi ve toprak tipine göre Kıraç Arazi-Yüzlek Toprak ve Taban Arazi-Derin Toprak olarak gruplanmıştır. Her bir arazi tipinde; Kontrol, Stres 1, Stres 2 düzeyi olmak üzere altı ayrı grup vardır. Hasatta tane özellikleri incelenmiş ve taneleri çaplarına göre 4 ayrı grup oluşturulmuştur (10mm-12mm, 12mm-14mm, 14mm-16mm). Sonuç olarak; 10mm-12mm tane boyut grubunun istenilen tane özelliklerini taşıdığı, KAYT Kıraç Arazi-Yüzlek Toprak grubunun küçük taneler verdiği ve Stres 2'nin tane kabuk alanı ve tane kabuk alanı/tane eti hacmi değerlerini yükselttiği belirlenmiştir.

Anahtar kelimeler: Cabernet Sauvignon, organik bağcılık, heterojenite, üzüm kalitesi.

INTRODUCTION

Since the beginning of the 21st century, the conversion rate of existing conventional vineyards to organic vineyards has significantly increased. The certified organic vineyard area increased by an average of 13% per year, while the non-organic vineyard area decreased by 0.4% during the same period. This development can be largely attributed to social issues related to consumer health and environmental protection (OIV, 2021). The goal of organic wine production is to cultivate high-quality grapes with minimal inputs and to minimize residue levels in grapes (Pedneault and Provost, 2016).

The development, yield, and grape berry composition of grapevines are influenced by various terroir factors, with the most important being climate and soil (Fayolle et al., 2019) and nutrient requirements. The main finding of the studies is that the quality of red wine grapes is generally associated with mild water stress (Brillante et al., 2016).

Water scarcity is endangering grape production and quality worldwide (Miras-Avalos and Araujo, 2021). Quality decline has been observed in vineyards associated with water stress and high temperatures resulting from climate change (Keller et al., 2023), posing serious threats in wine-producing regions and worsening scenarios of water scarcity (Aris et al., 2022). However, the proper use of water scarcity can be an effective tool in improving berry composition at harvest (Basile et al., 2022).

As known, the interaction between the scion and rootstock and mineral nutrition also affects the tolerance to abiotic stresses such as limestone, salinity, and drought (Keller, 2015). In vineyards, due to the increasing drought, the selection of rootstocks with high water use efficiency, growth capacity, and adaptation with the scions is an important strategy (Bianchi et al., 2020). Since rootstocks affect nutrient uptake from the soil, grapevine development, vegetation period length, and yield (Mijowska et al., 2017), suitable rootstocks for the climate and soil of the region should be selected when establishing a vineyard (Ferlito et al., 2020). On the other hand, the presence of drought-tolerant rootstocks can eliminate the need for irrigation arising from global warming (Tramontini et al., 2013). Kowalczyk et al. (2022) determined that the yield was not affected by the rootstocks they used, including 5BB. In their study examining 10 different rootstocks, Porro et al. (2022) obtained the highest yield from grafts of Sauvignon Blanc onto 1103P and 5BB rootstocks. Mehofer et al. (2021) determined that grafting Roesler variety scions onto 3 different rootstocks did not alter bud break and flowering dates. It was observed that the 1103P rootstock induced stomatal closure to reduce water loss during drought periods and increased water uptake, and it formed a wider and deeper root system than the 101-14Mgt rootstock (Alsina et al., 2011). Similarly, Bianchi et al. (2023) also demonstrated that the 1103P rootstock quickly sensed water limitation and rapidly coped with stress through avoidance strategy.

Grape quality is dependent on the size of the berry at harvest, as well as the ratio of skin area to berry volume, but the water status of the vine also influences berry size (Ojeda et al., 2002). Regular deficit irrigation (RDI) has been shown to improve berry quality by increasing the ratio of skin area to berry volume (Cáceres-Mella et al., 2018). However, Cooley et al. (2017) found that, RDI treatment resulted in smaller berries with a larger exocarp to mesocarp ratio, and a decrease in seed weight, but did not alter yield. Echeverria et al. (2017) reported that in cv. Tannat, shallow soil and low access to water increased grape quality due to decreased yield and slower vegetative growth. Buesa et al. (2017) suggested that continuously applying limited irrigation could be a suitable option, considering the negative effects of restricted irrigation that persisted for more than three seasons. Calderon-Orellana et al. (2019) found that exposure of grapes to post-harvest water stress did not affect berry mass. Kontoudakis et al. (2011) stated that the heterogeneity of grape berries has a significant impact on grape composition and quality, and that water stress leads to a decrease in grape size and an increase in tannin content, resulting in improved grape quality. Gil et al. (2015) separated Cabernet-Sauvignon cv. grape berries into three groups (large, medium, and small) and found that the weight of 100 berries in the control group was lower than that of the medium group. Chen et al. (2018) separated harvested cv. Cabernet-Sauvignon grape berries into three groups (large, medium, and small) based on berry mass. They observed that more than 50% of the medium-sized grape berries accounted for the majority of the grapes, and that smaller berries were more dense and mature. Melo et al. (2015) classified grape berries according to their diameter into small, medium, and large. They found that the number of small berries was greater than that of large berries. Additionally, they determined that the physical properties of the berries (mass, volume, and skin area) increased proportionally with berry size in both years.

The purpose of this study is to group grapes harvested at different leaf water potentials based on high water stress conditions experienced in organic and conventional vineyards over many years, and to determine the effect of grape berry heterogeneity on grape berry properties.

MATERIAL and METHODS

Site Properties

The study was conducted with cv. Cabernet-Sauvignon grapevines in two different vineyard parcels, one organic and one conventional, in Tekirdag province. The first parcel consisted of Cabernet-Sauvignon/1103P grafted combination vines, located between 41°02'20.74" K and 27°48'41.90" D coordinates at an altitude of 130 m in a certified organic vineyard. The vines were planted in 2006 with a spacing of 2 x 2.5 m in the N-S direction, with a VSP trellis system and a slope of 18%. The second parcel of the experiment is located at coordinates 40° 55' 50.23" N and 27° 25' 19.16" E, and at an elevation of 200 m, consisting of Cabernet Sauvignon cv. grafted onto the 5BB rootstocks. The vineyard was planted in 1993, 5 km away from the sea, with a row spacing and vine spacing of 1.5 x 2.5 m, and trained with a double-armed Cordon Royat system.

Methods

The experiment was conducted in a Split-plot Design, with two land-soil types (Dryland-Shallow Soil and Bottomland-Deep Soil) and three different stress levels (Control, S1 and S2), with three replications and two rootstocks in each replication. Based on the results of pre-dawn leaf water potential (Ψ_{pd}) measurements, grapevines with Ψ_{pd} values below -0.8 MPa and above -0.8 MPa were selected and grouped as "Dryland-Shallow Soil" (DLSS) and "Bottomland-Deep Soil" (BLDS) based on the soil type. Within the DLSS and BLDS groups, there were six subgroups: Control, Stress 1, and Stress 2. Three replicates were conducted for each subgroup, with two grapevines per replicate and four grape clusters per vine. The grape clusters were sorted according to their size, which were classified into four groups: 10-12 mm, 12-14 mm, 14-16 mm, 16-18 mm (Figure 1).

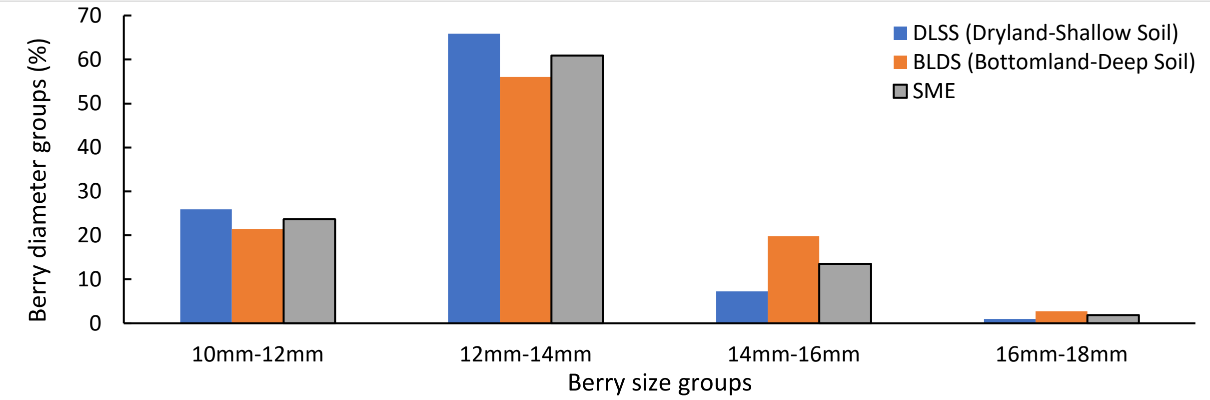

Figure 1. The grape size groups according to soil type.

Morphological characteristics

Climatic data and phenological development stages were determined in order to identify the effects of the applied treatments on vegetative growth, yield and quality (Lorenz et al., 1995). Leaf water potential (Ψ_{leaf}, -MPa) was measured with a Scholander Pressure Chamber. Predawn measurements were made using pure nitrogen gas between 03:00-05:00 in the predawn (Ψ_{leaf}) (Acevedo-Opazo et al., 2013; Levin et al. 2019). At harvest, berry width and berry length (mm), berry fresh mass and dry mass (g), and berry volume were measured (OIV, 2009). The values of 100-berry mass measured with a sensitive digital scale. Dry mass %=Berry dry mass/Berry volume x 100 was obtained from the formula. Berry volume (cm^3) was determined by the formula $4/3\pi r^3$. Depending on the calculated radius, berry skin area (cm^2) was calculated using the formula $4\pi r^2$ (Barbagallo et al., 2011). The calculated berry skin area (cm^2) was compared to the berry volume (cm^3) and given as a coefficient. Grape berry density (g cm^{-3})=Berry mass/berry volume was calculated (OIV, 2009). In addition, yield per decare (kg da^{-1}) was determined.

Statistical Analysis

The obtained data were analyzed using the MSTAT-C statistical program, and LSD test (%1 and %5) was applied to reveal the differences.

RESULTS and DISCUSSION

Climatical Data and Phenological Development Stages

During the vegetation period, 16 mm of rainfall occurred from veraison to harvest. The average temperature was 25.2°C and the average relative humidity was 71.5%. Winkler Index calculated as 2235 degree-days (TMM, 2018) (Figure 2). Phenological development dates for organic and conventional vineyard were recorded as April 15 budburst (EL 14). In organic vineyard May 25 flowering (EL 23), July 24 veraison (EL 35), and August 31 harvest (EL 38). In conventional vineyard, flowering on May 28 (EL 23), veraison on July 26 (EL 35), and harvest on September 17, 2018 (EL 38), after maturity analysis following veraison (Lorenz et al., 1995).

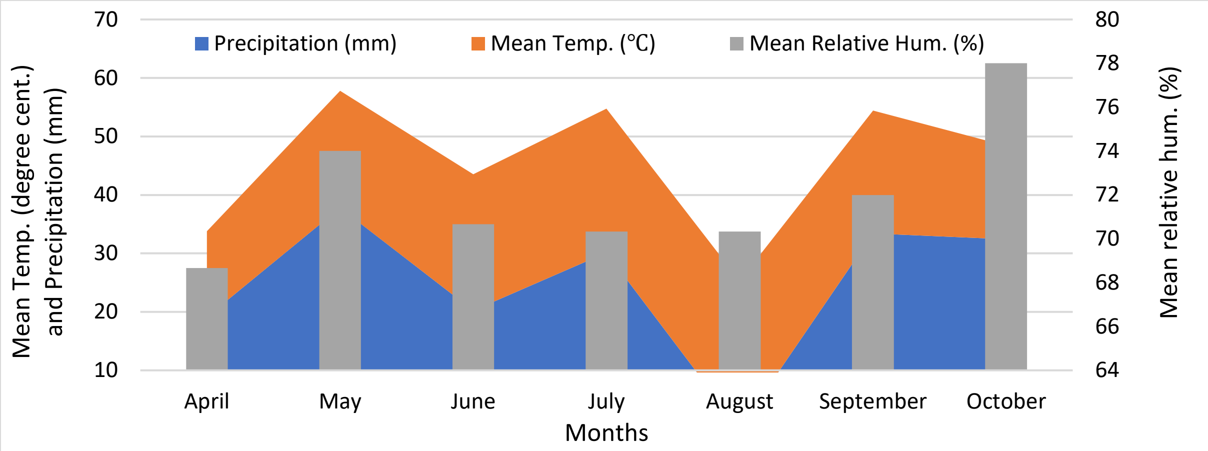

Figure 2. Some climatical data

Predawn leaf water potential (Ψ_{pd}) (-MPa)

DLSS clusters at the lowest Stress 1 level had an average Ψ_{pd} of -0.77 MPa, -1.22 MPa at Stress 2 level, and -0.92 MPa at Control level. The Ψ_{pd} of BLDS clusters was recorded as -0.29 MPa in Control, -0.77 MPa at Stress 1 level, and -0.92 MPa at Stress 2 level. According to Carbonneau (1998) and Deloire and Rogiers (2015), the DLSS x Control interaction had high stress with a value of -0.92 MPa, while the DLSS x Stress 1 interaction had severe-high stress with a value of -0.77 MPa, and the DLSS x Stress 2 interaction had high stress with a value of -1.28 MPa. As stated by Brillante et al. (2016), leaf water potential values increase when there is significant lateral and vertical variability in the soil that contributes to the vine's water uptake during the midday, when transpiration is high and tension in the plant is low, which is consistent with the high values for DLSS x Stress 2 interaction. For BLDS, the values for the interactions were -0.29 MPa for BLDS x Control, -0.77 MPa for BLDS x Stress 1, and -0.92 MPa for BLDS x Stress 2, indicating low-medium stress, severe-high stress, and high stress, respectively (Figure 3).

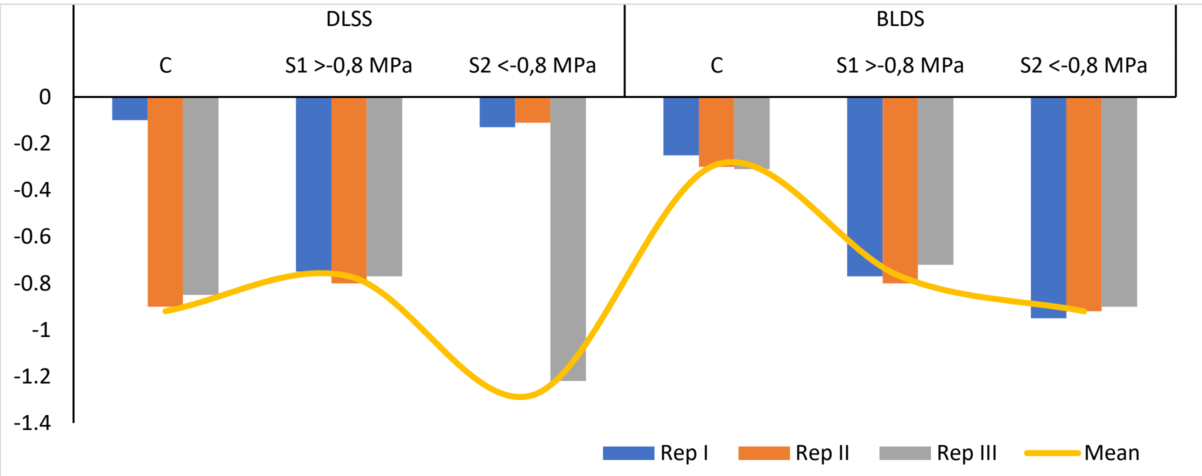

Figure 3. Leaf water potential (Ψ_{pd}) in terms of location-soil types and stress levels (-MPa).

Berry width (mm)

The group with berry width according to SME (Size Main Effect) values ranging from 10mm-12mm had a value of 11.07 mm, which formed the first important group. In terms of STME (Stress Main Effect), the berry width values were found to vary between Stress 1 (11.73 mm) and Stress 2 (12.69 mm). The berry width of Cabernet-Sauvignon cv. is classified as narrow (8mm-13 mm) according to OIV (2009) and assigned a code of 5. Ojeda et al. (2002) reported a decrease in berry size in vines subjected to post-veraison water deficit (-1.2 MPa) compared to those subjected to a mild deficit (-0.6 MPa) due to differences in predawn leaf water potential (Ψ_{pd}). The results are not consistent with the findings of previous researchers, and this inconsistency is thought to have been caused by terroir differences.

Berry lenght (mm)

In terms of SME, the 10mm-12mm size group formed the first importance group with the lowest berry lenght value (11.35 mm), and the 14-16 mm size group (13.94 mm) formed the highest berry lenght value. According to STME, Control formed the first importance group with a lenght of 12.52 mm, Stress 1 formed the second importance group with a size of 12.90 mm, and Stress 2 formed the third importance group with a lenght of 12.78 mm. The berry size of Cabernet Sauvignon cv. has been classified as narrow (8mm-13mm) according to OIV (2009) and given a code of 3. Ojeda et al. (2002) reported a decrease in berry size in grapevines subjected to post-veraison water deficit (-1.2 MPa) compared to those subjected to moderate water Stress (-0.6 MPa), but this result was not consistent with the findings of other researchers, which may have been due to terroir differences.

Berry fresh mass (g)

The 14mm-16mm berry size (1.86 g) was the most significant group for SME. The 12mm-14mm berry size (1.50 g) was in the second group, and the 10mm-12mm berry size (1.00 g) was in the last group. Regarding STME, the Stress 1 level (1.51 g) was in the first group, the Stress 2 level (1.48 g) was in the second group, and the Control level (1.40 g) was in the last group (Table 1). The results are similar to Calderon-Orellana et al. (2019) in that an increase in water stress after veraison did not affect berry mass, and to Nadal (2010) in that there was lower berry mass on hilltops. However, it is not consistent with the finding of Ojeda et al. (2002) that post-veraison water deficiency (-1.2 MPa) resulted in a decrease in berry mass, which is thought to be due to field conditions.

Table 1. Changes in berry fresh mass according to location and soil type and stress levels.

Location and Stress		Berry Size			LME, STME, and Location x Stress int.
		10mm-12mm	12mm-14mm	14mm-16mm	
DLSS		1.03	1.52	1.82	1.46
BLDS		0.97	1.48	1.90	1.45
Control		1.01	1.49	1.70	1.40 c
Stress 1		1.01	1.59	1.93	1.51 a
Stress 2		0.99	1.52	1.94	1.48 b
DLSS	Control	1.06	1.44	1.58	1.36
	Stress 1	1.05	1.57	1.92	1.51
	Stress 2	0.99	1.54	1.96	1.50
BLDS	Control	0.96	1.36	1.82	1.47
	Stress 1	0.97	1.61	1.95	1.51
	Stress 2	1.00	1.49	1.92	1.47
SME		1.00 C	1.50 B	1.86 A	

STME LSD %5 = 0.1133532
SME LSD %1 = 0.1521826

Berry dry mass (g)

When SME was examined, the 10mm-12mm berry size group (0.25 g) was the most important group, followed by the 14mm-16mm group (0.38 g) as the second and the 12mm-14mm (0.46 g) as the least important group. Bahar et al. (2017) reported that the highest berry dry mass value was between -0.7 MPa and -0.3 MPa, the second highest value was between -0.7 MPa and below, and the lowest value was between -0.3 MPa and -0.5 MPa, which was consistent with the results (Table 2).

Berry volume (cm^3)

According to SME, it was determined that the 10-12mm size had a berry volume value of 0.92 cm^3 in the last significant group, the 12-14mm size had a berry volume value of 1.38 cm^3 in the second important group, and the 14-16mm group had a berry volume value of 1.77 cm^3 in the first important group. The result was found to be in the same direction as the grouping of Gil et al. (2015). As a result, berry size was found to be directly proportional to berry volume.

Table 2. Changes in berry dry mass according to location and soil type and stress levels.

Location and Stress		Berry Size			LME, STME, and Location x Stress int.
		10mm-12mm	12mm-14mm	14mm-16mm	
DLSS		0.25	0.38	0.45	0.37
BLDS		0.24	0.36	0.46	0.36
Control		0.26	0.35	0.42	0.35
Stress 1		0.25	0.40	0.49	0.38
Stress 2		0.25	0.36	0.47	0.36
DLSS	Control	0.28	0.39	0.41	0.36
	Stress 1	0.26	0.41	0.51	0.40
	Stress 2	0.23	0.36	0.45	0.35
BLDS	Control	0.25	0.33	0.44	0.34
	Stress 1	0.24	0.39	0.48	0.37
	Stress 2	0.25	0.38	0.49	0.37
SME		0.25 a	0.37 b	0.46 c	

SME LSD %1 = 4.067252E-02

Mass of 100 berries (g)

In SME, the first important group was the 14-16mm size with a value of 180.60 g, the second important group was the 12-14mm size with a value of 147.49 g, and the third important group was the 10-12mm size with a value of 98.90 g. The mass of 100 berries obtained by Gil et al. (2015) for Cabernet Sauvignon cv., was found to be similar. It was also found to be similar to the result obtained by Blouin and Guimberteau (2000), who indicated that the average mass of 100 berries was 138 g.

Dry mass %

According to STME, the first important group was Control (25.57) and Stress 1 (25.27), and the second important group was Stress 2 (24.28). On the other hand, when Location x Stress interactions were examined, the first important group was DLSS x Control interaction (26.53) (Table 3). Bahar et al. (2017) reported that the highest dry mass % based on LWP conditions was obtained at stress levels of -0.3 MPa to -0.7 MPa. They also found that when predawn YSP dropped below -0.7 MPa, it had a reducing effect on the dry mass %, and the lowest dry mass % was observed at YSP levels between -0.5 and -0.3 MPa, which was in agreement with the results.

Table 3. Change in dry mass % by location and soil type and stress levels.

Location and Stress		Berry Size			LME, STME, and Location x Stress int.
		10mm-12mm	12mm-14mm	14mm-16mm	
DLSS		25.01	25.28	25.25	25.18
BLDS		25.16	24.83	24.70	24.90
Control		26.06	25.59	25.05	25.57 a
Stress 1		24.89	25.25	25.68	25.27 a
Stress 2		24.32	24.31	24.21	24.28 b
DLSS	Control	26.67	26.75	26.17	26.53 A
	Stress 1	25.11	26.02	26.66	25.93 AB
	Stress 2	23.26	23.06	22.91	23.08 C
BLDS	Control	25.44	24.43	23.93	24.60 BC
	Stress 1	24.66	24.49	24.70	24.61 BC
	Stress 2	25.38	25.56	25.50	25.48 AB
SME		25.08	25.05	24.98	

STME LSD %5 = 0.8777689
Location x Stress int. LSD %1 = 1.666581

Berry skin area (cm²)

With respect to berry skin area, the 14mm-16mm (5.54 cm²) and 12mm-14mm (5.13 cm²) berry size groups were in the first importance group. The last one was 10mm-12mm berry size group (3.39 cm²). Gil et al. (2015) obtained similar values to these research findings when they calculated the skin area per gram of berry. The conclusion that water stress during maturity has an increasing effect on skin area, reported by Matthews and Nuzzo (2007), was also obtained from this research.

Berry skin area to berry volume ($cm^2\ cm^{-3}$) (BSA/BV)

The 10mm-12mm group (4.30 $cm^2\ cm^{-3}$) was the first importance group, the 12mm-14mm group (3.75 $cm^2\ cm^{-3}$) was the second importance group, and the 14mm-16mm group was the last importance group (3.13 $cm^2\ cm^{-3}$) (Table 4). The findings were in agreement with those of Melo et al. (2015), who reported that as berry size increased, the BSA/BV ratio decreased.

Table 4. Changes in BSA/BV according to location and soil type and stress levels.

Location and Stress		Berry Size			LME, STME, and Location x Stress int.
		10mm-12mm	12mm-14mm	14mm-16mm	
DLSS		4.27	3.80	3.06	3.71
BLDS		4.35	3.70	3.21	3.75
Control		4.28	3.98	3.05	3.73
Stress 1		4.26	3.70	2.90	3.61
Stress 2		4.49	3.58	3.45	3.85
DLSS	Control	4.05	4.01	2.90	3.65
	Stress 1	4.27	3.77	2.82	3.62
	Stress 2	4.50	3.62	3.45	3.86
BLDS	Control	4.31	3.92	3.19	3.80
	Stress 1	4.24	3.63	2.99	3.62
	Stress 2	4.88	3.54	3.45	3.83
SME		4.30 a	3.75 b	3.13 c	

SME LSD %1 = 0.4026373

Berry density ($g\ cm^{-3}$)

In the study, location, size and stress and their interactions did not have a statistically significant effect on berry density. The finding reported by Lafontaine et al. (2013) that decreasing berry size may have an increasing effect on berry density is consistent with DLSS but not consistent with BLDS.

Yield per decare ($kg\ da^{-1}$)

In terms of STME values, the Control (1187.53 $kg\ da^{-1}$) was the first important group for yield, followed by Stress 1 (657.08 $kg\ da^{-1}$) as the second important group, and Stress 2 (457.36 $kg\ da^{-1}$) as the least important group (Table 5). When examining the interactions, the BLDS x Control interaction was the most important group with 1465.92 $kg\ da^{-1}$, followed by the BLDS x Stress 2 (536.42 $kg\ da^{-1}$) and DLSS x Stress 1 (526.12 $kg\ da^{-1}$) interactions in the least important group. Regarding LME, BLDS had the highest value of 930.13 $kg\ da^{-1}$, while DLSS was in the least important group. The study is consistent with the finding of Nadal (2010). The results also parallel the finding that vines that are not irrigated and are under severe stress have the lowest yield per vine (Carbonneau, 1998; Deloire et al., 2004; Deloire and Heyns, 2011). This indicates that the use of soil water by plants depends on the level of water stress they are under (Brillante et al., 2016).

Table 5. Changes in yield per decare according to stress levels and soil types.

Location	Stress Levels			LME
	Control	Stress 1	Stress 2	
DLSS	909.14 *b*	526.12 *d*	378.31 *e*	604.52 b
BLDS	1465.92 *a*	788.05 *c*	536.42 *d*	930.13 a
STME	1187.53 A	657.08 B	457.36 C	

STME LSD %1= 68.73231

Location x Stress int. LSD %1 = 97.20215

CONCLUSION

When examining berry characteristics in terms of the LME, it was determined that the DLSS properties had a slightly improving effect on berry characteristics compared to BLDS. When examining berry characteristics in terms of the SME, there were no significant differences in terms of numerical values among the stress groups. However, it was determined that Stress 2 had the highest values for BSA and BSA/BV, were desirable for quality in red wine grape varieties.

In terms of dry mass % criteria, the Control (25.57) and Stress 1 (25.27) were in the same group. The dry mass % of the berry comes from the berry flesh, berry skin, and seed (Barbagallo et al., 2011). In wine grape varieties, especially in red ones, small berries are proportional to wine quality (Chen et al., 2018). When examined in terms of size, the 10mm-12mm group was found to be superior in terms of berry width, berry length, BSA/BV, and berry density. The BSA/BV ratio is due to the change in the amount of skin with grape size. Small grape seeds provide more soluble material per berry volume and berry skin area because they have a higher skin-to-flesh ratio (Chen et al., 2018). Only high values were obtained from the BSA and berry density parameters in the 12mm-14mm size group. The 14mm-16mm size group had higher values in terms of berry mass and berry dry mass, mass of 100 berries, berry volume, and BSA as expected compared to other size groups. Based on all of these evaluations, it was determined that the morphological characteristics of grape berries vary depending on their size. In addition, as berry size decreases, berry mass decreases depending on stress level, while berry dry mass and dry weight % increase. Therefore, it was determined that the 10mm-12mm size group generally meets the desired criteria for all of the studied parameters.

As a result, to obtain high-quality grapes from the Cabernet Sauvignon cv. in Tekirdag province, cultivation should be carried out in Dryland-Shallow Soil conditions where leaf water potential (Ψ_{pd}) can drop to -0.8 MPa during the predawn period between the veraison and ripening stages. Furthermore, sorting based on berry size and using berries with a size between 10mm-12mm may be appropriate.

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