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Effect of Shading Cover on some Quality Properties of 'Bidaneh Sefid' and 'Bidaneh Ghermez' Grapes

20.1001.1.27170632.1401.15.3.1.9 **Research Article**

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Abstract

One protected horticultural method against biotic and abiotic stresses is shading covers. Using shading cover to reduce the damage of this stress can change the plant's microclimate and, subsequently, the final product's quality. This study aimed to investigate the effects of shading cover on grape quality. The grapevines were subjected to shading cover cloth with green color from March to September for two years. In the first year of the experiment, a shading cover with 50% shade was used for Bidaneh Sefid grape variety, and the result indicated that this percentage of shade reduced the final fruit quality. In the second year of the experiment, 20% shade was used for Bidaneh Sefid and Bidaneh Ghermez varieties. Results showed that this shading percentage improved the physical properties of the fruit, especially in the Bidaneh Sefid variety. Soluble solid content, titratable acid, and vitamin C of both grape varieties were not affected by 20% shade. Like 50% shade, total phenol and antioxidant capacity were decreased by 20% shade in both grape varieties. Further research for different shade percentages on different crops and cultivars in every climate will be necessary to develop shading cover technology for horticulture crops in Iran.

Keywords: Grape, Quality, Shading net, Microclimate, Protected horticulture.

Introduction

Grape (*Vitis vinifera* L.) is an importent fruit crop and one of the most diffuse fruits in the world, both as fresh fruit (table grape) and processed in grape juice, molasses, and raisins (Mullins et al. 1992; Reisch et al. 2012; Meng 2017). It is helpful in hemorrhoids, fighting dyspepsia, and stone in the urinary and bile tract. Grape also eases digestion, activate liver functions, help reduce cholesterol level in the blood and eliminate uric acid. This fruit is also antiviral and disinfectant that aids the nervous system and is useful in processes that demineralize the body, such as pregnancy and nursing (Reisch et al. 2012; Orak. 2007; Giovanelli and Brenna, 2007). Quality, the degree of excellence or superiority of edible horticultural crops, is a combination of properties that give each product value in term of food. To producers, the fruit must have a high yield and pleasing appearance and withstand long-distance transportation to markets. From the point of view of wholesale and retail marketers, appearance, firmness, and shelf-life are important. Consumers prefer fruits that have a good quality appearance, firmness, flavor, and nutrients such as vitamins, minerals, antioxidants, dietary fibers, and many bioactive compounds that enhance human health (Abbott. 1999; Kader. 1999). Maturity indices of fruit are important for deciding when it should be harvested to provide some marketing factors and acceptable eating quality to the consumers. The accumulation of sugars is the most important change in fruit quality in the ripening stage. Sugars give the sweetness desired in fresh or dried fruit and processed products (Mitcham et al. 1996; Hellman. 2004; Kader. 2003). Glucose and fructose are the main sugars of the mature grape berry. The major content of soluble solids in fruit juice is sugars, and therefore sugar content can be estimated by soluble solids content. The acidity level is one of the essential quality properties of table grapes and grape juice. Sugar strongly influences the acceptance of fresh grapes and their processed product to acid balance. More than 90% of the total acids in grapes are tartaric and malic. Both acids accumulate before the ripening onset, and their ratio varies in different cultivars (Giovanelli and Brenna, 2007; Hellman. 2004; Kader. 2003).

During grape ripening, berries lose chlorophyll and synthesize and accumulate phenolic compounds responsible for color development. Phenolic compounds are antioxidants that are naturally in horticultural products. The major phenolic compounds in grapes are tannins, anthocyanins, benzoic acids, cinnamic acids, and flavonols. Anthocyanins cause red and purple in some grape cultivars and are important quality factors in table grapes (Reisch et al. 2012; Giovanelli and Brenna, 2007; Hellman. 2004; Ford. 2007; Du Plessis. 2017; Faheem et al. 2021). Grape is known as an important source of antioxidants. Phenolic composition and other compounds found in fruits and vegetables might influence their antioxidant activities. The imbalance between free radicals and antioxidants is thought to be involved in developing cancers, diabetes, cardiovascular diseases, Alzheimer's disease, and Parkinson's disease. Fruits and vegetables reduce oxidative stress and are effective in preventing these diseases. Different kinds of fruits and varieties of a specific fruit can exhibit different antioxidant capacities (Giovanelli and Brenna, 2007; Mulero et al. 2010; Bunea et al. 2012; Songsermsakul et al. 2013). Vitamin C, known as ascorbic, is one of the crucial

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components of grape berries. This vitamin is an antioxidant that neutralizes free radicals, is required for many physiological functions, and improves protein metabolism and immune system activity (Okonogi et al. 2007; Kok et al. 2017; Liu et al. 2018). One protected horticulture method for cultivating many products is shading covers made from polyethylene, propylene, etc. These structures are used for radiation control, and protection against wind, hail, pest, bird, and insect-transmitted virus diseases (Shahak et al. 2004; Dussi et al. 2005; Costa et al 2010; Amaro de Sales et al. 2021; Mditshwa et al. 2019).

In addition, in hot and cold climates, high and low temperatures may cause many adverse effects on crop growth and quality. This technology improves climate factors (e.g., temperature, humidity, radiation, and wind speed) and can reduce the damages caused by inappropriate temperature and radiation of crops. Reducing irrigation water consumption due to the reduction of evaporation and transpiration is another important advantage of shading cover technology (Shahak et al. 2004; Costa et al 2010). Changes in the microclimate condition of a crop, incredibly light and temperature in different stages of growth and development, can be led to changes in the product's quality characteristics. For example, if the heat requirement of the plant is not met, the ripening of the final product will be affected, or the intensity and quality of light can affect the color and taste of the fruit (Du Plessis. 2017; Paradiso and Proietti, 2022; Tamim et al. 2022). Different shading percentages and cover colors can affect the plant microclimate and fruit quality (Mditshwa et al. 2019; Tamim et al. 2022; Miller et al. 2015).

In areas with high light, including many areas of Iran, the light intensity can lead to disorders in the development and appearance of fruits (Du Plessis. 2017; Paradiso and Proietti, 2022; Tamim et al. 2022). Sunscald injury and uneven ripening are two disorders brought on by the direct effects of light with high intensity on fruit. Sunscald injury of fruit increased with irradiance, air temperature, and their combined effects. In a specific grape cultivar, berries' chemical composition and appearance depend on the environmental condition, growing practices and ripening stages (Ford. 2007; Dokoozlian and Kliewer, 1996; Bergqvist et al. 2001; Chorti et al. 2010).

Little is known about the fruit quality properties of grapevines grown under shading covers developed in Iran. Thus, the objective of this study was to investigate the effect of shading cover on some appearance and physical (color components, weight, size, and firmness) and chemical properties (solid soluble content, titratable acid, vitamin C, total phenol, total anthocyanin, and total antioxidant capacity) of grapefruit (cv. Bidaneh Sefid and Bidaneh Ghermez) in Ghazvin province.

Materials and Methods

This study was carried out for two years (2021 and 2022) in a vineyard in Takestan, Ghazvin, Iran (longitude: 49◦ 31′ 02″ E, latitude: 35◦ 55′ 28″ N, altitude 1387 m) where the shading cover structure was built by Agricultural Research, Education and Extension Organization. The vines were ten years old, two meters apart in three-meter-wide rows, and were trained to bilateral cordon system. The grape vines were subjected to shading cover with green color (Exirsaz Shomal Co Ltd., Iran) from March to September. In the first year of the experiment, the shading cover

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with relative shading of 50% was used for the Bidaneh Sefid table grape (white variety). In the second year, a shading cover with 20% shade cloth was used because of the negative effect of the shading cover with 50% shade on fruit quality. For shading cover of 20%, Bidaneh Ghermez table grape (red variety) was also tested. The distance between the support columns of the covers on the rows and between the rows was 6 and 4 meters, respectively. The height of the structure was 3.3 meters. The clusters were harvested in September when non-shaded grapes were ripened. The t-test was used to compare means of quality properties of non-shaded with shaded the same trees as treatment. T-test was carried out using IBM SPSS Statistics 26 software.

Color and physical properties measurements

Berries color was measured with a Minolta Chroma Meter CR-400 colorimeter (Minolta, Japan). The chromaticity was recorded according to International Commission on Illumination L*, a*, and b* color space coordinates. This color space expresses color as three values: L* for perceptual lightness and a* and b* for the four unique colors of red, green, blue, and yellow (Mitcham et al. 1996). Cluster weight (gr), berry weight (gr), berry length (mm), berry width (mm), and berry firmness were measured as physical properties. Berries firmness was determined with a H5KS (Hounsfield, UK) penetrometer that had a 3.2 mm diameter tip and was expressed in N (Mitcham et al. 1996).

Internal quality parameters measurement

Soluble solid content (SSC) was measured using a digital refractometer DR-A1 (Atago, Japan) and was expressed in °Brix. Titratable acid (TA) was determined by titration of 10 ml sample juice with 0.1 M NaOH to an end point of pH= 8.2 and was expressed in percentage of tartaric acid (Mitcham et al. 1996). The Vitamin C content of samples was measured using the titration method (AOAC. 1980). To this end, vitamin C was extracted with metaphosphoric acid. The filtered extract was then titrated with 2,6-dichlorophenolindophenol which was reduced and changed from blue color to colorless by vitamin C. Vitamin C was expressed in 100 g fresh fruit.

Total phenolic content (TP) was determined using the Folin-Ciocalteu reagent. Briefly, 10 µl of the sample solution was mixed with 100 µL of Folin-Ciocalteu and 1580 µL of water. After a 5 minutes incubation at room temperature, 300 µL of a saturated sodium carbonate solution was added. The absorbance was read at 760 nm using a UV-Vis spectrophotometer after 2 h at room temperature. Gallic acid was used as a standard phenolic compound and the results were expressed as mg of gallic acid equivalent per liter (Raja et al. 2014).

The anthocyanin content (TAC) in the grape extracts was determined by the pH differential method. Absorbance of the samples in 0.025 M potassium chloride buffer (pH= 1.0) and 0.4 M sodium acetate buffer (pH= 4.5) were measured at 520 and 700 nm using the equation 1:

Equation 1 $$A = (A\lambda 520 - A\,\lambda 700)pH\ 1.0 - (A\lambda 520 - A\,\lambda 700)\ pH\ 4.5$$

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With a molar extinction coefficient of 28000. Total anthocyanin was expressed as mg of malvidin-3-Oglucoside equivalent in per 100 g fresh fruit (Wrolstad. 1976). Total anthocyanin was measured only for the Bidaneh Ghermez grape (red variety). The total antioxidant (TAO) activity was determined by the scavenging capacity of 1, 1-diphenyl-2-picrylhydrazyl (DPPH) free radicals. 0.1 mM solution of DPPH in ethanol was prepared. 0.1 ml of various concentrations of the grape extracts diluted in ethanol was added to 2.9 ml of DPPH solution. The absorbance at 517 nm was read after 5 min of incubation at room temperature. Radical scavenging capacity (RSC) was calculated using the equation 2 and was expressed as DPPH radical scavenging percentage (Blois. 1958).

$$\text{DPPH RSC (\%)} = [(Ac-As)/Ac \times 100] \qquad \textbf{Equaion 2}$$

Where Ac and As are the absorbance of the control in ethanol and absorbance of the grape sample, respectively, and DPPH RSC is free radicals scavenging of DPPH.

Results and Discussion

Table 1 shows the results of the t-test to compare firmness and some taste and internal quality traits (SSC, TA, Vit C, TP, and TAO) of Bidaneh Sefid grape that was grown under shading cover with 50% shade and outside the shade. A comparison of means showed a significant difference (*p<0.01*) between shaded and non-shaded fruits in all investigated traits except firmness. The SSC and TA outside the shade were 28.99 °Brix and 0.49%, respectively. Under the shade treatment, SSC was 20.70 °Brix and TA was 0.39%. SSC and TA, as the most important factors involved in fruit taste and ripening, were lower in the shaded grapes than in the non-shaded grapes.

Table 1. Results of t-test to compare some quality properties of the Bidaneh Sefid grape variety under 50% shad with non-shaded treatment.

Property	Statistics and t-test	Treatment	
		Non-shaded	Shaded
F (N)	No.	15	15
	Mean	4.23	4.14
	SD	0.75	0.69
	t	0.33	
	df	28	
	p	0.74	
SSC °Brix	No.	15	15
	Mean	28.99	20.70
	SD	0.39	0.49
	t	51.17	
	df	28	
	p	0.00	

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TA (%)	No.	15	15
	Mean	0.49	0.36
	SD	0.029	0.03
	t	12.61	
	df	28	
	p	0.00	
Vit C (mg/100gr)	No.	15	15
	Mean	29.11	20.88
	SD	1.23	1.28
	t	17.99	
	df	28	
	p	0.00	
TP (mg/L)	No.	15	15
	Mean	357.96	289.72
	SD	33.67	16.81
	t	7.02	
	df	28	
	p	0.00	
DPPH RSC %	No.	15	15
	Mean	78.30	57.60
	SD	0.29	1.23
	t	63	
	df	28	
	p	0.00	

The mean of the TP and Vit C contents, as the main component of grape antioxidant, in shaded grape (289.72 mg/Lit and 20.88 mg/100gr, respectively) were lower than those of non-shaded grape (357.96 mg/Lit and 29.11 mg/100gr, respectively). The same was true for DPPH RSC as TAO (57.60% for non-shaded and 78.30% for shaded treatments). However, no significant difference was observed between the firmness of grapes in the two methods (*$p>0.05$*). Photosynthesis produces carbon-based compounds within the grapevine: the most important include sugars and acids (Jackson. 2000). Light is the main effector in photosynthesis; thus, metabolite accumulation quality largely depends on light intensity and quality (Paradiso and Proietti, 2022; Tamim et al. 2022; Bartoli et al. 2009).

Berry exposure to appropriate light intensity has been found to significantly influence both acid accumulation and degradation of sugar during maturation (Ford. 2007). Results of these studies support findings by Dokoozlian and Kleiwer (1996), Bergqvist et al. (2001), and Chorti et al. (2010), which reported that berries grown in the inappropriate lighting condition through all stages of its development were lower in sugar concentrations compared with those grown in light-exposed (Dokoozlian and Kliewer 1996; Bergqvist et al. 2001; Chorti et al. 2010).

Marais (1996) and Chorti et al. (2010) found that sugar accumulation was slower in shaded grapes than in exposed grapes (Chorti et al. 2010; Marais, 1996). Matus et al. (2009) and Chorti et al. (2010) reported that grape phenolic compounds and antioxidant capacity were drastically reduced following shading treatment (Chorti et al. 2010; Matus et al. 2009). The result of the present research was consistent with the result of their research. Several studies show that environmental conditions during growth and development affect the vitamin C content in fruits (Albertini et al. 2006; Wang et al. 2007). Because of the negative effect of 50% shad on

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grape ripening, the appearance quality traits (weight, size and color) have not been measured and reported. Tables 2 and 3 show the results of appearance traits of weight, size (cluster weight, berry weight, berry length, and berry width), color components (L*, a* and b*), and firmness for Bidaneh Sefid and Bidaneh Ghermez varieties under 20% shade compared to non-shaded. The t-test showed that all weight and size properties of the Bidaneh Sefid variety were affected by shading ($p<0.05$). Cluster weight, berry weight, berry length, and berry width in the shaded treatment with the means of 456.67 gr, 2.01 gr, 16.91 mm, and 12.74 mm, respectively, were more than those of non-shaded grape with the means of 306.15 gr, 1.45 gr, 15.63 mm and 11.16 mm, respectively. Among the color components, a* was affected by shading ($p<0.01$), and shaded grapes were greener than non-shaded grapes. No significant differences were found between the shading and non-shading methods in cluster weight, berry weight, berry width and color components in the Bidaneh Ghermez variety ($p>0.05$) but berry length was significantly higher ($p<0.05$) in shaded treatment (1.67 mm) than in non-shaded (1.44). In shaded treatment, a slight increase in berry width and berry weight and a significant increase in berry length led to an increase in cluster weight. However, the difference between cluster weights in the two methods was insignificant. During the final ripening stage, direct sunlight and unusual winds may cause berry dehydration, loss of berry weight and size and subsequently, loss of cluster weight in the grapevine not protected by shading cover (Chorti et al. 2010). Not being exposed to grapevine to direct sunlight may influence the appearance of grapefruit (Ford. 2007). In this research, the reduction of direct light and other environmental changes caused by the 20% shading has improved some of the appearance properties of both grape varieties. This obtained results for cluster weight, berry weight, and berry size was in agreement with previous studies that indicated little positive effect (Chorti et al. 2010) or no effect (Spayd et al. 2002; Downey et al. 2006; Jeong et al. 2004; Cortell and Kennedy, 2006; Ristic et al. 2007) of shading on fruit cluster weight and berry size.

Table 2. Results of t-test to compare physical properties and color components of the Bidaneh Sefid grape variety under 20% shad with non-shaded treatment.

Property	Statistics and t-test	Treatment	
		Non-shaded	Shaded
Cluster weight (gr)	No.	13	9
	Mean	306.15	456.67
	SD	121.91	201.20
	t	2.19	
	df	20	
	p	0.04	
Berry weight (gr)	No.	20	20
	Mean	1.45	2.01
	SD	0.37	0.42
	t	4.5	
	df	38	
	p	0.00	

Berry length (mm)	No.	20	20
	Mean	15.63	16.91
	SD	1.75	1.53
	t	2.47	
	df	38	
	p	0.02	
Berry width (mm)	No.	20	20
	Mean	11.16	12.74
	SD	1.20	1.06
	t	4.38	
	df	38	
	p	0.00	
L*	No.	20	20
	Mean	49.51	48.84
	SD	4.42	1.58
	t	-0.64	
	df	38	
	p	0.53	
a*	No.	20	20
	Mean	0.6	-4.77
	SD	1.38	1.18
	t	-13.19	
	df	38	
	p	0.00	
b*	No.	20	20
	Mean	29.55	28.67
	SD	2.61	1.28
	t	-1.35	
	df	38	
	p	0.19	
F (N)	No.	10	10
	Mean	4.79	4.45
	SD	0.63	0.58
	t	-1.28	
	df	18	
	p	0.217	

Table 3. Results of t-test to compare physical properties and color components of the Bidaneh Ghermez grape variety under 20% shad with non-shaded treatment.

Property	Statistics and t-test	Treatment	
		Non-shaded	Shaded
Cluster weight (gr)	No.	13	11
	Mean	307.31	353.37
	SD	128.84	171.02
	t	0.75	
	df	22	
	p	0.46	
Berry weight (gr)	No.	20	20
	Mean	1.81	1.94
	SD	0.34	0.36
	t	-1.19	
	df	38	
	p	0.24	
Berry length (mm)	No.	20	20

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	Mean	18.04	16.92
	SD	1.44	1.67
	t	-2.27	
	df	38	
	p	0.03	
Berry width (mm)	No.	20	20
	Mean	11.91	12.00
	SD	0.76	0.91
	t	-0.31	
	df	38	
	p	0.76	
L*	No.	20	20
	Mean	39.51	38.80
	SD	2.49	2.65
	t	-0.87	
	df	38	
	p	0.39	
a*	No.	20	20
	Mean	8.53	8.30
	SD	2.63	2.56
	t	-0.31	
	df	38	
	p	0.76	
b*	No.	20	20
	Mean	12.90	13.62
	SD	2.00	3.06
	t	0.89	
	df	38	
	p	0.38	
F (N)	No.	10	10
	Mean	5.35	5.48
	SD	0.87	0.53
	t	0.42	
	df	18	
	p	0.68	

Tables 4 and 5 show the results of the t-test to compare some taste (SSC and TA) and nutritional properties (SSC, TA, Vit C, TP, TAO and TAC) of Bidaneh Sefid and Bidaneh Ghermez varieties under 20% shade with non-shaded, respectively. Also, results showed no significant differences between SSC, TA, and Vit C in both grape varieties. The reduction of light intensity or other environmental changes caused by the 20% shading did not significantly decrease the sugar, acid, and vitamin C concentration. These results were in agreement with the results of studies that reported no impact of shading on SSC and TA of grapes at the harvest stage (Jeong et al. 2004; Cortell and Kennedy et al. 2006; Ristic et al. 2007; Haselgrove et al. 2000). Like the 50% shade, TP, TAO and TAC (it was measured only for Bidaneh Ghermez variety) under 20% shade treatment were significantly lower than those of non-shaded (*$p<0.01$*). Sunlight and temperature affect the accumulation of some phenolic compounds in grape berries (Downey et al. 2006). Phenols have a high antioxidant capacity (Meng et al. 2017; Kok. 2017), and in the present study, antioxidant capacity is also reduced when they are reduced by shading cover. Light intensity positively affects grape anthocyanin concentration (Dokoozlian and Kliewer, 1996; Bergqvist et al. 2001; Spayd et al. 2002;

Jeong et al. 2004; Haselgrove et al. 2000), and it may be critical for maximum pigment production (Dokoozlian and Kliewer, 1996). The results were consistent with the result of Matus et al. (2009) (Matus et al. 2009).

Table 4. Results of t-test to compare some internal quality properties of the Bidaneh Sefid grape variety under 20% shad with non-shaded treatment.

Property	Statistics and t-test	Treatment	
		Non-shaded	Shaded
SSC °Brix	No.	9	9
	Mean	28.87	28.62
	SD	0.78	0.57
	t	-0.76	
	df	16	
	p	0.46	
TA (%)	No.	9	9
	Mean	0.48	0.47
	SD	0.03	0.04
	t	-0.37	
	df	16	
	p	0.71	
Vit C (mg/100gr)	No.	9	9
	Mean	28.82	27.48
	SD	2.60	2.42
	t	-1.13	
	df	16	
	p	0.27	
TP (mg/L)	No.	9	9
	Mean	392.60	350.52
	SD	5.14	8.41
	t	-12.80	
	df	16	
	p	0.00	
DPPH RSC %	No.	9	9
	Mean	71.30	60.72
	SD	1.56	1.55
	t	-14.42	
	df	16	
	p	0.00	

Table 5. Results of t-test to compare some internal quality properties of the Bidaneh Ghermez grape variety under 20% shade with non-shaded treatment.

Property	Statistics and t-test	Treatment	
		Non-shaded	Shaded
SSC °Brix	No.	9	9
	Mean	28.59	28.64
	SD	0.53	0.48
	t	0.23	
	df	16	
	p	0.82	

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TA (%)	No.	9	9
	Mean	0.31	0.30
	SD	0.03	0.02
	t	-0.38	
	df	16	
	p	0.71	
Vit C (mg/100gr)	No.	9	9
	Mean	21.52	19.20
	SD	1.98	3.25
	t	-1.83	
	df	16	
	p	0.09	
TP (mg/L)	No.	9	9
	Mean	354.27	300.22
	SD	5.38	6.17
	t	-19.79	
	df	16	
	p	00	
TAC (mg/100gr)	No.	9	9
	Mean	0.75	0.31
	SD	0.02	0.01
	t	-49.53	
	df	16	
	p	0.00	
DPPH RSC %	No.	9	9
	Mean	63.10	57.54
	SD	2.98	1.55
	t	-4.97	
	df	16	
	p	0.00	

Conclusion

The quality properties of grapes were affected by shading cover depending on shading percentage. Shading cover with 20% shade improved the weight and size of grapes, and Bidaneh Sefid grapes were greener under shading treatment than non-shading. The results indicated that 20% shade improved grape appearance and physical properties or had no effect on them. Considering annual damage caused by spring frost, hail, sunscald, pest, insect and bird, reduction of irrigation water consumption by using shading cover, and the further research for different shading percentages and colors on different crops and cultivars will be necessary to develop.

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بررسی تأثیر سایبان بر برخی ویژگی‌های کیفی انگور بیدانه سفید و بیدانه قرمز

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صفحه ۱۴-۱

چکیده

یکی از روش‌های محیط‌های کنترل شده در باغبانی در برابر تنش‌های زنده و غیرزنده، استفاده از سایبان‌ها است. استفاده از سایبان برای کاهش آسیب این تنش‌ها می‌تواند باعث تغییر خردقلیم گیاه و در پی آن، کیفیت محصول نهایی شود. هدف از این مطالعه بررسی اثرات سایبان بر کیفیت انگور بود. درختان انگور به مدت دو سال از اسفند تا شهریور در معرض سایبان سبز رنگ قرار گرفتند. در سال اول آزمایش، توری با سایه‌اندازی ۵۰ درصد برای رقم انگور بیدانه سفید استفاده شد و نتایج نشان داد که این درصد سایه باعث کاهش کیفیت نهایی میوه می‌شود. در سال دوم آزمایش از توری با ۲۰ درصد سایه‌اندازی برای ارقام بیدانه سفید و بیدانه قرمز استفاده شد. نتایج نشان داد که سایه‌اندازی ۲۰ درصد باعث بهبود خصوصیات فیزیکی میوه به‌ویژه در انگور رقم بیدانه سفید شد. مواد جامد محلول، اسید قابل تیتر و ویتامین ث هر دو رقم انگور تحت تأثیر سایبان ۲۰ درصد قرار نگرفت. فنل کل و ظرفیت آنتی‌اکسیدانی در سایبان ۲۰ درصد سایه در هر دو رقم انگور کاهش یافت. به‌منظور توسعه فناوری سایبان برای محصولات باغبانی در کشور، تحقیقات بیشتری برای سایبان‌های با درصد سایه‌اندازی مختلف روی محصولات و ارقام مختلف در هر اقلیم ضروری به‌نظر می‌رسد.

واژه‌های کلیدی: انگور، خرداقلیم، کیفیت، کشت‌های حفاظت شده، سایبان.