BUNCH NUMBER AND ANTIOXIDANT ACTIVITY IN 'SAHEBI' AND 'HALAGHO' GRAPES AFFECTED BY PRUNING INTENSITY AND CANE LENGTH

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ABSTRACT

Pruning methods can primarily affect grape production at various levels. Of the commonly affected features by pruning, the number of bunches has known to have a significant effect on the relation between the functions of assimilate sources and sinks. Further, fruitfulness can significantly be negatively influenced by shading. In this study, we aim to study the impact of 4, 6 and 8 buds per cane with pruning intensity as light, moderate and severely pruned and their interaction in the course two consecutive years, 2017 and 2018 in 'Sahebi' and 'Halagho' (both seeded red table grape cultivars). In 2018, lightly pruned 'Halagho' and having 8 buds per cane increased number of bunches by 54.00, which had the highest value. Results showed that there is apical buds bear more fruit by comparison to the buds with vegetative nature, 1 to 4 first buds. Based upon the outcomes of this study, it could be concluded that due to the stresses imposed by the pruning of the vines, therefore, the chemical compounds increases in order alleviate the negative aftermaths. In 2018, whole berry antioxidant activity in both cultivars was significantly lessened, and this decline was higher in 'Saahebi'. The number of bunches was increased by increasing cane length or bud load/cane. Overall, the pruning program has an impactful role in bunch number as well as antioxidant activity and in the long-run on accumulated reserves, which makes choosing and applying a specific pruning method undeniably important. Thus, emphasize the importance of further research in this field.

Keywords: *Bud fertility, fruitfulness, phytochemicals, fruiting unit, nutraceutical compounds*

1. INTRODUCTION

Table grapes are a common and chief source of phytochemical constitutes with positive effects on health (Lutz *et al.*, 2011). Among them, colored ones are known to have the most active with multiple biological effects and potential health benefits. The antioxidants content of red grape (namely, flavonoids, anthocyanins, and tannins) found to have considerable health benefits (Haminiuk *et al.*, 2012). Amongst grapes and even other fruits, red grape, is one of the renown fruits worldwide. However, there are some issues with red grape cultivars, *V. vinifera* L., namely lack of complete differentiation process for flower buds, weak coloration, as well as significant vulnerability to fungal pathogens (Wu *et al.*, 2006). The

intensity of winter pruning has a significant influence on the levels of light in the canopy (Smart *et al.*, 1985). The absence of an appropriate degree of radiation in the clusters in the company of the high crop loads postpones the maturation process and harms the qualitative features. High altitude vineyards specially those in mountain, often located on steep, which is a common form of using those lands and are known to produce distinguishably high-quality grapes (Stanchi *et al.*, 2013).

Viticultural methods that gardners put into practice are essential ways to regulate the plant reaction to the stressors and enhance the number of secondary chemicals, therefore, improving the quality of table grape, since these compounds are much responsible for fruit taste and antioxidant

activity of fruit. Moreover, production control through pruning is a reliable method to enhance grapes quality (Coban and Kara, 2002). The determination of the initial number of shoots and clusters is squarely affected by pruning severity (Smart *et al.*, 1985), and its influences can be traced in the berry chemistry by changes in yield. The qualitative characteristics of berry and level as well as the detailed profile of polyphenolic constituents of grapes, are commonly prone to be influenced by seasonal and weather fluctuation (De Pascali *et al.*, 2014), abiotic and biotic stresses and canopy management (Rusjan *et al.*, 2012).

To acquire a proper level of quality in grape production, having an adequate level of sunlight radiation is pivotal. Although there are some studies published on the antioxidant potential in grapes, the information on antioxidant activity of grape cultivars in Iran is limited. There are few works published on table grapes, whose texture attributes and chemical constituents have an essential role in determining the overall quality, and therefore the market value. Hence, here two red seeded grapevine cultivars grown in west of Iran were studied to evaluate the natural antioxidants in the stage of full ripening to determine the best pruning treatment for the production of grape with the aim of enrichment with antioxidant.

2. MATERIALS AND METHODS

2.1. Site description

The study was conducted in two consecutive growing seasons of 2017 and 2018, in a commercial vineyard located in Sarbarzeh region of Kermanshah province, in west of Iran in which two seeded red table grape cultivars, 'Sahebi' and 'Halagho' chosen from 20 year-old vines with head training at a spacing of 1.5 by 2.5 m in an east-west row orientation in a relatively similar status were considered. The targeted cultivars were originated from hardwood cutting and benefited from the drip irrigation system. In the course of each phenological period, the irrigation applied beside probable precipitation.

2.2 Pruning method

The vines considered as control were 20 years old that yearly, a moderate pruning program applied to them. In this study, our focus was investigating the possible effects of length of canes and severity of pruning. The application of the pruning program was in late - Apr in 2017 and late- Mar in 2018. Pruning intensity treatments

were composed of two types of pruning; lightly pruned

Table 1. Meteorological and pedological situation

Parameters	Indices/Values
Latitude	34° 45' 46" N
Longitude	47° 11' 34" E
Elevation above sea level	1923 m
Soil texture	Loam
Soil/Water EC	0.58 ds m ⁻¹
Soil/Water pH	7.15
Relative humidity	64%
Mean of yearly precipitation	380 mm

of the red seeded grapes vineyard in the experimental orchard in Sarbarzeh region, Kermanshah-Iran

with the formula 40 + 20 and severely pruned with 20 + 20 formula (Ahmedullah and Himelrick, 1989). Then, in the number of buds per cane, substitute cane (two-node spur) were pruned with 2 bud lengths and by randomly with respective treatments: pruning, 4, 6, and 8 buds on the cane and different pruning intensity of light and intensity). To repeat this experiment in 2018, the substitute canes (two-node spur) pruned, and each on a cane, two buds remained untached.

2.3 sampling

Samples were obtained at the berry fully ripe stage, considering the red color appearance. Picking grape bunches was carefully randomized throughout the vines for each cultivar. Vines were well managed, uniform in size, and had no nutrient deficiency or pest damage. Each year, sampling, including two red cultivars, were harvested at their fully ripe. Plants were well managed, uniform in size, and had no nutrient deficiency or pest damage. The grape yield and its components were measured once at harvest time (Delpuech *et al.*, 2015). Total bunches of each vine were separated and counted and were monitored at harvest during late - September in 2017 and 2018.

Fundamental juice composition analyses were performed at Guilan University, Rasht, Iran. Total antiradical capacity was extracted with DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical-scavenging capacity as described by Brand-williams (1995), scavenging capacity was estimated spectrophotometrically at 517 nm (T80+UV/VIS PG Instrument Ltd spectrophotometer). The DPPH solution was

prepared daily and protected from the light. The results were expressed as a percent. Briefly, 50 μ l of grape extracts were mixed with 950 μ l DPPH 0.1 N and kept in the dark for 30 min of reaction at room temperature.

The percentage inhibition of DPPH in the test sample was calculated by Equation 1:

$$\% \text{ Inhibition} = ((A_0 \text{ control} - A \text{ sample}) / \text{control}) \times 100 \quad (\text{Eq. 1})$$

Where A_0 was the beginning absorbance at 515 nm, obtained by measuring the same volume of solvent, and A was the final absorbance of the test sample at 515 nm by UV-Visible spectrophotometer.

2.4 Statistics

The experimental design used was a split-split plot with three replicates. The main factors consisted of time (year) with two levels (2017 and 2018) and grape cultivars with two levels ('Sahebi' and 'Halghoo'). The severity of pruning (light, moderate, and severe) was considered as sub-plot factor and number of buds per cane (4, 6, 8 buds per cane) as sub-sub (or split-split) factors. Analysis of variance was performed using the SAS statistical package (version 9.4; SAS Institute, Cary, NC, USA). Differences among treatments were assessed by Duncan's range test at the level of 1% and 5%.

3. RESULTS AND DISCUSSION:

The bunch number as an essential parameter can be influenced by several factors. In this study, the interaction between factors: years, grape cultivars, pruning severity, and the number of buds per cane showed that when 'Halagho' lightly pruned in 2018 with 8 buds per cane, the number of bunches increased significantly up to 54.00 which had the highest value. Increasing the length of cane significantly increased the cluster number (Table 1). The results in this respect are in accordance with previous studies, Abbas *et al.*, (2008) and Gaser *et al.*, (2017), who displayed that vines with long pruning resulted in a higher number of bunches in comparison with short pruning. Inflorescence primordia are formed by extensive branching of the anlage (Vasconcelos *et al.*, 2009): bud fertility (number of bunches per shoot) and flower number per bunch are closely linked, as primary branching of inflorescences exerts a robust control over the total number of flowers per inflorescence (Dunn and Martin, 2007).

According to Palanichamy *et al.* (2004), among the three pruning treatments viz., 4, 6 and 8 buds per cane retaining uniformly 12 canes per vine in the 'heading system', the maximum number of bunches (36.2 per vine) were obtained with pruning 6 bud treatment. Kohale *et al.* (2013) reported in 'Sharad Seedless' that eight buds/cane level recorded the maximum number of bunches (30.68 per vine), whereas, in six buds/cane and 4 buds/cane, the number of bunches were 29.04 and 27.03, respectively.

Numerous factors are known to affect the formation of flowers. The vegetative and reproductive growth during the current year may interact with the development of flowers for the next year, depending on the timing of floral induction. The alternate-year bearing phenomenon observed on numerous fruit tree species results from endogenous factors involved in this interaction (Wilkie *et al.*, 2008). Other factors are directly linked with weather conditions such as temperature and light. Since the availability of carbohydrates is the determinative factor of flower induction and fruit set (Vasconcelos *et al.*, 2009; Keller, 2015). A training system, along with pruning application, has the most substantial effect on yield due to the source/sink relationship associated with the number of buds retained during pruning (Howell, 2001). Training and pruning systems have a significant impact on yield. This impact is partly attributed to the strong association between cluster numbers per vine and cluster weight, where an increase in cluster count has been linked to a decrease in cluster weight (Gladstone and Dokoozlian, 2003, Reynolds and Heuvel 2009). Since flower buds in grapes are initiated during the previous summer, and fruitfulness of buds is determined prior to the annual pruning, the increased cluster number and plant yield seem to be owing to an increment in flower bud initiation.

Based on the level of intensity in pruning, significant amounts of the stored carbohydrates in dormant wood can be eliminated, which as a result, the shoot development process at the early season slows down. In a study conducted by Bowed and Kliewer (1990) showed that severely pruned vines develop less individual leaves on a whole vine basis in compare to non-severely pruned vines, but leaf numbers per shoot and individual leaf sizes increased. Light pruning method as another part of their study showed that generally increases yield, however, only to some extent where the vines are too large afterward fruitfulness gradually lessens. Further, in this case, the pruning severity is also under question.

The effect of pruning intensity on yield parameters is not always stable from one year to another, as reported in a long-term four-year study carried out by Freeman *et al.* (1979). The fluctuation in results was vivid in which the number of clusters per shoot was had not influenced the number of clusters per shoot in a statistically significant norm (Freeman *et al.*, 1979). In a similar study, clusters per vine almost doubled by lowering the severity of pruning from 10+10 to 50+10 increasing from 67 per vine to 112 per vine (Byrne and Howell, 1978).

The total antioxidant activity is a reliable measure in the evaluation of the effects of a specific pruning program. In this experiment the antioxidant activity affected by different interaction of the factors years, grape cultivars, pruning severity and the number of buds per cane, from which the lightly pruned 'Halaghoo' in 2017 and maintenance of 4 or 8 buds per cane enhanced the total antioxidant activity in the whole berry. Also, values in comparison with control treatment in 2017 were not statistically significantly difference. In other treatments, total antioxidant activity in the whole berry decreased significantly. In 2018, whole berry antioxidant activity in both cultivars was significantly decreased, which this decline was higher in 'Saahebi' compared to 'Halaghoo' (Table 5).

Grapes are long known to be a distinguishable source of antioxidant compounds, such as polyphenols. The polyphenols are able to squarely act as antioxidants or to affect the biosynthesis of other antioxidants constitutes, in the body. (Sato *et al.*, 2000; Wolpert *et al.*, 1980). The natural features of grapes also significantly contribute to their phytochemical potentials, for example, color-skinned grapes aggregate high amount of anthocyanins in their skins, while such ability is absence in white-skinned varieties. In a study, the polyphenol level of black- and red-skinned cultivars were statistically higher than white-skinned cultivars. (Shiraishi *et al.*, 2018).

The correlation between high total phenolic contents and high antioxidant activities has been reported in various grape cultivars (Meyer *et al.*, 1997). The present study reveals a strong correlation between total antioxidant activity and total phenolics ($R^2 = 0.9829$, $p < 0.05$). Kanner *et al.* (1994) found a correspondence pattern between the antioxidant activity of grape varieties and the concentration of phenolics in a number of different systems.

The variation in antioxidant activity of

various parts of berry has been well-documented, in which Xu *et al.* (2010) conducted a comparative study on that the antioxidant profiles of 18 Chinese grape cultivars with to European grapes and Muscadine grapes. Among them, *V. vinifera* "Cabernet Sauvignon" and Muscadine grapes had the highest amount of phenolic compounds and antioxidant properties in seed, while the Oriental *Vitis* species "Black Pearl" and "Sangye" were found to be the richest in phenolic contents in the skin. Variations in the number of growing fruits not only have a direct effect on yield but may have undesirable effects on the size and quality of harvested organs (Kliwer and Dokoozlian, 2005). The effects of training systems on grape quality were investigated in relation to a particular training system since it affects the light interception (Smart, 1984) and the microclimate inside the canopy and around the clusters (Gladstone and Dokoozlian, 2003). Pruning method can be useful on other phytochemicals such as anthocyanin level, for instance, Zonouri *et al.* (2019) reported that severity of pruning significantly increased the anthocyanin of berry majorly due to imposing a stress condition as result of intense pruning.

4. CONCLUSIONS:

Obviously, numerous studies are required to unmask the underlining patterns affected by pruning procedure and influences the qualitative characteristics of the grape. To fill the information gape in this case, the impact of pruning severity was evaluated on two Iranian red grape cultivars 'Saahebi' and 'Halaghoo'. Which lightly pruning method in 'Halaghoo' happened to have the highest number of bunches in the second year. While the same cultivar due to experiencing stress conditions in the first year even under lightly pruned conditions had highest amount of antioxidant activity. The practical knowledge that this study provides could be applied by viticulturists in order to have suitable and optimized pruning program. However, there a lot more need to be discovered, specially the effect of similar pruning procedure on chemical profile of grapes at the biosynthetic level or establishing long-term experiments to find behavioral patterns.

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