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Bunch Load Changes Berry Quality, Yield and Raisin Recovery in Thompson Seedless Grapes

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A B S T R A C T

An experiment on effect of bunch load on berry quality, yield, raisin recovery and biochemical parameters in Thompson Seedless grapes grafted on 110-R rootstock was carried out in ICAR National Research Centre for Grapes, Pune during 2015-16. The crop load was adjusted to 50, 75, 100 and 125 bunches per vine. Increase in number of bunches/vine reduced the leaf area index. Highest LAI (1.24) was observed in treatment with 50 bunches/vine. The treatment also observed highest shoot length (68.65 cm), shoot diameter (7.85 mm), inter nodal length (5.74 mm), bunch weight (316.59 g), berry length (21.20 mm) and 50-berry weight (144.2 g). However, with an increase in bunch load per vine reduction in total soluble solids (19.2 ^{o} Brix) was observed in treatment with 125 bunches/vine. Similarly an increase in yield/vine of 28.25kg and raisin recovery of 27.10% was recorded in same treatment. Significant differences were recorded for biochemical parameters of raisin obtained from different bunch load. Thus it was observed that though with an increase in bunch load, yield and raisin recovery increases but for production of quality raisins low bunch load should be maintained.

Introduction

Grape (*Vitis vinifera* L.) is one of the major important commercial fruit crops grown in the country. India produces 2.68 million tons of grapes from an area of 0.135 million hectare (Anonymous, 2017). In India, nearly 22.5% grapes are dried for raisin production. Maharashtra is a leading state in area and production of the crop. In the state, raisin production is the second most important business after table grapes for export. The quality of raisin in national and international market depends on the size of the raisins, uniformity in colour, texture of skin and the presence of foreign matter (Thakur *et al.*, 2010). In general practice for vineyards meant for raisin production use of growth regulators for increase in berry size is not recommended as application of these regulators deteriorates the eating quality of raisins. Due to non-application of growth regulators berry size remains small leading to reduction in recovery and quality. To produce quality raisins with internationally and nationally acceptable quality careful balance of source sink ratio i.e. vegetative growth and number of bunches to retain in vine is required (Somkuwar and Ramteke, 2006).

Cultural practices viz., nutrient, irrigation and canopy management practices plays an important role in producing good quality raisin. Physical parameters such as (berry size, berry colour, nature of waxy cuticles) and chemical parameters (moisture content, sugar content and acidity) of berry at harvest influences quality of dried grapes (Sharma *et al.*, 2013).The growers try to exploit vines to the maximum extent by retaining more number of bunches per unit area on the vine leading to poor quality grapes (Somkuwar and Ramteke, 2006). Bunch load/vine plays an important role in producing quality raisin with higher raisin recovery. In view of above discussion an experiment was conducted to study the effect of bunch load on yield, quality and raisin recovery in Thompson Seedless grapes grafted on 110-R rootstock.

Materials and Methods

The study was carried out during 2015-2016at an experimental farm of ICAR-National Research Centre for Grapes, Pune, Maharashtra (18.32 °N, 73.51 °E). The bunch load level of Thompson Seedless was controlled immediately after berry set by cluster thinning to 50, 75, 100 and 125 bunches/vine respectively. The experiment was laid out in randomized block design with four treatments of bunch load. Each treatment was replicated five times. In each replication, vines spaced at 10 X 6 feet distance were tagged. All the vines received uniform cultural practices during the season. The observations on vegetative growth parameters were recorded at 90 days after fruit pruning. The shoot length was measured by measuring tape whereas inter nodal length and shoot diameter were measured using digital Vernier caliper (0-300 mm, RSK™) at 90 days after fruit pruning. Leaf area was measured using portable leaf area meter (model CI- 203 leaf area meter, CID, Inc. USA).

The assay of total soluble solids (TSS) and titratable acidity (TA) was done by extracting juice from crushed berries and centrifuged at 5000 rpm for 5 minutes. Readings were taken on Oeno Foss (FTIR based analyzer) for total soluble solids and titratable acidity and expressed in °Brix and g/lit respectively. Dinitrosalicylic acid (DNSA) method was used for the estimation of reducing sugar while, total carbohydrate was determined using Anthrone method with D-glucose as the standard (Sadasivam and Manickam, 1997).

Protein estimation was done as per Lawry *et al.*, (1951) and was expressed in mg g^{-1}. The phenols were determined by Folin-Ciocalteu method as suggested by Singleton (1965) using gallic acid as standard. The concentration of phenols was expressed in mg g^{-1} and starch by Anthrone method using D-glucose as standard. The data recorded on various parameters was tabulated using means of each treatment. The data was analyzed using SAS version 9.3.

Results and Discussion

Effect of bunch load on vegetative growth and yield parameters

It was observed that the shoot length was minimum 61.3 cm in treatment with

125bunches per vine and highest 68.65 cm in treatment with bunch load of 50 bunches per vine. The increased bunch load per vine reduced the shoot length and also the leaf number per shoot (Table 1). The highest leaf area index (LAI) of 1.46 and total leaf area (189.62 cm^2) was recorded in minimum bunch load treatment (50 bunches/vine) while the minimum leaf area index (1.18) was recorded in treatment with 100 bunches per vine.

The increase in shoot vigor was positively correlated with higher leaf area. An increase in leaf area index was observed in treatment with 50 bunches/vine and in case of treatment having more than 50 bunches a reduction in leaf area index was observed. During the development of a bunch, the bunch acts as a sink while the leaf area acts as a source where the photosynthesis occurs. Hence, the leaf area plays an important role in feeding the developing bunches. The increase in the total leaf area might have helped to store more food materials through photosynthesis and transported to sink.

Somkuwar *et al.,* (2013) reported that an increase in leaf area results in high active photosynthesis rate which helps to fulfill the demand of carbohydrate in the sink (the bunch). Similar results were also obtained by Omar *et al.,* (2000) in Thompson Seedless and El Baz *et al.,* (2002) in Crimson Seedless grapevine. Fruit production and shoot growth compete for available carbohydrates. Potential of a vine to produce carbohydrate to meet the demands of fruit production and vegetative growth is based on effective leaf area. Proper crop load is important to achieve maximum yields of highest quality fruit without sacrificing vine capacity. The yield among the different bunch load treatments varied significantly. The highest yield/vine was recorded in 125 bunches (28.25kg) followed by 100 bunches (26.50kg) while the lowest yield was recorded in 50 bunches/vine treatment (15.80 Kg). The results of the present study indicate that the increase in number of bunches/vine increased the total yield/vine.

Effect of bunch load on berry quality and raisin recovery

It was observed that average bunch weight was reduced from 50 bunches/vine (316.59g) to 125 bunches/vine (242.05g) as presented in Table 2. The results of present study revealed that the average bunch weight was reduced significantly with the increase in number of bunches per vine. This result confirms the findings of Dami *et al.,* (2005) who reported that increase in yield of shoot trimmed vine with 50% to 75% cluster thinning increases in cluster weight in Merlot and Cabernet Sauvignon grapevine. The findings of the present study are also is in accordance with the results of Omar and Abdel-kawi (2000) who reported that bunch weight decreased by increasing bud load in Thompson seedless grapes.

Fawzi *et al.,* (2010) also reported that increasing bud load/ vine reduces the average weight of cluster in Crimson Seedless grapes. Significant differences were recorded for 50-berry weight, berry length and berry diameter. The 50-berry weight varied from 144.21g in treatment with minimum bunch load (50 bunches/vine) to 103.68g in treatment with highest bunch load (125 bunches/vine). The decrease in 50-berry weight was found to be associated with increase in number of bunches. The reduction in berry weight might be due to reduced supply of food material from the source to the sink due to increase in competition for the food material among the growing berries. Ashwini *et al.,* (2016) also observed that a negative correlation exists between number of canes and growth of vine and due to the competition between sink and source there is dilution effect which leads to reduce in growth. Several studies reported that an increase in cluster weight is directly correlated with decrease in number of cluster/vine because of subsequent increase in berry weight (Reynolds *et al.,* 1994 and Edson *et al.,* 1993). Significant differences were also recorded for berry length and berry diameter in relation to bunch load treatments. The berry diameter ranged from 15. 6mm in 125 bunches/vine to 17.2mm in 50 bunches/vine. Similar trends were also observed for berry length where minimum berry length of 19.1 mm was observed in 125bunches/vine and maximum berry length 21.2 mm was observed in 50 bunches/vine. The increased berry diameter and berry length contribute to increase in average bunch weight in the present study. Sukhsagar *et al.,* (2016) observed an increase in berry length at crop load of 50 bunches/vine in cultivar Flame Seedless. Noar *et al.,* (2002) reported increase in berry weight due to cluster thinning while working on Sauvignon Blanc grapevine.

Significant differences were recorded for total soluble solids, titratable acidity and pH from the grape juice. Highest total soluble solids were recorded in minimum bunch load treatment of 50 and 75 bunches/vine (22.4°Brix each respectively) while it was lowest (19.20° Brix) in the higher bunch load (125 bunches/vine). In the present study, it was observed that with the increase in cluster per vine, the total soluble solid in berries was decreased. These findings also confirm the results obtained by Dami *et al.,* (2005) who reported increase in soluble solids with cluster thinning in grapevine. Ramteke *et al.,* (2016) also observed a positive correlation between berry diameter and TSS in Manjri Naveen. In our study we also observed a positive correlation between TSS and berry diameter among different treatments. The data recorded on raisin recovery was found to be statistically non-significant within the different treatments of bunch load. However, an increase in raisin recovery was observed where highest recovery of 27% was observed in treatment with 125 bunches/vine and lowest recovery of 25% was observed in 50 bunches/vine.

Effect of bunch load on biochemical parameters

The data recorded on various biochemical parameters are presented in Table 3. Significant differences were recorded for reducing sugar, proteins, phenols, starch and carbohydrate. The reducing sugar significantly varied among different bunch load treatments. Among the different treatments, 50 bunches/vine treatment showed maximum amount of reducing sugar (7.80 mg/g) followed by 75 bunches/vine (6.20 mg/g), whereas the least amount of reducing sugar was recorded with 125 bunches/vine (5.10 mg/g). The variations in the results of reducing sugar might be due to the changes in photosynthetic activity of grapevines. The results of the present study confirm the findings of Gao *et al.,* (1994) who reported that total sugar decreases by increasing bud load/vine on Crimson Seedless grapes. Somkuwar *et al.,* (2013) also reported that by increasing the number of shoots, leaf area increases which contribute for better photosynthates. Increase in leaves leads to heavy canopy with increase in active photosynthesis and store carbohydrate in the new canes (Kliewer, 1981 and Gao *et al.,* 1994). The differences for starch and proteins were significant within the different bunch load treatments. The amount of protein increased with the increase in number of bunches/vine. The highest amount of protein (27.40 mg/g) was recorded with 125bunches/vine while the least amount was recorded with the 50 bunches/vine (19.00 mg/g).

Table.1 Effect of bunch load on vegetative parameters and yield (Kg/vine)

Bunch load/vine	Shoot length (cm)	Shoot Diameter (mm)	Inter nodal length (cm)	No. of canes/ vine	No of leaves/ shoot	LAI	Leaf area (cm^2)	Yield / vine (kg)
50-bunches	68.65	7.855	5.745	40.5	11.70	1.465	189.62	15.80
75- bunches	68.50	7.285	5.465	43.0	12.60	1.370	186.06	23.33
100-bunches	66.55	7.630	5.495	52.0	10.90	1.185	185.28	26.50
125-bunches	61.30	7.345	5.235	47.5	9.43	1.240	183.20	28.25
CV %	1.77	1.72	1.66	2.19	1.84	1.57	1.68	11.78
LSD 5 %	1.61	0.17	0.12	1.38	0.28	0.02	4.32	3.70

Table.2 Effect of bunch load on berry quality parameters and raisin recovery

Bunch load/ vine	Av. bunch wt (g)	Berry length (mm)	Berry diameter (mm)	50 berry wt (gm)	TSS (° Brix)	pH	Raisin recovery (%)
50-bunches	316.59	21.2	17.2	144.21	22.4	3.72	25.43
75- bunches	311.16	20.9	16.7	134.81	22.4	3.72	25.80
100- bunches	265.24	19.7	16.0	129.49	19.8	3.56	26.00
125- bunches	242.05	19.1	15.6	103.68	19.2	3.61	27.10
CV %	1.70	1.68	1.67	1.93	1.64	1.61	4.84
LSD 5 %	6.65	0.46	0.37	3.40	0.474	0.08	NS

Table.3 Effect of bunch load on biochemical composition of raisins

Bunch load/vine	Reducing Sugar (mg/g)	Proteins (mg/g)	Phenols (mg/g)	Starch (mg/g)
50-bunches	7.80	19.00	2.50	18.0
75- bunches	6.20	25.40	2.78	10.0
100- bunches	5.40	23.27	3.00	11.1
125- bunches	5.10	27.40	3.10	13.7
CV %	4.287	2.678	2.813	5.644
LSD 5 %	0.362	0.877	0.110	1.027

There were no consistent trends observed for starch with different bunch load treatments. The total phenol content in the berries significantly varied among the different bunch load treatments. Phenol content in the berries increased with the increase in bunch load/vine. Total phenol ranged from 2.50 mg/g (50 bunches/vine) to 3.10 mg/g (125 bunches/vine). The varied results for total phenols may be due to the accumulation of anthocyanin in the berries with increase in bunch load. Mota *et al.*, (2010) reported accumulation of higher anthocyanin and total phenol in the skin of untrimmed vines, as compared in 50% and 75% cluster thinned vines where the trimming treatment increased anthocyanin and total phenol in Merlot berries. The source: sink alteration by bunch removal showed positive impact on vegetative growth, quality yield, raisin recovery, and biochemical composition of raisin. Considering the above observations, it was found that though by keeping 50 bunches/vine bunch weight, berry length an 50-berry weight berry diameter and TSS was increased however, raisin recovery and yield was found to be highest in treatment with 125 bunches/vines. For commercial point of view though treatment with 125 bunches /vine is found to be best as yield and raisin recovery is increased but for production of quality raisins in order to meet the demand of international and national market without application of growth regulators treatment with low bunches/vine is preferred.

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