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EFFECT OF BUNCH LOAD ON YIELD, QUALITY AND BIOCHEMICAL CHANGES IN SHARAD SEEDLESS GRAPES GRAFTED ON DOG RIDGE ROOTSTOCK

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ABSTRACT

A field experiment was conducted during the year 2007-08 to study the effect of bunch thinning on bunch yield, berry quality and biochemical changes in Sharad Seedless table grapes. Crop load level was adjusted to 30, 40, 50, 60, 70, 80 and 90 bunches per vine. Significant differences were observed for all physicochemical and biochemical parameters except shoot diameter, inter nodal length and berry length. Average bunch weight was increased (466.02 g) with the reduction in number of bunches per vine (30 bunches). The same trend was also observed for average berry weight. Highest berry diameter (20.20 mm) was recorded in 30-bunch treatment followed by 19.90mm in 40-bunches per vine treatment whereas with the highest bunches per vine treatment (90-bunches/vine) the berry diameter was reduced to 17.50mm. It was observed that the reduction in bunch load per vine resulted into increase in total soluble solids in berries up to 18.50^0 Brix. Significant differences were recorded for reducing sugar, total phenols, proteins and total carbohydrate. The carbohydrate concentration was increased with the increase in number of bunches, however, the concentration was more in berries than in the rachis. Reducing sugar and starch was reduced with the increase in bunch load. Negative correlation of yield per vine with average bunch weight and berry weight was recorded. With the increase in number of bunches per vine, the yield per vine was also increased. The source: sink alteration by bunch removal had impact on yield, berry quality, sugar accumulation and berry composition. Considering the berry diameter as main quality parameter and the concentration of carbohydrate

content, reducing sugar, starch and in berries and total phenols in the rachis, retention of 50-bunches per vine for the purpose of local market seems to be an ideal one.

Keywords: Sharad Seedless, Bunch Load, Total Soluble Solids, Carbohydrate, Phenols

INTRODUCTION

Grape (*Vitisvinifera L.*) is one of the major important fruit crops of the country grown on an area of 111,000 ha with an annual production of 1,235,000 tones **[1]**. In India, 74.5 per cent of produced grape is available for table purpose, nearly 22.5 per cent is dried for raisin production, and 1.5 per cent for winemaking and 0.5 per cent is used for juice making. For as long as grapes have been grown, it has been known that the best grapes come from those vineyards where vegetative growth and crop yield are in balance **[2]**. Sharad Seedless is one of the important grape varieties among the grape growers in Maharashtra.

Popularity of this variety is mainly due to bold berry size and high demand during off-season. This variety is in cultivation particularly for local market and some quantity is exported to Bangladesh, Dubai, Sri Lanka, etc. To meet the demand, maintaining the quality of the grapes is a perquisite. Therefore, proper balance between quality and quantity needs to maintain.

Balanced pruning is the standard cultural practice used to control grapevine crop level and regulate vine vigour. Some table grape cultivars developed, tends to be vigorous and produce an over abundant amount of fruiting clusters. If extra clusters are retained through bloom, a reduced berry set per cluster may result. A practice commonly used to decrease cluster compactness and improve berry size is cluster thinning. When fewer clusters on the vine are retained, the grape clusters have more berries set on the rachis and larger berries result. Due to the heavy load on the vine, cluster drying from tip is also observed in majority of the vineyards. However, controlling yield via cluster thinning is an important way to increase the table grapes quality.

Considering the problems mentioned above, the research work on different bunch load was carried out on black Sharad Seedless grafted vines and the effects of bunch level on quality parameters were investigated.

MATERIALS AND METHODS

The study was conducted at the farm of National Research Centre for Grapes, Pune during the year 2007- 2008. The rootstock Dog Ridge was planted during March 2000 and the grafting of Sharad Seedless grapes was done during October, 2000. The experimental site is situated in Mid-West Maharashtra at an altitude of 559 m; it lies on 18.32 °N latitude and 73.51 °E longitudes. Pune has a tropical wet and dry climate with average temperatures ranging between 20 to 28 °C. The vines were trained to flat roof gable system of training with four cordons on a horizontally divided canopy trellis with vertical shoot positioning. The height of cordon from the ground surface was 1.20 m and was separated by 0.60 m wide cross arms. The distance from the fruiting wire to the top of foliage support wire was 0.60 m. The vines were planted at the spacing of 3.0 m between the rows and 1.83 m between the vines with the density of 1815 vines per hectare.

Since the region falls under tropical condition, double pruning and single cropping pattern is followed. Hence, the vines were pruned twice in a year (once after the harvest of crop i.e. back pruning and second for fruits i.e. forward pruning). After back pruning, approximately 80-100 shoots with varying thickness appears on all cordons of a vine. Hence, the shoot thinning was performed at 7-leaf stage and the sub cane system was followed. The fruit pruning was done during September and the vines under each treatment were cluster thinned after berry setting. The canopy size was controlled by shoot thinning before inflorescence emergence. The bunch load level was controlled by bunch thinning to 30, 40, 50, 60, 70, 80, and 90 bunches per vine respectively. The experiment was laid out in simple randomized block design with four replications. Five vines were selected under each replication to record the observations.

To study the effect of these treatment on growth, yield and quality, bunches under each treatment were harvested at the same date. The shoot length, inter nodal length and shoot diameter were measured at 120 days after fruit pruning. At harvest, average bunch weight, berry diameter, berry length, yield per vine was recorded. Fifty berry samples were randomly selected from each replicate and processed in a blender and strained through two layers of muslin cloth. Soluble solids concentration was determined from the juice using a digital refractometer (model ERMA of Japan).

The total phenolic content was determined using the Folin-Ciocalteu method using 4 methylcatechol as the standard. The concentration of total phenolics was expressed as the catechol equivalent (mg/g) of the lyophilized sample. Reducing sugar was estimated by the dinitrosalicylic acid (DNSA) method and total carbohydrate was estimated by the Anthrone method using D-glucose as the standard. Protein was estimated by using the method described by **Lowry *et al*. 1951 [3]**. The total protein concentration was expressed as a Bovine Serum Albumin Fraction-V equivalent (mg/g). The standard reference chemicals like D-glucose, 4-methylcatechol, Bovine serum albumin etc. used were obtained from the s.d fine chemicals Ltd., Mumbai (India). All other buffers and chemicals were of AR grade and obtained from Merck Pvt. The biochemical parameters were studied to correlate with berry qualities. The data was statistically analyzed using SAS 9.3 software.

RESULTS AND DISCUSSION

Effect of Bunch Load on Vegetative Growth, Yield and Quality

The observations recorded on vegetative parameters are presented in **Table 1**. The shoot length ranged from 99.23 cm in minimum bunch load to 74.93 cm in maximum bunch load treatment. The trend for reduction in shoot length with the increase in bunch load was recorded among the different bunch load treatments. However, the differences for shoot diameter and inter nodal length was found to be non-significant. These results supports the findings of **[4]** who reported that the decrease in crop load by cluster thinning within each of the two shoot density treatment did not affect vegetative parameters in Sauvignon Blanc grapevine. The lack of effect of bunch load per vine on vegetative parameters measured indicated that there was no significant sink-competition between cluster and vegetative growth. The bunch weight was found to increase linearly with reduction in number of cluster per vine. Highest bunch weight of 466.02 g was recorded in minimum bunch retention (30bunches/ vine) as compared to the highest (90) bunches per vine (299.64 g). The results of present study revealed that the bunch weight was reduced significantly with the increase in number of bunches per vine. This result confirms the study on Chambourcin grapevine **[5]**. In their studies on biochemical and agronomical responses of Merlot and Cabernet Sauvignon grapevine to cluster thinning and shoot trimming reported that there was an increase in yield of shoot trimmed vines with 50% and 75% cluster thinning which seems to be related to an increase in cluster weight **[6]**. According to **[7]**, the increase in cluster weight is observed by cluster thinning while cluster weight was not influenced by cluster removal or shoot trimming practice **[8, 9]**. Significant differences were recorded for average berry weight and berry diameter. The average berry weight was increased from 5.37g in minimum bunch load (30 bunches) to 3.79g in highest bunch load of 90 bunches per 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, the developing bunch. The increase in average berry weight in the present study also contributed to the increase in bunch weight. In most cases, the cluster weight was found to increase as the number of clusters per vine decreased, because of increase berry weight **[7, 10, 11]**. With the increase in number of cluster per vine, the total yield per vine was also increased. The reduction in yield following cluster thinning has been previously reported in several other grape cultivars by **[4, 7, 12, 13, 14]**. However, cluster thinning reduced the crop load without reducing the crop yield **[10]**. Average berry diameter was ranged from 17.50mm in highest bunch retention (90 bunches) to 20.20mm in minimum bunch load (30 bunches). Significant differences were also recorded for berry weight and berry diameter in relation to cluster thinning treatments. Increase in berry weight and berry diameter was found to be associated with reduction in cluster per vine. The increase in berry diameter also contributed to the increase in yield per vine via bunch weight. While working on Sauvignon Blanc **[4]** reported that berry weight was increased slightly due to cluster thinning. Decrease in bunch weight was associated with increase in bud load on a vine **[15]**. These finding supports that the cluster thinning decreases crop weight per vine which resulted in an increase in clusters and berry weight **[5]**.

Significant differences were recorded for yield per vine. With the increase in number of bunches per vine, the yield per vine was also increased. The yield ranged from 14.01kg in 30-bunches per vine treatment to 26.96kg in 90 bunches per vine. The increase in yield per vine might be due to increase in both number of bunches per vine and also the weight per bunch. This result also confirms the findings of **[16]** who reported the increase in yield per vine due to increase the number of cluster of Crimson Seedless grapevine and on Thompson Seedless grapevine **[15, 17].**

Significant differences were recorded for total soluble solids in the berries. It was observed that with the reduction in cluster per vine, the total soluble solid in berries was increased. Highest total soluble solids (18.50^0Brix) was recorded in minimum number of bunches treatment (30 bunches/vine) as compared to least total soluble solids (16.15^0 Brix) in highest number of bunch retention per vine. Total soluble solids in the berries were negatively correlated with the yield per vine. With the increase in number of bunches/vine, the yield was also increased. However, the total soluble solid was reduced to the maximum **(Table 3)**. These findings are in accordance with the results obtained by **[5]** who also reported increase on soluble solids with cluster thinning. The increase in soluble solids with cluster thinning has also been reported in the other cultivars by **[4]**.

The significant changes in acidity among the different cluster thinning treatments were also recorded in this studies. Though the acidity reduces with the increase in number of clusters, the retention among the different cluster thinning treatments did not justify increase in acidity percent by increase in bud load per vine **[16]**. It is clear from the studies that the effect of cluster per vine on total soluble solids also had similar effect on acidity.

Effect of Bunch Load on Biochemical Parameters

The data recorded on various biochemical parameters in berries and also in the rachis of a bunch is presented in **Table 2**. Significant differences were recorded for reducing sugar, starch, phenols and proteins. The carbohydrate content in berries varied significantly with the variation in the bunch load. However, though the differences for carbohydrate content in rachis were non-significant, the carbohydrate was significantly varied among the different bunch loads per vine treatment. The carbohydrate content ranged from 13.67 mg/g in 30 bunches per vine to 19.80mg/g in 90 bunches per vine treatment. With the increase in cluster per vine, carbohydrate content in berries was also increased to the maximum extent. The increase in carbohydrate content might be due to increased canopy with increase in leaf area in the cluster load treatment that have been resulted in highest active photosynthesis rate which helps to store more carbohydrate in the sink, the bunch. This increase in food material is then transported from source to sink, the berries. In tropical viticulture region, after fruit pruning, shoot density is maintained based on the number of bunches retained. This is mainly require to nourish the developing bunch. The increase in leaf area by increasing the number of shoots in this study might have contributed for better photosynthesis. This study supports the results obtained by **[18, 19]** who reported that increase in leaves leads to heavy canopy with increase in active photosynthesis and store carbohydrate in the new canes. Similar results were also obtained by **[15]** on Thompson Seedless and Crimson Seedless grapevine **[20]**. Potential of a vine to produce carbohydrate to meet the demands of fruit production and vegetative growth based on effective leaf area, whereas proper crop load is important to achieve maximum yields of highest quality fruit without sacrificing vine capacity. Fruit production and shoot growth compete for available carbohydrates.

The concentration of reducing sugar in berries as well as in bunch rachis varied significantly among the different bunch load treatments. The concentration of reducing sugar was double in the berries than in the bunch rachis. The concentration of reducing sugar was found to be reduced with the increase in bunch load in Sharad Seedless grapevine. In the berries, the concentration varied with the minimum bunch load of 30- bunches (213.50 mg/g) to 129.19 mg/g in 90-bunches per vine treatment. The same trend was also observed in the rachis. In rachis, it ranged from 165.29 (30-bunches/vine) to 72.24 (90-bunches/vine). The changes in sugar content might be due to the changes in the photosynthetic activities of vine. The studies on Crimson Seedless found that total sugar decreases by increasing bud load per vine **[16]**. Also found that decrease in fruit sugar content by increasing the number of buds per vine **[21]**. High crop levels have been found to delay sugar accumulation in some studies **[22]**. Overcropping ordinarily delays fruit maturation and therefore decreases grape sugar and color if harvest is delayed. However, the effect of crop load on berry composition depends on the cultural practices followed during the season.

The differences for starch and protein content in the berries and rachis of a bunch varied significantly among the different bunch load treatments. However, the consistent results for these parameters were not observed. Total phenol content in berries was significantly varied among the different bunch load treatments. Phenol content in berries and also in rachis was increased with the increase in number of bunch load. In berries, phenol content ranged from 0.85 mg/g (30-bunches/vine) to 1.45 mg/g (90-bunches/vine). It was observed that the total phenol content was less in berries than in the bunch rachis. The phenol content in rachis was almost six times more than that of berries of Sharad Seedless grapevine. The concentration in the rachis ranged from 5.94 mg/g to 15.79 mg/g. In Merlot berries with highest yield (no cluster removal) showed higher anthocyanin and total phenol in the skin of untrimmed vines, whereas in 50% and 75% cluster thinning, the trimming treatment increased anthocyanin and total phenol **[6]**.

Table 1: Effect of Bunch Load on Vegetative Growth, Yield and quality in Sharad Seedless Grapes

Bunch load/vine	Shoot Length (cm)	Shoot Diameter (mm)	Inter nodal Length (cm)	Average Bunch wt. (g)	Average Berry wt. (g)	Berry Diameter (mm)	Berry Length (mm)	T S S (^{0}Brix)	Acidity (%)	Yield / vine (kg)
T1 - 30 Bunches	99.23	7.76	5.82	466.02	5.37	20.20	24.90	18.50	0.60	14.01
T2 - 40 Bunches	97.70	7.52	5.40	387.42	5.24	19.90	24.50	17.95	0.62	15.49
T3 - 50 Bunches	95.43	7.36	5.34	327.22	4.58	18.50	22.30	17.80	0.67	16.36
T4 - 60 Bunches	87.23	7.74	5.44	319.77	4.30	17.50	22.30	17.50	0.58	19.14
T5 - 70 Bunches	86.37	7.49	5.82	317.90	3.98	17.60	22.30	16.56	0.64	22.26
T6 - 80 Bunches	74.93	7.81	5.89	305.49	4.03	17.50	21.50	16.65	0.63	24.22
T7 - 90 Bunches	75.20	7.26	5.45	299.64	3.79	17.50	21.50	16.15	0.76	26.96
CD @ 5 %	3.54	0.72	0.62	32.95	0.17	0.49	2.52	0.51	0.03	1.75
Significance	**	NS	NS	**	**	**	NS	**	**	**

Table 2: Effect of Bunch Load on Biochemical Parameters in Sharad Seedless Grapes

Bunch load	Carbohydrate (mg/g)		Reducing Sugar (mg/g)		Starch (mg/g)		Protein (mg/g)		Phenol (mg/g)	
	Berry	Rachis	Berry	Rachis	Berry	Rachis	Berry	Rachis	Berry	Rachis
T1 - 30 Bunches	13.67	10.44	213.50	165.29	3.55	3.74	1.99	83.11	0.85	5.94
T2 - 40 Bunches	15.43	10.86	183.77	135.68	3.59	4.13	2.05	103.48	1.14	7.33
T3 - 50 Bunches	16.71	10.91	169.93	129.59	1.40	3.53	2.94	128.77	1.26	11.83
T4 - 60 Bunches	16.85	11.40	165.16	115.96	1.78	3.01	3.69	130.53	1.30	11.88
T5 - 70 Bunches	17.00	11.60	150.78	97.12	2.39	3.85	4.2	140.15	1.34	13.98
T6 - 80 Bunches	17.50	12.04	130.24	84.14	2.56	3.14	6.42	151.78	1.41	14.71
T7 - 90 Bunches	19.80	12.12	129.19	72.24	3.37	2.72	7.22	155.07	1.45	15.79
CD @ 5 %	0.6052	1.238	8.547	6.242	0.2214	0.619	0.1835	9.65	0.129	0.4576
Significance	**	NS	**	**	**	*	**	**	**	**

Table 3: Correlation Between Various Physiochemical and Quality Parameters in Sharad Seedless

	SL	SD	IL	ABuW	ABrW	BD	BL	TSS	A	YV
SL	1.000	0.076	-0.243	0.766	0.891	0.823	0.851	0.916	-0.497	-0.972
SD		1.000	0.593	0.357	0.290	0.137	0.269	0.357	-0.830	-0.260
IL			1.000	0.194	-0.097	-0.073	0.021	-0.160	-0.294	0.197
ABuW				1.000	0.912	0.924	0.947	0.826	-0.458	-0.782
ABrW					1.000	0.965	0.955	0.939	-0.519	-0.923
BD						1.000	0.949	0.839	-0.311	-0.820
BL							1.000	0.841	-0.501	-0.841
TSS								1.000	-0.622	-0.979
A									1.000	0.616
YV										1

NOTE: Sl – Shootlength, SD – Shoot diameter, IL – Internodal length, ABuW – Average Bunch Weight, ABrW – Average Berry Weight, BD – Berry Diameter, BL – Berry Length, TSS – Total soluble solids, A – Acidity, YV – Yield per Vine

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