Performance of Thompson Seedless Grape and its Clones on Dog Ridge Rootstock

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International Journal of Horticulture, 2019, Vol.9, No.1  doi: 10.5376/ijh.2019.09.0001
Received: 24 Jul., 2018
Accepted: 20 Mar., 2019
Published: 30 Jun., 2019

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Preferred citation for this article:
Shelake T.S., Shikhamany S.D., Kalbhor J.N., and Mungare T.S., 2019, Performance of Thompson Seedless Grape and its Clones on Dog Ridge Rootstock, International Journal of Horticulture, 9(1): 1-9 (doi: 10.5376/ijh.2019.09.0001)

Abstract A field trial was conducted at the R&D Farm of Maharashtra State Grape Growers' Association, Pune, India to assess the performance of Thompson Seedless and its clones, namely Tas-A-Ganesh and Sonaka on Dog Ridge rootstock. Brix-yield the ultimate measure of productivity in grape, particularly in raisin grapes, was more in Sonaka compared to the rest, which were at par. Dominance of yield/vine over Brix content was evident in determining the brix yield. Vine yield was more in Sonaka compared to other varieties because of more number of clusters in spite of less bunch weight. Factors impairing shoot maturity namely, shoot length and rate of shoot growth were more; NO3-N status was more and K status less after back pruning in Sonaka. Fruitfulness of buds as indicated by the cluster/cane ratio was more resulting in more clusters/vine in Sonaka, though the canes/vine was less. Yield increase in Sonaka was mediated through more cane diameter, shoot length on the 45th day and shoot growth rate during 30-45 days after back pruning; less number of shoots/vine and shoot length at veraison. Results of this trial revealed that Sonaka is the best variety on Dog Ridge for obtaining high yield of quality grapes and that the viticultural practices that increase the cane diameter, shoot length on the 45th day and shoot growth rate during 30-45 days after back pruning; and reduce the number of shoots/vine and shoot length at veraison might help increase the yield in Thompson Seedless and Tas-A-Ganesh.

Keywords Thompson seedless; Clones, Dog Ridge; Performance; Brix-yield

Background Tas-A-Ganesh and Sonaka are the bud sports from Thomson Seedless identified by progressive farmers of Maharashtra(Chadha and Shikhamany, 1999). Thompson Seedless and its clones are the predominant grape varieties grown in this State. While Thompson seedless and Tas-A-Ganesh are grown for dual purpose, viz. Table and raisin, Sonaka is mainly grown for processing to raisins. Dog Ridge, as the rootstock has shown its promise in sustaining the production of table grape of Tas-A-Ganesh in saline alkali soils of Maharashtra (Sharma and Upadhyay, 2008). When grown for table purpose, the clusters are subjected to various treatments to make them loose and increase berry diameter, and harvested when their total soluble solids (TSS) content reaches 16°Brix (B). Whereas clusters are not subjected to any treatment for berry thinning and increase its diameter, and retained on the vine until the TSS content of berries reached 20-21°B. While the Brix content determines the raisin recovery, Brix yield does the raisin yield. In this background, a trial was conducted at the R&D Farm of the Maharashtra State Grape Growers’ Association, Pune, to assess the suitability of Dog Ridge rootstock to Thompson Seedless and its clones in raisin grape production.

1 Material and Methods The trial was laid out in the field in a randomized block design with seven blocks and three plots in each block. Plot size was 2.7 x 7.5 m accommodating five vines spaced at 2.7 x 1.5 m. Dog Ridge rootstocks were planted at this spacing in February 2012 and grafted in-situ in October 2012 with varieties according to the plan. Vines were trained to Geneva Double Curtain system with a cordon length of 60 cm on an extended Y-trellis. Vines were subjected to uniform viticultural practices including nutrition and irrigation during the entire period of experimentation. Pre-bloom GA sprays were given for cluster elongation, but clusters were not treated for berry
thinning or its enlargement. Observations on the following vine growth yield and quality parameters were recorded in each plot during 2016-17 and 2017-18 corresponding to the 4th and 5th cropping seasons respectively.

1.1 Observations on vine growth parameters
Mean shoot length was derived from the length of ten shoots selected at random was measured on the 30th day after bud break after back pruning, while the mean of total length of sub-shoots including the terminal one on the selected shoots on the 45th day. Mean number of shoots was derived by counting all shoots on the five vines in a plot. The days taken from forward pruning to appearance of green tissue in any bud on any cane and vine in a plot was recorded as the day for initiation of bud break. The difference in days from the initiation to cessation of bud break was considered as the duration of bud break. Percentage of shoot maturity was derived from the mean percentage of number of canes retained/vine after forward pruning to the number of shoots/vine. Mean shoot length at full bloom and at veraison were derived by measuring the length of the same 10 shoots selected at random repeatedly at both stages.

1.2 Observations on vine vigour and apical dominance
Rate of shoot growth during the i) the first 30 days after back pruning, ii) during 30-45 days after back pruning, iii) from bud break to full bloom and iv) from full bloom to berry softening was calculated by the following formula.

\[ \text{Rate of shoot growth (mm/day)} = \frac{\text{Final shoot length in mm - initial shoot length in mm}}{\text{duration in days}}. \]

Mean weight of prunings was recorded from all the vines in a plot at forward pruning.

Internodal length: Length of the internode in cm between 4th and 5th node of 10 selected canes after forward pruning. Mean diameter of the cane was determined by measuring with calipers at the middle length of the internode between 4th and 5th node of 10 canes selected at random on each vine after forward pruning. Mean Percentage of the number of shoots was derived by the number of shoots in the apical 30 cm portion to the total number of shoots in a cordon on the 45th day after back pruning. Number of laterals arising from a shoot, after pinching above the 7th node for sub-cane development, was recorded on the 60th day after back pruning. Mean number of buds broken after the cessation of bud break in 10 selected canes. Index to apical dominance (AD) was calculated by the following formula based on the shoot length measured at two stages after initiation of bud break after back pruning.

\[ \text{Index to AD} = \frac{\text{shoot length on the 45th day} - \text{shoot length on the 30th day}}{\text{shoot length on the 30th day}} \times \frac{\text{no. of lateral shoots on a shoot}}{\text{no. of shoots on a shoot}}. \]

1.3 Observations on yield and quality
Mean number of canes retained in five vines after forward pruning was recorded. Mean number of clusters harvested and mean yield/vine were recorded in five vines of each plot, and the mean weight of five clusters selected at random from each plot was derived at harvest. Total soluble solids (TSS) content: Soluble solids content was determined in O B using hand refractometer in the juice extracted by crushing the 25 selected berries and the brix-yield/vine was derived by the following formula for each plot.

\[ \text{Brix-yield (Kg/vine)} = \frac{\text{Yield/vine (kg)}}{100} \times \text{TSS content}. \]

Titratable acids content was determined by titrating an aliquot of 10 ml juice against 0.1N NaOH using phenolphthalein indicator and expressed as gram equivalent tartaric acid in 100 ml juice and the Brix-acid ratio was calculated by the ratio of TSS content to corresponding acids content of each sample.

1.4 Petiole nutrient contents
Eighty petioles were collected from each plot at fruit bud differentiation stage (45 days after back pruning) and full bloom. Petioles of leaves at the fifth node above the condensed node at base at fruit bud differentiation stage, whereas the petioles of leaves opposite to flower cluster at full bloom. NO₃–N, total N, P, K, Ca, Mg, S, Fe, Mn,
Zn, Cu, Na and Cl content in the petioles were estimated by the Standard laboratory procedures given by the AOAC.

1.5 Statistical analysis
Data were analyzed in factorial A x B (2 x 3) design with six treatment combinations and seven replications. Where, A was the season and B-varieties. Petiole nutrient contents were not analyzed statistically, as petiole samples could not be drawn replication-wise. Hence were compared graphically.

2 Results and Discussion
Performance of varieties was assessed based on the effect of rootstock on yield attributes, yield and quality.

2.1 Effect on canes/vine
Cane is the unit of production in grape. Number of canes determines the yield of grapevine. Canes/vine varied significantly with season and variety, but not by their interaction. They were less in season 1 (2016-17) compared to season 2 (2017-18). Canes/vine depends on the number of shoots and the degree of shoot maturity. Shoot vigour, high nitrogen and low potassium status of vines; low light regime and high soil moisture were reported to impair shoot maturity (Chadha and Shikhamany, 1999). Less shoot maturity in season 1 could be attributed to more NO$_3$–N but less K at bud differentiation stage (Table 1).

It could also be attributed to the prevailing weather conditions during shoot maturity; because neither the shoot length (Table 2) nor the rate of shoot growth (Table 3), the factors of shoot vigour; nor the number of shoots/vine and lateral shoots/shoot (Table 3), the factors of foliage density after back pruning, differed significantly in seasons. Shoots mature during July-August under the peninsular Indian conditions (Chadha and Shikhamany, 1999). The number of rainy days was more (22) and mean number of sunshine hours/day less (3.6) during these months in season 1 as against 17 and 4.6 in season 2 at the experimental site.

Number of canes/vine was more in Thompson Seedless compared to other varieties; more in Tas-A-Ganesh than Sonaka. This was due to more number of shoots in Thompson Seedless compared to other varieties and higher degree of shoot maturity compared to Sonaka. Factors contributing for shoot maturity namely shoot length and rate of shoot growth were less; NO$_3$-N status was less and K status more after back pruning in Thompson Seedless compared to Sonaka.

Table 1 Mean contents of petiole nutrients in grape varieties at different stages and seasons

| Nutrient | Season 1 | Season 2 | Thompson Seedless | Tas-A-Ganesh | Sonaka |
|----------|----------|----------|-------------------|--------------|--------|
|          | BD       | FB       | BD     | FB       | BD   | FB   | BD   | FB   | BD   | FB   |
| NO$_3$-N (ppm) | 1130    | 1116    | 667    | 548    | 893  | 821  | 814  | 825  | 989  | 850  |
| Total N (%) | 0.92    | 1.56    | 1.17   | 1.45   | 1.13 | 1.46 | 0.93 | 1.40 | 1.07 | 1.65 |
| P (%) | 0.227   | 0.317   | 0.463  | 0.287  | 0.360 | 0.280 | 0.335 | 0.280 | 0.340 | 0.345 |
| K (%) | 1.23    | 1.57    | 1.52   | 1.41   | 1.56 | 1.35 | 1.47 | 1.53 | 1.10 | 1.60 |
| Ca (%) | 1.44    | 0.74    | 1.36   | 0.68   | 1.20 | 0.71 | 1.67 | 0.73 | 1.33 | 0.70 |
| Mg (%) | 0.79    | 0.37    | 0.66   | 0.52   | 0.76 | 0.47 | 0.71 | 0.47 | 0.71 | 0.41 |
| S (%)  | 0.087   | 0.123   | 0.067  | 0.200  | 0.075 | 0.165 | 0.08 | 0.165 | 0.075 | 0.155 |
| Fe (%) | 91      | 169     | 62     | 124    | 79   | 147  | 80   | 121  | 72   | 172  |
| Mn (%)  | 252     | 130     | 120    | 180    | 192  | 161  | 190  | 144  | 177  | 161  |
| Zn (%)  | 76      | 67      | 87     | 93     | 71   | 76   | 85   | 78   | 88   | 87   |
| Cu (%)  | 56      | 15      | 26     | 73     | 44   | 46   | 40   | 44   | 39   | 44   |
| Na (%)  | 1.00    | 0.85    | 0.62   | 0.74   | 0.87 | 0.72 | 0.84 | 0.90 | 0.73 | 0.78 |
| Cl (%)  | 0.189   | 0.123   | 0.189  | 0.617  | 0.248 | 0.320 | 0.142 | 0.375 | 0.177 | 0.415 |

Note: BD= Bud differentiation stage; FB= Full bloom
The yield with variety was observed in the present study in accordance with the observations of Shikhamany and
does not differ significantly at P=0.05 within a column

A. SEASON
Season 1 Season 2 CD @ 5%
Th.Seedless 49.6 49.1 NS
Tas-A.-Ganesh 49.6b 103.9b 72.7a
103.9b 91.4a 32.6a
Sonaka 51.1b 67.3b 72.7a
107.3c 75.0b 91.2a
CD @ 5% 1.7 NS NS NS
Season Variety NS NS NS NS NS NS NS
Note: Figures super-scribed with a same alphabet do not differ significantly at P=0.05 within a column

B. VARIETY
Th.Seedless 47.5a 100.3a 77.3c
100.3a 96.3b 34.1b
Tas-A.-Ganesh 49.6b 103.9b 72.7a
103.9b 91.4a 32.6a
Sonaka 51.1b 107.3c 75.0b
107.3c 91.2a 31.9a
CD @ 5% 1.7 2.1 1.6
x NS NS NS
Season Variety NS NS NS
Note: Figures super-scribed with a same alphabet do not differ significantly at P=0.05 within a column

Table 3 Effect on vine vigour and apical dominance

| Treatment | Rate of shoot growth (mm/day) | Prunings weight (kg/vine) | Percentage of shoots in apical 30 cm of cordon | Sub-shoots / Bud. | Broken Buds / Cane | AD index |
|-----------|--------------------------------|---------------------------|-----------------------------------------------|------------------|------------------|---------|
|           | 1-30 DABP 30-45 DABP 1-45 DABP |                            |                                               |                  |                  |         |
| A. SEASON | Season 1 16.5 16.0 16.7 3.20 1.16 3.63 8.16 69.4 2.9 3.9 0.18 |                           |                                               |                  |                  |         |
|           | Season 2 16.4 16.5 16.7 3.19 1.08 3.60 8.33 67.9 2.7 3.6 0.19 |                           |                                               |                  |                  |         |
|           | CD @ 5% NS NS NS NS 0.05 NS NS 0.16 NS NS NS NS NS |                           |                                               |                  |                  |         |
| B. VARIETY | Th.Seedless 15.8a 15.2a 17.2c 4.34c 1.14b 3.27a 7.79a 66.0a 2.6 4.2b 0.19 |                           |                                               |                  |                  |         |
|           | Tas-A.-Ganesh 16.5b 16.2a 16.2a 2.91b 1.24c 4.11c 8.19b 69.0b 2.8 3.5a 0.18 |                           |                                               |                  |                  |         |
|           | Sonaka 17.0b 17.5b 16.7b 2.33b 0.99a 3.46b 8.76c 70.8b 2.9 3.6a 0.18 |                           |                                               |                  |                  |         |
|           | CD @ 5% 0.6 1.2 0.4 0.37 0.06 0.17 0.20 2.1 NS 0.5 NS |                           |                                               |                  |                  |         |
| Season x Variety | NS NS NS NS ** ** NS NS NS NS NS |                           |                                               |                  |                  |         |
| CD @ 5% | - - - - 0.08 0.20 - - - - |                           |                                               |                  |                  |         |

Note: ** Significant at P=0.01; Figures super-scribed with a same alphabet do not differ significantly at P=0.05 within a column

2.2 Effect on yield/vine

Yield/vine did not vary significantly with the season but varied with variety (Table 4). It is a function of the number of clusters/vine and the mean weight of cluster. Number of clusters/vine was less but mean weight of cluster was more in season 1, resulting in non-significant difference in yield between the seasons. More number of clusters/vine in season 2 could be due to more canes. Fruitfulness of the canes as indicated by the cluster/cane ratio was not influenced significantly by the season, indicating that the factors contributing to fruit-bud formation were not different during the seasons. More weight of cluster in season 1 could be attributed to less number of clusters/vine. Negative relationship between cluster number/vine and cluster weight was observed in Thompson Seedless (Shikhamany et al., 2015).

Yet another factor affecting vine yield is its vigour. Prunings weight an indicator of vine vigour was more but yield was less in Thompson seedless and Tas-A-Ganesh compared to Sonaka. A negative relationship of prunings weight with yield was observed in the present study in accordance with the observations of Shikhamany and
Reddy (1992). Prunings weight was more, but yield was not less in season 1, while the number of clusters/vine was less, indicating the negative effect of prunings weight on clusters/vine, which was observed in this study (Table 5). Variation in prunings weight among seasons could be attributed to inverse variation in shoot maturity (Tables 2&3), because immature shoots were removed at pruning and weighed.

Vine yield was more in Sonaka compared to other varieties. Yield was more in this variety compared to Thompson seedless, because of more number of clusters in spite of less bunch weight. Though the canes/vine was less, yield was more in Sonaka due to more fruitfulness of its canes as indicated by the cluster/cane ratio. It implies that fruitfulness of buds is more in sonaka. Shoot length on the 30th and 45th day was less in Thompson Seedless compared to other varieties. Tas-A-Ganesh and Sonaka were at par in respect of shoot length on the 30th day, but Sonaka had longer shoots than Tas-A-Ganesh on the 45th day. Significance of shoot length during the growth season (after back pruning) lies in the fact that it is detrimental to yield. Although, Shikhamany and Reddy (1992) found a negative relationship of shoot length at 45 days after back pruning with yield in Thompson Seedless, a positive relationship was observed in this study (Table 5). This discrepancy can be attributed to shoot pinching to develop sub-canapes practiced in this study, resulting in more number of fruiting units and yield as evidenced by the positive correlation of shoot length at 45 days with the number of clusters /vine (Table 5). It was the total length of sub-shoots on a cane that was measured on the 45th day. Hence the variation among the varieties in respect of the clusters/vine was in accordance with the variation in their shoot length on the 45th day (Table 2). Less vine vigour as indicated by less weight of prunings could be the reason for more yield mediated through more number of clusters/vine in Sonaka compared to Thompson Seedless (Tables 3&4), in light of the negative correlation of prunings weight with yield and clusters/vine (Table 5).

Interaction of season with varieties influenced the yield as well as clusters/vine (Table 6). While Sonaka out-yielded the rest in both the seasons, Tas-A-Ganesh yielded more than Thompson Seedless in season 1 and vice-versa in season 2. This could be due to more clusters/vine in Tas-A-Ganesh in both the seasons. While there was consistency in Tas-A-Ganesh and Sonaka between two seasons in respect of clusters/vine, they were more in season 2 than in 1 in Thompson Seedless. It implies that less sunshine hours more soil moisture caused by more frequent rains impaired the bud fruitfulness in Thompson Seedless.

Mean weight of cluster was influenced significantly by season and variety. Although negative relationship between clusters/vine and mean cluster weight was implicated for the variation in the latter due to season and variety in the present study, it is basically a varietal character. It varies with the variety on account of the number of flowers formed (Mullins, 1967), fruit-set, berry retention and characteristic size of the berries (Chadha and

### Table 4 Effect on yield attributes, yield and quality

| Treatment | Canes / vine | Yield / Vine (kg) | Clusters / vine | Mean weight of Cluster (g) | Cluster/ Cane ratio | T.S.S (º B) | Brix Yield/vine (kg) | Acidity (g/100ml) | Brix-acid Ratio |
|-----------|--------------|------------------|----------------|---------------------------|---------------------|------------|---------------------|-----------------|----------------|
| **A. SEASON** |              |                  |                |                           |                     |            |                     |                 |                |
| Season 1  | 30.1*        | 10.73            | 37.5*          | 291.2b                    | 1.246               | 19.95b     | 2.140               | 0.467           | 43.0           |
| Season 2  | 31.7b        | 10.72            | 39.5b          | 273.9a                    | 1.246               | 19.74a     | 2.118               | 0.448           | 44.7           |
| CD @ 5%   | 0.8          | NS               | 1.2            | 9.3                       | NS                  | 0.19       | NS                  | NS              | NS             |
| **B. VARIETY** |             |                  |                |                           |                     |            |                     |                 |                |
| Th. Seedless | 32.6*        | 10.36*           | 32.6*          | 319.9b                    | 1.000a              | 20.02b     | 2.075*              | 0.436*          | 46.5b          |
| Tas-A-Ganesh | 30.8b        | 10.45*           | 40.3b          | 259.7a                    | 1.308b              | 19.74b     | 2.064b              | 0.458ab         | 43.4b          |
| Sonaka     | 29.4a        | 11.36b           | 42.6b          | 268.0*                    | 1.449b              | 19.78b     | 2.247b              | 0.479b          | 41.6e          |
| CD @5%     | 1.0          | 0.24             | 1.5            | 11.4                      | 0.076               | 0.23       | 0.052               | 0.033           | 3.3            |
| Season x Variety | NS          | *                | *              | NS                        | *                   | **         | NS                  | NS              |                |
| CD @5%     | -            | 0.34             | 2.1            | -                         | -                   | 0.33       | 0.073               | -               | -              |

Note: *: Significant at P=0.05; **: Significant at P=0.01

Figures super-scribed with a same alphabet do not differ significantly at P=0.05 within a column.
Shikhamany, 1999). Leaf area available/cluster at veraison also influenced the cluster weight (Purohit et al., 1979; Chelvan et al., 1985). Variation in shoot length at veraison was in accordance with that in mean cluster weight among varieties (Tables 2 & 4). Intermodal length is the indication of vine vigour. Shikhamany (1993) reported negative relationship of intermodal length with clusters/vine and cluster/cane ratio in Thompson Seedless. Whereas, a positive correlation of intermodal length with canes/vine and a negative correlation with cluster weight was observed in the present study (Table 5). Discrepancy in the correlation between intermodal length and clusters/vine could be attributed to inherent variation in vine vigour among varieties and seasonal influence on it.

Intermodal length was more in Tas-A-Ganesh, compared to the rest, in turn more in Sonaka than in Thompson Seedless (Table 3). It was also influenced by the season x variety interaction. Intermodal length in Sonaka was
more in season 1, but at par with Thompson Seedless in season 2 (Table 7).

Higher ratio of cluster/cane observed in Sonaka could be attributed to more cane diameter (Table 3), because of their positive relationship (Shikhamany et al., 2018). Variation in the number of clusters/vine (Table 4) was similar to the variation in cane diameter among the seasons and varieties (Table 3). A positive correlation of cane diameter with yield and clusters/vine was observed in the present study (Table 5).

2.3 Effect on apical dominance
Apical dominance was measured as percentage of shoots in the apical 30 cm length of the cordon, number of lateral shoots on a shoot after pinching, the number of buds broken in a cane after forward pruning and the index to apical dominance as calculated by the formula mentioned in “Material and Methods”. Significance of apical dominance lies in the fact that, it determines the number of sub-shoots, eventually the fruiting terminals; and the number of shoots emerging from a cane after forward pruning offering a scope for increased cluster/cane ratio and varies with the rootstock (Satisha et al., 2004). While percentage of shoots in the apical 30 cm cordon was less (less apical dominance), the number of broken buds after forward pruning was more (less apical dominance) in Thompson Seedless compared to other varieties. Thus apical dominance was less in Thompson Seedless than other varieties. None of the indices of apical dominance had relationship with yield and yield attributes; particularly, buds broken with clusters/cane; because clusters/cane depend primarily on the fruitfulness of buds. Days taken for bud break and duration of bud break was not influenced either by the season or varieties (Table 2).

2.4 Effect on brix-yield
Brix-yield is the ultimate measure of productivity in grapes (Winkler et al., 1974). It denotes the yield of quality grapes as it is derived amalgamating the yield and total soluble solids content of grapes. It bears more significance in raisin grape production, wherein, the recovery of raisins depends on TSS content and raisin yield on the brix yield. Brix-yield was not influenced by the season, but influenced by the varieties and their interaction with season. It was more in Sonaka than the other two varieties, which were at par (Table 4). Variation in Brix-yield was similar to the variation in yield/vine rather than brix content among the seasons and varieties. Though the Brix content was more in Thompson Seedless, the Brix-yield was less, because of less yield. So also in the interaction effect of season x Variety, the differences between Thompson Seedless and Tas-A-Ganesh in seasons was similar in respect of Brix-yield and yield/vine (Table 2B & 2D). Thus, the dominance of yield/vine in determining the brix yield was evident.

2.5 Effect on nutrient absorption
Absorption of nutrients as indicated by their petiole contents was less in case of Zn, but more Cu an Cl by Thompson Seedless at fruit bud differentiation stage, though the differences were not significant. Similarly, Ca was more in Tas-A-Ganesh; NO$_3$N was but K was less in Sonaka. Petiole content of K was less but Cu more in Thompson Seedless at full bloom stage, whereas Na content was more in Tas-A-Ganesh and the contents of total-N, P, Fe and Cl were more in Sonaka. Thus Sonaka appeared to be more efficient in the absorption of nutrients at full bloom (Figure 1).

Table 7 Effect of Season x Variety interaction on vine vigour

| Variety          | A. Prunings weight (kg) | B. Inter-nodal length (cm) |
|------------------|-------------------------|-----------------------------|
|                  | Season 1 | Season 2 | Season 1 | Season 2 | Season 1 | Season 2 |
| Thompson Seedless|          |          |          |          |          |          |
|                  | 1.21$^a$ | 1.07$^b$ | 3.33$^a$ | 3.21$^a$ |          |          |
| Tas-A-Ganesh     | 1.30$^a$ | 1.17$^c$ | 4.06$^c$ | 4.16$^c$ |          |          |
| Sonaka           | 0.97$^a$ | 1.00$^b$ | 3.50$^b$ | 3.41$^b$ |          |          |
| CD at 5% = 0.08  |          |          |          |          |          |          |
| CD at 5% = 0.20  |          |          |          |          |          |          |

Note: Figures super-scribed with a same alphabet do not differ significantly; at P=0.05 within a sub-table
Figure 1 Petiole nutrient contents in grapes varieties on Dog Ridge root stock

Petiole nutrient content was shown to be the outcome of the interaction of root stock and the scion variety in grapes (Cook and Lider, 1964). Though Dog Ridge, a common rootstock for these three varieties was found to be
more efficient in restricting the absorption of Na\(^+\) and Cl\(^-\) ions (Fisarakis et al., 2005). Cl content was more in Tas-A-Ganesh at fruit bud differentiation stage and Sonaka at full bloom. So also Na content was more in Tas-A-Ganesh at full bloom stage. This could be due to iso-ionic substitution (Kirkby and Mengel, 1967) by Na\(^+\) and Cl\(^-\) to fulfil the physiological demand for K\(^+\) and NO\(_3\)\(^-\) respectively.

**Acknowledgements**

The authors are grateful to the Office Bearers and the Chairman, Central Research Committee of The Maharashtra Grape Growers’ Association for facilitating the conduct of the Survey; and the members of the research Advisory Committee for their suggestions and guidance in conducting the research.

**References**

AOAC International, 2016, Official Methods of Analysis (20th Edition)  
Chadha K.L., and Shikhamany S.D., 1999, *The Grape-Improvement, Production and Post Harvest Management* (ISBN: 81-85048-40-1), Malhotra Publishing House, New Delhi, India, pp. 213-251  
Chittirai Chelestan R., Shikhamany S.D. and Chadha K.L., 1985, Contribution of leaf area towards bunch development in Thompson Seedless grape, *Indian J. Hort.*, 42(3&4): 156-60  
Cook J.A., and Lider L.A., 1964, Mineral composition of blooming grape petiole in relation to rootstock-scion variety behaviour. *Proc. Amer. Soc. Hort. Sci.*, 84: 243-254  
Fisarakis I., Nikolaou N., Tsikalas P., Therios I., and Stavrakas D., 2005, Effect of Salinity and Rootstock on Concentration of Potassium, Calcium, Magnesium, Phosphorus, and Nitrate–Nitrogen in Thompson Seedless Grapevine, *Journal of Plant Nutrition*, 27(12): 2117-2134  
Kirkby E.A., and Mengel K., 1967, Ionic balance in different tissues of the tomato plant in relation to nitrate, urea or Ammonium nutrition, *Plant Physiology*, 42: 6-14  
Purohit A.G., Shikhamany S.D., and Prasanna Kumar B., 1979, Effect of number of leaves per bunch on growth and quality of tropical grape variety Anabar Shahi (*Vitis vinifera* L.), *Indian J. Hort.*, 36: 36-41  
Satisha J., Shikhamany S.D., and Sonkuwar R.G., 2004, Variation in apical dominance of Thompson Seedless grapes grafted on different rootstocks. *Indian J. Hort.*, 61(4): 350-351  
Sharma J., and Upadhyay A.K., 2008, Rootstock effect on Tas-A-Ganesh (*Vitis vinifera* L.) for sodium and chloride uptake. *Acta Horticultura*, 785: 113-116  
Shikhamany S.D., 1983, Effect of time and different doses of N and K on growth, yield and quality of Thompson Seedless grapes (*Vitis vinifera* L.), Ph.D. thesis. University of Agricultural Sciences, Bangalore, India  
Shikhamany S.D., Borade S.V., Jeughale S.K. and Patil S.Y., 2018, Variation in the Relationship among Cane and Cluster Characters in Thompson Seedless Grape and its Clones, *Agric. Res.*, (on line DOI 10.1007/s 40003-018-0296-8)  
Shikhamany S.D., Jeughale S.K., Khapare K.N., and Venugopalan R., 2015, Variation in relation between yield and yield attributes in Thompson Seedless Grape and its clones, *Journal of Horticultural Sciences.*, 10 (1): 8-12  
Shikhamany S.D., and Reddy N.N., 1992, Effect of Paclobutrazol on growth and productivity of bower trained Thompson Seedless grapevines, *Proc. Int. Symp. Recent Advances in Vitic. Oenol. February 14-17, 1992, Hyderabad*, pp. 163-172  
Winkler A.J., Cook J.A., Kliewer W.M., and Lider L.A., 1974, General Viticulture, University of California Press, Berkeley, USA, pp. 138-196 & 338-370