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STATUS OF DRY MATTER AT HARVESTING STAGE IN COMMERCIALLY GROWN GRAPE VARIETIES UNDER TROPICAL CLIMATIC CONDITION

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ABSTRACT: The experiment was conducted at NRC for Grapes, Pune during year 2007-08.Four commercially cultivated grape varieties viz. Thompson Seedless, Tas-A-Ganesh, Flame Seedless and Sharad Seedless were analyzed for dry matter content during harvesting stage of the crop. Dry matter partitioning in different parts of vines were observed. Highly significant differences were observed among varieties, various vine parts and their combinations. Among the varieties, maximum dry matter content was recorded in Sharad Seedless (42.87%) followed by Tas-A-Ganesh (42.29%) and among the various parts of the vine, it was found maximum in cordon (54.84%) followed by trunk (54.39%). When dry matter content was measured in particular variety in specific part of the vine, maximum dry matter was recorded in the trunk of Sharad Seedless variety. Roots are the source of nutrient absorption by the vine. Root health found to be positively correlated with the health of the plant and productivity. In the present experiment, highest dry matter content of the roots was observed in the Sharad Seedless with the mean value of 47.72%. Also the dry matter content of the harvestable organ (bunches) was found maximum in Sharad Seedless (25.73%) as compared to other variety.

Keywords: *Dry matter, cordon, trunk, petiole, bunches, harvesting stage, grape.*

Grape is grown under a variety of soil and climatic conditions in India. Grape (*Vitis vinifera* 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 tonnes (Anon., 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, 1.5 per cent for wine making and 0.5 per cent is used for juice making. Farming for desired flavour, quality and economic sustainability is an ultimate goal of viticulturists. This should be achieved through best management practices for a vineyard site. 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 (Dry *et al.* 8). Vine balance was defined by Gladstones (12) by stating, "balance is achieved when vegetative vigour and fruit load are in equilibrium and consistent with high fruit quality."

The dry matter partitioning is the end result of the flow of assimilates from the source organ via a transport path to the sink organ (Marcelis, 23). The term dry matter partitioning may be defined as for instance, the distribution of dry matter between the organs of a plant or as a distribution between different processes (Marcelis, 23).

Any environmental factors or cultural practices that alter the demand-supply relationship of crop load, water, nutrient and pest and diseases will likely affect the vine reserve status (Cheng and Xia, 4). Although, there is a considerable information on the operations of individual processes in plants such as photosynthesis, sugar metabolism, translocation and cell expansion, the control which actually regulate the partitioning of dry matter at the crop level are still only poorly understood (Wardlaw, 31). However, there has been recently some progress in quantifying and modeling dry matter partitioning in fruits (Wermelinger *et al.*, 32; Grossman and DeJong, 14). Besides genotypes, developmental stages of plant in many growth conditions and internal regulation by plants may also affect dry matter partitioning (Marcelis, 23). Palmer (27) suggested

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that for a regular perennial production pattern of apple fruits, the fraction of assimilates partitioned into the fruits should not exceeds 60-65%.

More productivity is generally comes from healthy vines. This can be measured in terms of dry matter production. In the present investigation, dry matter status was measured from source to the sink (harvestable organ-bunches) at harvesting stage.

MATERIALS AND METHODS

The trial was conducted at the farm of National Research Centre for Grapes, Pune during 2007-2008. The grape rootstock Dog Ridge was planted during March, 2001 and the grafting of table grape varieties (Thompson Seedless, Tas-A-Ganesh, Flame Seedless and Sharad Seedless) was done during October, 2001. The vines were planted at the spacing of 3.0 m between the rows and 1.83 m between the vines, totalling the density of 1800 vines per hectare. The vines were trained to flat roof gable system of training with four cordons (H shape) developed horizontally. The vines were trained 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 experimental site is situated in Mid-West Maharashtra at an altitude of 559 m above sea level; it lies on 18.32 °N latitude and 73.51 °E longitudes. The climate in this region is mild to slightly dry. Since the region falls under tropical condition, double pruning and single cropping 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). The trial was laid out in factorial Randomized Block Design. The land in the experimental plot was uniform and levelled. During the season, all the recommended cultural operations like fertilizers, irrigation and plant protection, etc. were given to the vine. The vines were irrigated with drip irrigation system having 2 drippers/vine of 8-litre capacity. A light trench of 0.6 m × 1.2 m trench was opened at a depth of 10 cm twice in a year to apply well rotten farmyard manure and single super phosphate and the trench were closed back. At the time of harvest, the vines under each variety were uprooted and the samples were brought to the laboratory. The observations on fresh weight of different parts of vine (roots, trunk, cordons, shoot, petiole and bunches) were recorded. The samples were then kept in the oven for about 3 days at 50°C to record the observations on dry weight. The data on fresh weight and dry weight of individual vine parts were recorded and the dry matter was calculated. The varieties used under the study were 1. Thompson Seedless, 2. Tas-A-Ganesh, 3. Flame Seedless, and 4. Sharad Seedless. These varieties were studied for dry matter content in various parts of the vines, such as : Root, Trunk, Cordon, Shoot, Petiole, and Bunches. There were total 24 treatment combinations for dry matter estimation (Table 1).

Table 1 : Treatment combination for present study.

Treatment	Treatment combination	
	Variety	Vine part
1	Thompson Seedless	Root
2	Thompson Seedless	Trunk
3	Thompson Seedless	Cordon
4	Thompson Seedless	Shoot
5	Thompson Seedless	Petiole
6	Thompson Seedless	Bunches
7	Tas-A-Ganesh	Root
8	Tas-A-Ganesh	Trunk
9	Tas-A-Ganesh	Cordon
10	Tas-A-Ganesh	Shoot
11	Tas-A-Ganesh	Petiole
12	Tas-A-Ganesh	Bunches
13	Flame Seedless	Root
14	Flame Seedless	Trunk
15	Flame Seedless	Cordon
16	Flame Seedless	Shoot
17	Flame Seedless	Petiole
18	Flame Seedless	Bunches
19	Sharad Seedless	Root
20	Sharad Seedless	Trunk

21	Sharad Seedless	Cordon
22	Sharad Seedless	Shoot
23	Sharad Seedless	Petiole
24	Sharad Seedless	Bunches

The shoot samples were collected leaving one node at the base and the initial weight was measured. The samples were then allowed to dry for 72 hours in hot air oven at 75°C or until no change in dry weight and again weight was measured after drying and the dry matter was calculated. The data was analyzed statistically using SAS version 9.3, where all the data tested for treatments effects on individual parameters was arranged by the general linear model (GLM) and analysis of variance (ANOVA) techniques as a combined analysis was presented.

RESULTS AND DISCUSSION

The observations recorded on dry matter content in various parts of different grape varieties (Thompson Seedless, Tas-A-Ganesh, Flame Seedless and Sharad Seedless) presented in Table 2 and 3 revealed that significant differences were recorded for dry matter content in the varieties. Considering the total amount of dry matter content in the vine, the variety Flame Seedless had highest per cent dry matter content followed by Sharad Seedless, Tas-A-Ganesh and Thompson Seedless. The dry matter content in different parts of vine also varied significantly. The dry matter content in roots was maximum in Tas-A-Ganesh grapes (54.17%) followed by Sharad Seedless (47.72%) whereas the least amount of dry matter was recorded in Thompson Seedless grapes (45.17%). The variation in availability of dry matter in different grapevine parts suggests the response of different grape varieties differently for physiological developments. The root system plays an important role in grape production. In peninsular condition, grapevine is pruned twice in a year for two different purposes. Cultural practices like opening of light trench to apply farm yard manure and the fertilizers are followed before each pruning. The new root growth starts alongwith the shoot growth after pruning of a vine. F value estimated for varieties, different parts of the vine and their interaction were 40.61, 1974.89 and 12.33, respectively. Also significant differences were recorded for varieties, different vine parts and their interactions (Table 4). Miller and Howell (26) also reported that high capacity vines produced the greatest quantity of fruits, leaves, shoots and total canopy dry mass. The fruits are produced by partitioning of carbohydrates to berries at the expense of vegetative tissues and an increase dry matter production/unit leaf area as the sink strength increases (Layne and Flore, 22 Miller and Howell, 25).

Although there is considerable information on the operation of individual processes in plants such as photosynthesis, sugar metabolism, translocation, and cell expansion, the controls which actually regulate the partitioning of DM at the crop level are still only poorly understood (Wardlaw, 31). However, there has recently been quite some progress in quantifying and modeling dry matter partitioning in fruits (Wermelinger *et al.,* 32; Grossman and DeJong, 14) and vegetables (Dayan *et al.,* 6 Marcelis, 24; De Koning, 7; Heuvelink, 15). There seems to be a great diversity in the way a crop partitions its assimilates. Consequently, the simulation models available at the moment are rather species specific. The most suitable simulation approach depends on the type of crop studied and the aim of the model.

The trunk is considered as one of the major plant part for food reserve that can supply food material to the sink, a developing bunch. Canopy management plays an important role in storing the food material in grapevine. The dry matter content varied significantly in the trunk part of all the four varieties studied (Table 3 and Fig. 1). The highest dry matter content in the trunk was recorded in Sharad Seedless (53.92%), however, the lowest quantity of dry matter was recorded in Tas-A-Ganesh grapes (52.58%). Clingeleffer and Krake (5) suggested that the amount of biomass partitioned to the stem declines as the number of shoots per vine increases. Orientation of shoots also

Table 2: Dry matter content in different parts of grape varieties.

Vine parts	Varieties			
	Thompson Seedless	Tas-A-Ganesh	Flame Seedless	Sharad Seedless
Roots	45.17^{e} (5.00)*	54.17^{ab} (4.00)	46.27^{de} (5.00)	47.72^{de} (5.51)
Trunk	53.90^{ab} (5.00)	52.58^{bc} (5.00)	53.92^{ab} (3.00)	57.15^{a} (5.00)
Cordon	54.66^{ab} (4.00)	55.68^{ab} (5.00)	53.64^{ab} (3.00)	55.38^{ab} (4.00)
Shoot	40.17^{f} (3.00)	45.88^{e} (4.51)	39.30^{f} (4.00)	49.69^{cd} (5.00)
Petiole	20.25^{j} (3.00)	20.48^{ij} (2.00)	19.35^{j} (2.00)	21.54^{ijh} (1.00)
Bunches	24.42^{gh} (4.00)	24.98^{gh} (4.00)	23.97^{igh} (3.00)	25.73^{g} (4.00)

* The values in brackets are standard deviations.

Table 3: Mean dry matter content comparison in different varieties and parts.

Mean dry matter content among varieties	Mean dry matter content among different parts
39.76^{b}	48.33^{b}
42.29^{a}	54.39^{a}
39.41^{b}	54.84^{a}
42.87^{a}	43.76^{c}
	20.41^{e}
	24.78^{d}
LSD 0.78	0.96

Table 4: ANOVA for four grape varieties, parts of vine and their combinations.

	Mean Square	F Value	Pr > F
Variety	55.25	40.61	<.0001
Parts	2686.86	1974.89	<.0001
Variety*parts	16.77	12.33	<.0001

decides the availability of biomass (Kliewer *et. al.,* 18).

Primary and secondary cordons combine together supply food material to the developing shoots that ultimately offer the fruit bud differentiation. Basically, a cordon becomes the primary source of food material to the canes. Higher amount of dry matter was recorded in the cordons of Tas-A-Ganesh vines (55.68%) as compared to the lowest in cordons of Flame Seedless (53.64%). In crop growth models, the dry matter partitioning among plant organs is often described as only a function of the developmental stage of the crop (Penning de Vries and van Laar, 29).

The dry matter partitioning between root and shoot has been described as a functional equilibrium between root activity (water or nutrient uptake) and shoot activity (photosynthesis); i.e. the ratio of root-to-shoot weight is proportional to the ratio of shoot-to-root specific activity (Brouwer, 2). Although in this way the ratio between shoot and root dry weight can often be estimated fairly well in vegetative plants, the mechanism underlying this equilibrium is quite complicated and not well understood (Brouwer, 3; Lambers, 19; Farrar, 11). Furthermore, this equilibrium can only be applied to shoot:root ratios and not easily to ratios between other plant organs, because of the absence of functional interdependence. Dry matter partitioning is the end result of a co-ordinated set of transport and metabolic processes governing the flow of assimilates from source organs via a transport path to the sink organs. The activities of these processes are not static, but may change both diurnally and during plant development (Patrick, 28). Assimilates are produced by photosynthesis in the source organs (mainly leaves). The assimilates can be stored or transported from the source to the different sink organs via vascular connections (phloem). The translocation rate of assimilates in the phloem is often considered to be driven by gradients in solute concentration or in water or turgor potential between the source and the sink ends of the phloem (Ho, 16; Wolswinkel, 33; Lang

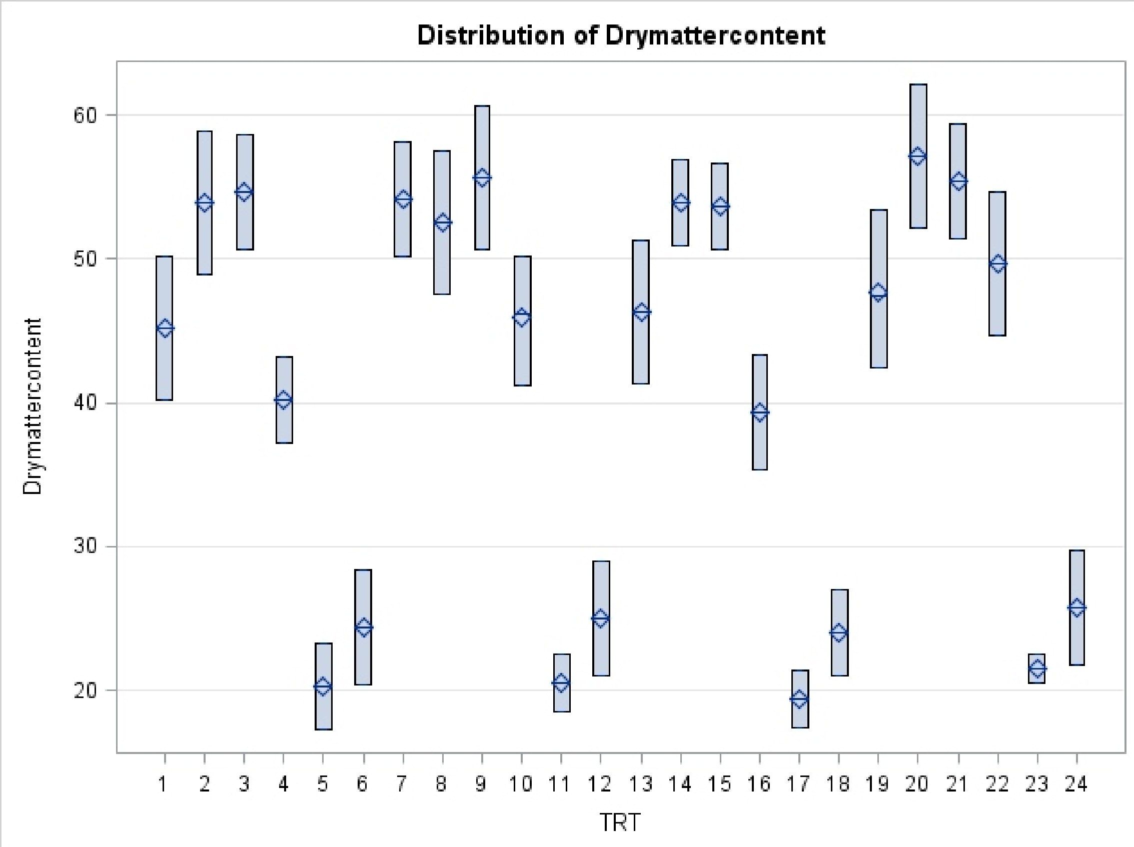

Figure 1 : Dry matter distribution among various combinations of grape varieties and parts of the vine.

and Thorpe, 21; Patrick, 28; Lang and During, 20). Utilization and compartmentation of the assimilates in the sink are important to maintain these gradients. The control of dry matter partitioning may be at the source, at the sink and/or at the transport path. However, several authors have found indications that dry matter partitioning among sink organs is primarily regulated by the sinks themselves (Gifford and Evans, 13; Farrar, 10; Ho, 17; Verkleij and Challa, 30).

The considerable amount of dry matter varied significantly in the shoots of different varieties. Higher dry matter was recorded in the canes of Sharad Seedless (49.69%) as compared to the lowest in the canes of Flame Seedless variety (39.30%). This indicates the availability of dry matter for developing bunch varies with the variety.

Petiole is considered as an indicator for nutrient requirement of a vine. In grape vineyard, generally after 45th day during both pruning, the petiole of 5th leaf is harvested to study the nutrient status of a vine. The dry matter content in the petiole indicates the vine storage. Significant differences were recorded for dry matter content in the petiole. The petiole of Sharad Seedless had higher dry matter (21.54%) than the lowest in Flame Seedless (19.35%). Higher dry matter also recorded in bunches of Sharad Seedless grapevine (25.75%) and was followed by Tas-A-Ganesh (24.98%), however, the lowest dry matter content was recorded in Flame Seedless (23.97%).Edson and Howell (9) considered the interaction of the yield components: total yield, clusters per vine and berries per vine and how these reproductive components might influence the source: sink relationship.

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