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Research Paper

Bunch sizing of 'BRS Nubia' table grape by inflorescence management, shoot tipping and berry thinning

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ABSTRACT

'BRS Nubia' is a new seeded table grape with dark black color, high yield, neutral flavor, and crunchy large berries. However, this cultivar frequently presents very dense bunches, limiting its commercialization. The aim of this work was to obtain uniform and loose bunches of 'BRS Nubia' table grape by means of inflorescence and bearing shoot management associated to berry thinning. The trial was conducted during two consecutive seasons of 2015 and 2016, in a 2-year old commercial vineyard located in Marialva, Parana, Brazil. The vines were trained in an overhead trellis system and spaced at 2.5 × 9.0 m distance. The experimental design was randomized block with four replications in a 2-factor arrangement with two additional treatments (factorial 2 × 2 + 2). The following factors were evaluated: inflorescence management (with tipping before anthesis and without tipping), bearing shoot tipping (before or after anthesis), and two additional treatments consisted of two controls (with or without berry thinning). The berry thinning was performed in all treatments, except in control without berry thinning, by means of picking when berries were at pea size. Physico-chemical analysis of the berries as well as bunch compactness and yield were evaluated at harvest time. Means were subjected to analysis of variance and compared using Tukey's test at 5% probability. Additionally, the Principal Components Analysis (PCA) was used to describe the relation of physico-chemical and productive characteristics of grapes with the inflorescence and shoot management. The inflorescence tipping before anthesis is a useful practice by facilitating and saving time to perform berry thinning of 'BRS Nubia' table grapes, while the bearing shoot tipping after the anthesis may accelerate the bunches ripening. Combined to these practices, berry thinning is a mandatory procedure in order to obtain medium loose bunches of 'BRS Nubia' table grape, with larger and uniform berries.

1. Introduction

The demand for good quality table grapes is increasing all over the world (Leao, 2010), and in order to meet the demands of growing market, new table grape cultivars such as 'BRS Nubia' have been developed to overcome the predicaments faced by the table grapes industry worldwide (Verneque, 2015).

'BRS Nubia' is a "vinifera-like" new seeded hybrid table grape with dark black color, large berries and good adaptation to tropical and subtropical climates, however, this cultivar frequently presents very dense bunches, demanding specific traits to overcome this problem (Maia et al., 2013).

The appearance and homogeneity as well as color of the berries are very important factors for table grapes due to its fresh consumption, unlike winemaking grapes where grapes are processed (Pommer et al., 1995).

The main purpose of inflorescence or bunch management, also known as bunch sizing, is to improve the visual appearance of the bunches, bring uniformity in shape, size and color of the berries, and also to increase its total soluble solids along with elimination of small, deformed or damaged berries, eventually making handling and harvest of the grapes more simpler (Roberto et al., 2015; 2017). Thinning is the most frequent technique used for this purpose, which can be performed in different ways, such as by brushing prior to anthesis, by berry-cluster thinning and by berry thinning (picking), which involves removal of individual berries along the bunch (Roberto et al., 2015). However, as berry abortion is frequent and inconsistent for 'BRS Nubia' after flowering, brushing prior anthesis is not used for this cultivar, even though

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it is considered a fast and easy thinning technique.

There are other techniques used for bunch sizing, such as the inflorescence and bearing shoot tipping or trimming. The inflorescence tipping is the method of removing its terminal portion (Gil et al., 2013). Removing the apical dominance of the rachis induces the higher development of the shoulders and the side berry-clusters, especially when performed before the anthesis, improving of the size and shape of bunches, turning them longer and with more spaced berry-clusters, facilitating the prospective berry thinning labor to avoid bunch compactness (Leao, 2010). The bearing shoot tipping involves removing a small portion of its tip in order to suppress temporarily its apical dominance, deflecting more quantity of assimilated compounds to the inflorescences or bunches. Enhancing the elongation of inflorescence and uniform development of the grapevine branches are also among its key features (Kishino and Roberto, 2007).

As 'BRS Nubia' is a new table grape and there is limited information available regarding the effectiveness and the best time to perform bunch sizing to prevent compactness, the aim of this work was to obtain uniform and loose bunches of this cultivar by means of inflorescence and bearing shoot management associated to berry thinning under subtropical conditions.

2. Material and methods

2.1. Grapevines and growing conditions

The study was conducted on 2-year-old vines of 'BRS Nubia' grape (*Vitis* spp.) grafted on 'IAC 766 Campinas' rootstock, in a commercial vineyard located in Marialva city, state of Parana, Brazil (23°29′06" S, 51°47′31" W, elevation 602 m), during two consecutive seasons of 2015 and 2016. The vines were trained using an overhead trellises system and spaced at a distance of 2.5 × 9.0 m apart.

According to the Köppen classification, the climate of the region is Cfa, i.e. subtropical with an average temperature in the coldest month below 18 °C and average temperature in the warmest month above 22 °C. Maximum temperature is approximately 31 °C, and the average annual rainfall is 1596 mm, with concentrated rainfalls during the summer season.

Vines were pruned with four buds left per cane and afterwards, 6% hydrogen cyanamide was applied to the buds in order to induce and standardize the sprouting. For load adjustment, 48 canes per vine were left to achieve a density of six bunches per m^2. However, since this was the first crops of the vineyard which were being evaluated, therefore the density of maximum two and four bunches per m^2 were achieved for 2015 and 2016 seasons, respectively.

2.2. Treatments and experimental design

The experimental design was randomized block with four replications and two vines per plot, in a 2-factor arrangement with two additional treatments (factorial 2 × 2 + 2). The following factors were evaluated: inflorescence management (with tipping before anthesis and without tipping), bearing shoot tipping (before or after anthesis), and the two additional treatments consisted of two controls (with or without berry thinning). Only one trained worker performed all techniques.

The inflorescence tipping consisted of a removal of around 40% of its length, two days before anthesis using a thinning-scissor (Fig. 1), while the bearing shoot tipping consisted of the manual removal of the its tip, two days before anthesis or 10 days after this phase (Fig. 2). Both techniques were considered easy and fast to perform, as the time required to perform each one was around 5 s per inflorescence or shoot. The berry thinning was performed in all treatments, except in control without berry thinning, by means of picking using a thinning-scissor when berries were at pea size, removing around 45% of berries of each bunch, followed by bunch tipping, if necessary. The time required to perform this technique was around 60 s (0.0166 h) per bunch, but when applied to bunches which inflorescences had been previously tipped, the time was reduced to half. During the trial, all the cultural practices of the area like fertilization, weed, pest and disease control were carried out as usual.

2.3. Berry sampling and fruits analysis

For bunch mass (g), length (cm) and width (cm), 10 bunches per plot were collected at harvest of each season, while for berry mass (g), length (mm) and width (mm), two berries were collected from each bunch, totaling 20 berries per plot. The number of berries per bunch was estimated by the relation bunch mass/berry mass.

For chemical evaluation of berries, such as total soluble solids (TSS), titratable acidity (TA) and maturity index − MI (TSS/TA), 20 berries per plot were evaluated. The TSS was determined using a digital refractometer with automatic temperature compensation (DR301-95 Model, Krüss Optronic, Germany), and result were expressed in °Brix. Titratable acitidy (TA) of the berries was calculated via titration of the grape juice with a standard 0.1 N NaOH solution in a semi-automatic titrator, adopting pH = 8.2 as the end point of titration, and results were expressed in per cent of tartaric acid (Youssef and Roberto, 2014).

The production per plant (kg) and yield (ton ha^{-1}) were estimated from the number of clusters per vine and their mass.

The compactness distribution of bunches (%) was calculated by visual observations of bunches, using the following classification based on descriptor code #204 for *Vitis* cultivars proposed by OIV (2001) and Albuquerque (1999): very loose (rachis very visible), medium loose (separated berries, well distributed and non-visible pedicels) and very dense bunches (berries completely compact, deformed). For 'BRS Nubia' grape, bunches classified as medium loose were considered ideal for the table grape market.

Means were subjected to analysis of variance (ANOVA) and compared using Tukey's test at 5% probability using the Assistat® software (Silva de and Azevedo, 2002).

Additionally, data were subjected to Principal Component Analysis (PCA) aiming to describe the relation of physico-chemical and productive characteristics of grapes with the inflorescence and shoot management. The PCA was performed using the Software R (R Development Core Team, 2012) and the FactoMineR package. For this analysis, the treatments were distributed throughout the principal component axis, i.e., the closer a treatment of the other, the more similar they were, while the treatments that were more distant from the axis of the main components were the most discrepant.

3. Results and discussion

From the data analysis of both seasons, it has been observed that there is no interaction between factors and the evaluated variables, indicating their self-reliance. However, berry mass and number of berries per bunch differed significantly with control treatments, either with or without berry thinning (Table 1). The berry thinning resulted in higher berry mass for both seasons, whereas the number of berries per bunch were lower, which was to be expected since berries were removed during thinning process.

Thinning procedure performed on 'Black Star' table grapes, in order to reduce its compactness, in response increased the berries size (Roberto et al., 2017). Similarly, berry thinning in 'Perlette' grapes resulted in higher berry mass, compensating berries loss caused by thinning procedure and therefore not affecting total yield (Cheema et al., 1997). On the other hand, there was no difference in the berry mass of 'Recel Uzumu' table grapes subjected to thinning (Özer et al., 2012). It can be noticed that depending on a cultivar and the characteristics of its berries, the effect of thinning on their mass may be different, since 'BRS Nubia' table grape has large berries and it is clear that the development of these berries is reduced due to excessive