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Ethephon and abscisic acid for improving colour of 'Crimson Seedless' table grape in the Vale do São Francisco, Northeastern of Brazil in 2012 growing season

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Background and Aims

The Vale do São Francisco, in the Northeast region of Brazil, is one of the most important tropical grape growing regions in the world. In this region there are 11,000ha of cultivated table grapes. This region is also responsible for 99% of Brazilian exports of table grapes. 'Crimson Seedless' grapes growing in these tropical conditions generally exhibit clusters with a poor and uneven red colouring, especially when they are harvested in October, in the hottest period of the year. Crop practices, such as thinning, leaf removal, topping and tying are undertaken by growers to minimise shading but is insufficient to solve the problem of poor colour development. For that reason, some plant growth regulators (PGRs) have been adopted.

The aim of this study was to assess the effect of different concentrations and time periods of application of ABA and ethephon, on the properties of colour and quality of 'Crimson Seedless' grapes produced in the Vale do São Francisco. This study, undertaken in the 2012 season, aimed to improve the colour of grape cv. Crimson Seedless through the application of plant growth regulators.

Experimental Procedure and Results

The study was conducted over a single season in 2012 in Petrolina, PE (9° 23'S, 40° 39'W, 394m Alt.). Eight-year-old commercial *Vitis vinifera* L. cv. 'Crimson Seedless' vineyard grafted on IAC 313 rootstock were trained to bilateral cordons, supported by an overhead trellis system, and cane (10-12 buds) pruned. The vines were spaced 4.0m within rows and 5.0m between rows. The vineyard was drip irrigated and vineyard management and fertilisation was similar to the practices recommended in that region.

A randomised complete-block design was used with a single vine per treatment replicate with two adjacent vines in-row, between replicates, used as buffer vines. There were ten treatments and four replications. Treatments consisted of Ethephon and Abscisic Acid (ABA) or the combination of both PGRs, applied at two phenological phases: first one in berry softening or *véraison* and second one was carried out about 15 before harvest. The treatments were as follows:

- (T1) control (no treatment)
- (T2) Ethephon
- (T3) ABA, 400mg.L^{-1} at 117 days after pruning (DAP)
- (T4) ABA, 200 + 200mg.L^{-1} at 97 and 117 DAP
- (T5) ABA, 400mg.L^{-1} at 97 DAP
- (T6) ABA, 600mg.L^{-1} at 117 DAP
- (T7) ABA, 300 + 300mg.L^{-1} at 97 and 117 DAP
- (T8) ABA, 600mg.L^{-1} at 97 DAP
- (T9) Ethephon + ABA, 200mg.L^{-1} both of them applied at 97 DAP
- (T10) Ethephon + ABA , 300mg.L^{-1} at 97 DAP

Pruning was held on 13/07/2012, the first application of ethephon and ABA on 18/10/2012, the 2nd application on 07/11/2012 with harvest on 21/11/2012. The Commercial products were Ethrel® 720 (1mL.L^{-1}), and VBC 30101 (ProTone®) provided by ValentBiosciences®, USA, containing 100g of abscisic acid (S-ABA) per litre, the latter still not registered in Brazil. A non-ionic wetter/spreader surfactant (0.5mL.L^{-1}) was added to the solution for all treatments. The PGRs were applied directly to the clusters with a handheld sprayer until runoff, the total volume of solution used was 1.0L per plant or 500L.ha^{-1}.

Clusters from each vine were harvested after most of the fruits were considered to have exceeded the minimum market requirements of 16.5% total soluble solids (TSS), and 20:1 total soluble solids:titratable acidity ratio. Only commercially acceptable clusters were harvested. The grape yield components and physicochemical characteristics of all treatments were assessed by determining the yield (kg) and number of clusters in classes of colour (Class 1: 0 - 25% of uniform red colour of berries; Class 2: 26 - 60%; Class 3 : 61- 90% and class 4: 91 - 100% of red berries and uniform colour); mass of cluster (g); length and diameter of berry (mm); firmness and elasticity of berry; soluble solids; titratable acidity; anthocyanins content. The surface colour of berries in each sample were measured with a reflectance colourimeter to obtain the colour index of red grapes (CIRG) calculated as $CIRG = (180- h°)/(C^{*}+L^{*})$, where L^{*} is the lightness and corresponds to a black-white scale (0, black; 100, white), $h°$ is the hue angle on the colour wheel, and C^{*} is the chroma, a measure of the intensity of colour, which begins at zero (achromatic) and increases in intensity. Data were subjected to analysis of variance and the means were compared by Tukey test ($P < 0.05$).

The results showed that there was an increase of 39% in yield when ethephon + ABA 300mg.L^{-1} were applied compared to the treatment ABA 400mg.L^{-1} at 97 DAP. Those effects were observed as a consequence of an increasing in mass of clusters. On the other hand, the other treatments were not significantly different from each other, which do not allow associating those effects in increasing the mass of cluster and the yield per plant with use of PGRs.

In regard to the colour coverage and colour intensity of 'Crimson Seedless' berries, significant differences were observed only in the number of clusters in classes 1 and 4. A larger number of clusters in class 1 were observed in control, but did not differ from treatments with ABA, independent of the dose, number and timing of application. On the other hand, the fewer clusters in class 1 were observed in the following treatments: ethephon + ABA 300mg.L^{-1}, ethephon + ABA 200mg.L^{-1} and ethephon alone, respectively with 9 (8.9%), 14 (13%) and 17 (16 %) of clusters per plant. The best responses to improve colour of ' Crimson Seedless' berries was shown in class 4, where larger number of clusters were obtained in the treatments combining ethephon and ABA (200 or 300mg.L^{-1}) These treatments differed significantly from all the other treatments.

All components of the colour were affected by treatments, the lightness of surface of berries increased in control, ethephon, ABA 400 mg.L^{-1} applied at 117 DAP or 97 DAP and ABA in two applications of 200mg.L^{-1} at 97 and 117 DAP. The higher colour intensity (chroma) was observed in berries treated with ABA 600mg.L^{-1} at 97 DAP. However, treatments combining ethephon and ABA at 200mg.L^{-1} and ABA 600mg.L^{-1} at 117 DAP showed similar responses. The values of hue angle ($h°$), indicated closest tones of red (low values of $h°$) were observed in the berries that received ethephon alone or combined with ABA. As a consequence of the integration of the values of attributes mentioned in particular the direct relationship with $h°$, the highest values of CIRG were observed in berries treated with ethephon alone, ethephon combined with ABA (200 or 300mg.L^{-1}), ABA applied twice (200 or 300mg.L^{-1}) and ABA 400mg.L^{-1} at 97 DAP.

The anthocyanin contents were higher in the surface of grapes treated with ethephon + ABA 200mg.L^{-1} but that effect did not differ from the ethephon + ABA 300mg.L^{-1} and ABA 300mg.L^{-1} applied twice at 97 and 117 DAP.

The berry size, total soluble solids and titratable acidity were not affected by PGR treatments. Other studies have also showed similar results indicating that ABA increases the synthesis of anthocyanins without changing the size of clusters, size of berries and flavour.

Discussion and Significance of the Study

The results obtained under tropical conditions of Vale do São Francisco showed that combination of growth regulators ethephon and ABA (200 or 300mg.L^{-1}) and ABA applied twice at 300mg.L^{-1} improve the level of anthocyanins and colour of berries in 'Crimson Seedless' grapes. However there was no treatment effect on soluble solids, titratable acidity, size of berry and yield. The decision to adopt ABA and/or ethephon can be guided by the costs involved in the application, presence of residues in fruit and acceptance of products by certification systems for safe and sustainable production.