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Effect of Date of Spraying CPPU (Sitofex®) on Fruit Quality of 'Meski' Table Grapes

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ABSTRACT

The objective of this study was to evaluate the effect the synthetic cytokinin forchlorfenuron, most commonly known as CPPU (Sitofex®), on fruit quality of 'Meski' table grape grown in central Tunisia. Application of 1% CPPU was performed at 1 (A), 2 (B) and 3 (C) weeks following full bloom. All treatments enhanced berry size, berry weigh and bunch weight by at least 10, 17% and 20% respectively, while bunches length improved slightly ($P = 0.15$). In addition, the number of berries per bunch was increased only by treatments A and B. Yet, these two treatments significantly increased fruit set which produced very compacted and unmarketable bunches. On the other hand, CPPU application reduced °Brix and pH of bunches juice and then delayed maturity which can be advantageous in fresh market fruit. In conclusion, the best results with regard to fruit size and quality of 'Meski' table grape were obtained when CPPU was sprayed at 1% (v/v) three weeks after full bloom. However, early applications will be more advantageous if combined with a growth regulator that allowed better growth of the rachis.

Keywords: berry size, synthetic cytokinin, total soluble solids, *Vitis vinifera*
Abbreviations: CPPU, 1-(2-chloro-4-pyridyl)-3-phenylurea

INTRODUCTION

Grapevine (*Vitis vinifera* L.) is one of the most widely distributed fruit crop in the world (Westood 1993; Marzouk and Kassem 2011). In Tunisia, the area of grapevine increased currently throughout the country especially in the south and in the centre. The recent increase in table grape production has placed new importance on fruit quality. Therefore, any efforts that could be done to maintain the grape fruits with high quality characteristics such as berry size, weight, firmness and cluster uniformity at harvest, and during marketing, would be very important for the table grape growers in order to obtain higher monetary.

Quality components of grapes are influenced by genotype, climate, cultural practices and horticultural practices. Practices aimed at improving the quality of grapes include those which improve the physical characters of bunches, berries and chemical composition of the berries. Berry size, which is the main quality factor affecting sales of table grapes in international markets, is genetically predetermined among cultivars, but it can be considerably increased by adjusting the crop load (Dokoozlian *et al.* 1994a), by employing cluster and berry thinning (Sharples *et al.* 1955), trunk girdling (Dokoozlian *et al.* 1994b), and with the use of growth regulators (Reynolds *et al.* 1992; Abu-Zahra 2010; Ben Mohamed *et al.* 2010). Indeed, berry size and bunch conformation of table grapes are customarily improved through the application of some growth regulators. Gibberellic acid (GA_3) is widely used as a thinning spray when seedless grapevine cultivars are used for table grape production (Dokoozlian *et al.* 2000). The thinning spray promotes flower abortion and increases rachis elongation. Generally, GA_3 application reduced berry set, increased berry weight, and improved juice quality (Teszlak *et al.* 2005). Nowadays, forchlorfenuron (CPPU) is a substance derived from phenylurea with cytokinin activity that influences cell division and promotes fruit growth in various species such as apple, kiwifruit and grape (Ogata *et al.* 1989; Abu-Zhahra 2010). However, the effectiveness of treatments is timing and rate dependant. The objective of the current study was to estimate the proper time to apply Sitofex® CPPU in order to improve fruit characteristics of 'Meski' table grape.

MATERIALS AND METHODS

Plant material

This study was conducted on 6-year-old table grapes, cv. 'Meski' the most widely planted table variety in Tunisia, in a drip fertigated commercial vineyard located in the centre of Tunisia near the town of Rgueb (34° 52′ N; 9° 47′ E). The vines were supported on an overhead arbor 2m high (pergola) and planted with 3.5 m × 3 m spacing.

CPPU treatments

An aqueous solution of 1% Sitofex® (Degussa AG, Trosberg, Germany) (v/v) was applied directly to the bunches with a handheld sprayer until runoff in the early morning one (A), two (B) or three (C) weeks following full bloom. Similarly, others vines were sprayed with water on the 1st week following full bloom to serve as controls. Each treatment was applied to 4 blocks consisting of 3 vines.

Measured parameters

For each treatment, random samples of two bunches per vine were collected at the beginning of the commercial harvest. Fresh weigh and length of each bunch were determined. The berries of each collected bunch were weighed and their diameters were measured, then they were crushed and the juice was used to determine total soluble solids (°Brix) using a hand refractometer and pH (Ben Mohamed *et al.* 2010).

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Short Communication

Statistical analysis

Data were subjected to analysis of variance (ANOVA) using SAS statistical software version 6.12 (SAS Institute, Cary, NC, USA). Means were separated by Duncan's multiple range test at $P < 0.05$.

RESULTS

Effects on fruit growth

Post flowering applications of CPPU improved bunch development. Indeed, bunch weight was markedly increased by 24, 31 and 20% (compared to the control) by treatments A, B and C, respectively (**Fig. 1A**). However, bunch length was less affected by CPPU treatments and it tended to slightly increase for all treatments compared to the control ($P = 0.15$) (**Fig. 1B**).

All the used treatments hastened berries diameter by 13, 10 and 12% for treatments A, B and C, respectively, as compared to the untreated berries (**Fig. 2A**). Bunches treated with CPPU resulted in development of larger berries with a significant difference with the control treatment, which produced the smallest ones. Accordingly, berry weight was increased by 28, 17 and 26% for treatments A, B and C, respectively (**Fig. 2B**).

To better appreciate the effect of these treatments on berry weight, we examined weight distribution among 3 arbitrary classes (**Table 1**). All treatments, especially treatments A and C, reduced the percentage of small berries in favor of medium and large berries. Therefore, Sitofex® promoted berry growth and homogeneity. However, for treatments A and B, the increase in bunch mass appears to not be due only to berry size improvement but also to increased fruit set (number of berries per bunch) (**Fig. 3**). This caused the bunch to become too tightly packed reducing their commercial value.

Treatment C was more interesting; it produced heavier bunches with larger berries without the compaction effect; consequently, the marketability of the crop improved.

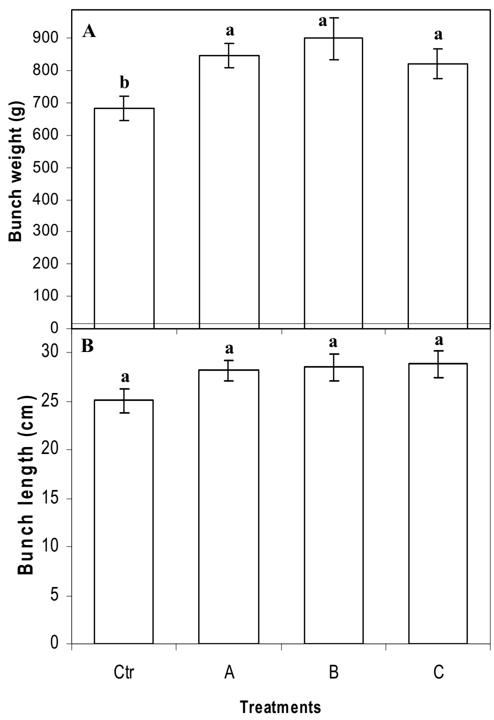

Fig. 1 Effect of CPPU applications on bunch weight (**A**) and length (**B**). The vines were either sprayed with water (Ctr) or with a 1% (v/v) aqueous solution of Sitofex® on the 1 (A), 2 (B) or 3 (C) weeks after full bloom. Values followed by the same letter are not significantly different according to Duncan's Multiple Range Test ($P < 0.05$).

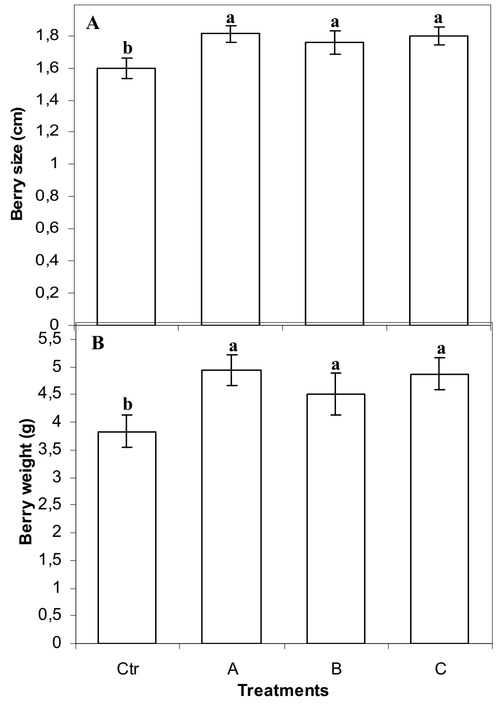

Fig. 2 Effect of CPPU applications on berry weight (A) and diameter (B). Berries were collected from vines sprayed with water (Ctr) or with a 1% (v/v) aqueous solution of Sitofex® on the 1 (A), 2 (B) or 3 (C) weeks after full bloom. Values followed by the same letter are not significantly different according to Duncan's Multiple Range Test ($P < 0.05$).

Table 1 Effect of CPPU treatments on berry distribution into three classes of weight.

Treatments	[0 - 2g[	[2 - 4g[	≥ 4g
Ctr	17%	35%	48%
A	3%	22%	75%
B	11%	30%	59%
C	5%	16%	79%

Table 2 Effect of CPPU applications on total soluble solids (°Brix) and pH of 'Meski' grapes.

Treatments	°Brix*	pH*
Ctr	15.3 a	4.0 a
A	14.4 b	3.7 b
B	14.0 b	3.3 b
C	14.3 b	3.5 b

* Different letters within a column indicate significant differences according to Duncan's Multiple Range Test ($P < 0.05$).

Effects on fruit maturity

Berry total soluble solids content (°Brix) was decreased by all treatments compared to the control. So, CPPU tended to delay fruit maturity as indicated by a significant reduction in degree Brix as well as a decrease in pH compared with the control (**Table 2**).

DISCUSSION

Currently a large number of growth regulators are used on table grapes to achieve different objectives. However, the effectiveness of these products remains controversial. It depends on the concentration and time of application. The best prices of table grapes are always obtained for large berries. For that reason, growers frequently use GA_3. Nowadays, the use of CPPU has also been suggested to be a potent growth regulator with strong cytokinin activity for enhancing fruit size.

In the present study, we used a concentration of 1% Sitofex®, containing 10 ppm CPPU. Spraying CPPU was made on three date: one (A), two (B) or three (C) weeks

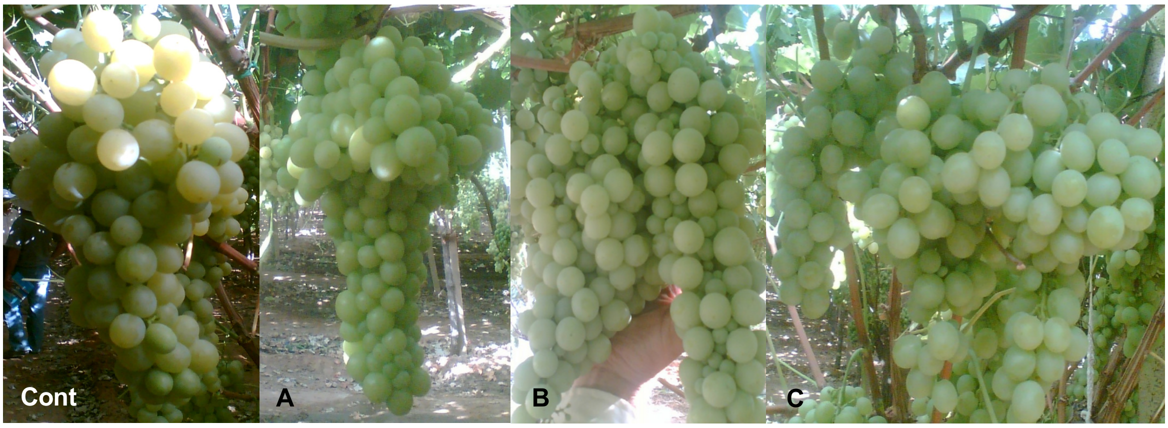

Fig. 3 Effect of CPPU treatments on the general appearance and shape of clusters.

following full bloom. CPPU treatments generally have limited effect on the length of bunches while bunches weight was significantly increased. This difference may due to the increase in bunch load or fruit set. Thus, it appears that CPPU treatments reduce the coulure or shatter phenomena (fall of flowers and/or young berry) and ameliorate the rate of fruit set. Nonetheless, the increase in bunch load was not accompanied by an extension in the vegetative structure (rachis). Thus, the resulting bunches are very compact for the earliest two treatments A and B but not for treatment C (**Fig. 3**). This caused bunches to become too tightly packed with poor quality, prone to fungal diseases and accordingly reducing their commercial value. These observations confirm in part those of Rizk *et al.* (2003) who reported that CPPU application at early stages increases detrimentally the bunches compactness and develop unmarketable product.

To avoid such undesirable effect of CPPU on bunches compactness, it would be interestingly to combine or to precede the early applications (A, B) with a proper cultural treatment that could increase rachis seize. This allows the berry to find the appropriate space to grow and providing a charged bunches with a good presentation. Gibberellic acid (GA_3 generally) application just at full bloom can ameliorate the rachis development and reduce the compactness of bunches (Omran *et al.* 2005), it may be useful for correcting the adverse treatments (A, B). Such kind of combination of GA_3 and cytokinins is effective in improving the size and yield (Reynolds *et al.* 1992; Zoffoli *et al.* 2009).

Independent of the application date, berry size and weight was significantly increased and the larger and heavier berries were obtained with treatment A and C. In addition, these two treatments reduce the percentage of small berries in favour of medium and larger ones. However, treatment C was most effective. It provides a heavier bunch with large berries without affecting bunch compactness improving, therefore, the presentation and quality of fruit. Similarly, such effect was observed kiwi-fruit (Cruz-Castillo *et al.* 2002). It was well established that both cytokinins and gibberellins improve seize of many fruits by stimulating cell division and/or cell expansion in many fruit including apple, kiwi-fruit (Ogata *et al.* 1989), sweet cherry (Zhang and Whiting 2011) and gourd (Yu *et al.* 2001). In this way, further research is needed to demonstrate the effect of CPPU on this phenomenon.

With increasing fruit size by CPPU treatment, a significant reduction in total soluble solids (°Brix) and pH were also observed. Similar results were reported by du Plessis (2008). The reduction in the total soluble solids content may reflect the influence of CPPU on the maturation process by slowing the accumulation of sugars and the delay in fruit maturity.

In conclusion, our results indicate that CPPU was most effective in improving berry size and homogeneity when applied 3 weeks before full bloom (treatment C). However, earlier applications (treatments A and B) should be advantageous if combined with a growth regulator (e.g. GA_3) which allows better growth of the rachis.

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