

**EFFECT OF GIRDLIN, STRAPPING AND ETHEPHON
SPRAYING ON FRUIT QUALITY OF (*Vitis vinifera*) cv.
ALPHONSO LA VALLE**

By

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ABSTRACT

This study was carried out to evaluate the effect of girdling, strapping and ethephon spraying, alone or in combinations, on fruit quality of grape c.v.” Alphonso Lavelle”. This study was conducted in ElHawary area, Benghazi, Libya during the summer seasons of 2008 and 2009. The vines were girdled and strapped two weeks after petal fall. Ethephon was sprayed at (0.0, 500, and 1000) ppm on bunch at the start of berry coloration (veraison). Girdling and strapping significantly increased the average bunch weight, berry weight, length, and width, while as quality of grape in terms of “TSS”, acidity, and TSS/acid ratio did not differ significantly. Ethephon spray significantly increased bunch weight, TSS and TSS/Acid ratio, however, fruit acidity was decreased. Girdling and strapping combined with ethephon especially at 500 ppm proved most effective in increasing all studied parameters in compare to untreated control trees.

INTRODUCTION

Grape (*Vitis vinifera* L.) is considered as one of the most important commercial fruit crops of temperate to tropical regions (Gowda *et al.*, 2008). The grape is gaining popularity for its high nutritive value, excellent in taste, multipurpose use and better returns (Ghosh *et al.*, 2008). A constant and steady improvement is observed in worldwide table grape consumption (Celik *et al.*, 2005). Alphonso Lavelle is a

medium ripening grape variety suitable for north Libyan conditions. It is quite vigorous, seedy, with medium sized bunches and attractive black berries. In spite of these qualitative attributes it is also beset with serious problems like shot berries formation, heterogeneity of maturity of the cluster (including the green immature berries at harvest), and lesser total soluble solids. Girdling (phloem stress) has been, worldwide horticultural practice used to manipulate tree growth and development. (Chun *et al.*, 2003). The girdling and scoring have been shown to be effective techniques to reduce vegetative growth, promote flowering, improve fruit set, increase fruit size, sugar content of fruits and advance maturity in a wide variety of fruit trees (Goren *et al.*, 2004; Onguso *et al.*, 2004; Hossain *et al.*, 2007; Hossain and Boyce, 2009). Girdling involves the removal of a strip of phloem from the circumference of the trunk or branch and has been considered a dangerous technique that could result in the death of a tree if the xylem is severed or if the girdle is too wide (Goren *et al.*, 2004 Hamada *et al.*, 2009). Strapping, wire-girdling, is the least aggressive form of girdling that has been used extensively in persimmon to increase fruit size and total soluble solids (TSS) as well as promote fruit maturation and yield (Hasegawa *et al.*, 2003 and 2009 ;Hamada *et al.*, 2009). The increase in berry size due to girdling may result from better carbohydrate accumulation above the girdle as the transport of sugars from leaves to the root system is effectively blocked (Roper and Williams, 1989). As results of girdling leaf N content, C/N ratio and carbohydrate were improved therefore, flowering and fruit set were increased (Shao *et al.*, 1998). Alternatively; changes in the hormone balance of the vine after girdling may have a role on increasing berry size (Kriedemann and Lenz, 1972). Girdling the trunks of grapevines can affect water use when compared to non-girdled grapevines (Williams and Ayars (2005). Ethephon is a growth –regulating chemical which acts through its release of ethylene (Edgerton and Blanpied, 1968). It is most often used in orchards as a spray shortly before harvest to advance and promotes early uniform fruit maturation (Peterson and Wolford 2001). Glozer *et al.* (2006) reported that application of ethephon in sweet cherry did not affect the fruit color. However, the ‘Windsor’ sweet cherry

cultivar showed increasing weight and color when ethephon was applied at rates of 500 ppm or higher (Bukovac, *et al.* 1971). The reaction appears to be cultivar-dependent, because subsequent research showed no significant changes in fruit quality (Bukovac, 1979). Total SSC was significantly lower in ethephon-treated sour cherry.

Ethephon spray did not have any significant effect on pH, TA, and SSC/TA ratio. Szyjewicz *et al.*, (1984) mentioned that the effect of ethephon on fruit composition varied with cultivars, and timing, concentration, and method of application, so contradictory results have been noted about its effects on SSC, TA, and pH. Aryanpooya and Davarynejad (2009) reached the same result about pH, TA, and SSC/TA ratio in 'Érdi Jubileum' sour cherry treated with various concentrations of ethephon which was not different from control. On the other hand, as reported by Delgado *et al.*, (2004), ethephon application decreased the SSC of 'Tempranillo' grapes at harvest time in relation to the control. Lombard *et al.* (2004) reported that SSC and TA levels of 'Flame Seedless' grape decreased or tended to decrease by increasing ethephon dosages above 100 mg·L⁻¹. The higher dosages having significantly lower SSC and TA levels than the control. Singh and Shafiq (2008) resulted that there were no significant differences in fruit firmness, SSC, or TA of the fruits harvested from ethrel -treated and control 'Pink Lady' apple trees, at commercial harvest. Average berry mass of flame seedless grape was influenced by dosage of ethephon and tended to reach a maximum at 200 ppm (Lombard *et al.* 2004). El-Zeftawi (1976) reported ethephon at 250 ppm produced the largest and heaviest 'Imperial' mandarin. Smith and Whiting (2010) indicated that ethephon-treated 'Chelan' sweet cherry was significantly heavier and darker than non-treated fruit. The literature contains numerous contradictory reports of berry composition in response to ethephon. There is a lack of information about the effect of a combination of Ethephon and girdling or strapping on fruit quality of seedy grapevine. The objectives of this research were to assess effectiveness of girdling techniques such as strapping (wire-girdling) and severe girdling entailing removal of 5 mm bark, as well as the use of the PGR's ethephon, and a combination of both practices on

fruit quality and to advance and promotes early uniform fruit maturation of “Alphonso Lavelle” grape cultivar grown in Plain area in Benghazi, the Great artificial River Project.

MATERIALS AND METHODS

The present study was carried out on Alphonso Lavelle grape cultivar (6 year old vines) trained on cordon system. Various treatments i.e., girdling of fruiting spurs of 9 grapevines and scoring (Strapping or wire-girdling) of fruiting spurs of 9 grapevines were done two weeks after petal fall and 9 grapevines without girdling or strapping served as a control. Ethephon treatments were applied at the beginning of the berry coloration by spraying the bunches with ethephon at (0,500 and 1000 ppm) alone and in combination as follow:

Girdling of fruiting spur only (G) (3 grapevines), G + spraying of bunches with ethephon at 500ppm (3 grapevines), G + spraying of bunches with ethephon at 1000ppm (3 grapevines). Strapping of fruiting spur only (S) (3 grapevines), S + spraying of bunches with ethephon at 500ppm (3 grapevines), S + spraying of bunches with ethephon at 1000 ppm (3 grapevines). Control 3 grapevines without any treatments (C) , C + spraying of bunches with ethephon at 500ppm (3 grapevines), C+ spraying of bunches with ethephon at 1000 ppm(3 grapevines), Girdling of fruiting spurs was carried out two weeks after petal fall and was done with the help of girdling knife having 5 mm width. It was ensured that cambium layer of stem was completely removed. However, strapping (wire-girdling) was done by using of wire tied around the circumference of the spurs. Spraying of the bunches was done at the beginning of fruit coloration. Physicochemical analysis of the bunches was done at the time of harvest(end of August)to assess the quality of grapes.100 berries were selected at random and were used to ascertain average berry weight., berry length, berry width ,cluster weight , Juice from these berries was extracted with a hand press and filtered through cheesecloth. The TSS was measured with a refractometer Cambridge Instruments, Buffalo, NY), and the titratable acidities (TAs) were determined by titration of 3

ml of juice with 0.1N sodium hydroxide (NaOH) according to A.O.A.C (1981). The statistical design of the experiment was a factorial design arranged in a completely randomized block design (CRBD) with three replicats.variance analysis was carried out through COSTAT statistical software and means were compared by Duncan Multiple Range Test (0.05).

RESULTS AND DISCUSSION

1.Berry and cluster weight:

Results in (Fig.1) indicated that the girdling and strapping increased significantly berry weight of Alphonso Lavelle grape cultivar in compare to untreated vines in both seasons. Girdling posted the highest weight of berries and this was followed by strapping, whilst control treatment produced the lowest value in case of fruit weight. However ethephon has no effects on average berry weight in both seasons (Fig.2). Concerning the effect of the interaction between the different types of girdling and the ethephon concentrations, it was found that strapping and girdling accompanied with ethephon at 500 or 1000 ppm increased significantly berry weight in compare to untreated bunch in both seasons. The highest average of berry weight resulted from ringing accompanied with ethephon at 500 ppm in both seasons, however the lowest values were resulted from both untreated (control) and unringing accompanied with ethephon at 500 ppm in both seasons (Tables 1 and 2).

The results presented in Fig.(3 and 4) indicated that both scoring and girdling significantly increased average cluster weight in both seasons in compare to untreated control. Also, ethephon at 500 and 1000 ppm significantly increased average cluster weight in both seasons compare to untreated control. Concerning the interaction effects it was found that strapping treated with ethephon at 500 ppm resulted in the highest value of cluster weight in both season in compare to other treatments.

The present results are in harmony with those previously reported by Hossain *et al.*, (2007) who mentioned that fruit weight is an important

quality parameter of fruit production and bark ringing or girdling significantly increased the fruit weight as well as yield. Scoring, i.e., cutting through the phloem without removal of any material, is a less aggressive treatment that has increased fruit mass (Juan *et al.*, 2009) and fruit set in 'Triumph' persimmon (Steyn *et al.*, 2008). Strapping, also referred to as wire-girdling or strangulation, is the use of wire tied around the circumference of the tree and is the least aggressive form of girdling that has been used extensively in persimmon to increase fruit size. (Hasegawa *et al.*, 2003; Hamada *et al.*, 2009). A cane-scoring technique proved effective in increasing average berry size and increased bunch weight, compared with unscored bunches but had no effect in 'Aledo' seeded grape (Casanova, *et al.*, 2009). Girdling will increase berry size despite the fact that it reduces net CO₂ assimilation rate (A) and stomatal conductance (gs) of individual leaves of grapevines (Roper and Williams, 1989). The increase in berry size due to girdling may result from better carbohydrate nutrition above the girdle as the transport of sugars from leaves to the root system is effectively blocked (Roper and Williams, 1989). Alternatively, changes in the hormone balance of the vine after girdling may have a role in increasing berry size (Kriedemann and Lenz, 1972). Different types of girdling particularly increased mean fruit weight, dry matter and chlorophyll content and anthocyanin content in the fruits (Khandaker *et al.*, 2011). Girdling and scoring have been shown to be effective techniques to reduce vegetative growth, improve fruit set, increase fruit size and advance maturity in a wide variety of crops (Goren *et al.*, 2004 and Scheepers, 2010). Our results, disagree with the findings of Lombard *et al.*(2004) who reported that average berry mass was influenced by dosage of ethephon and tended to reach a maximum at 200 ppm. The reaction appears to be cultivar-dependent, because subsequent research showed no significant changes in fruit quality (Bukovac, 1979). Also, El-Zeftawi (1976) reported that ethephon at 250 ppm produced the largest and heaviest 'Imperial' mandarin. Smith and Whiting (2010) indicated that ethephon-treated 'Chelan' sweet cherry was significantly heavier and darker than non-treated fruit. Szyjewicz *et al.*, (1984) and Aryanpooya and Davarynejad (2009) mentioned that the effect of

ethephon on fruit composition varied with cultivars, and timing, concentration, and method of application, so contradictory results have been noted about its effects.

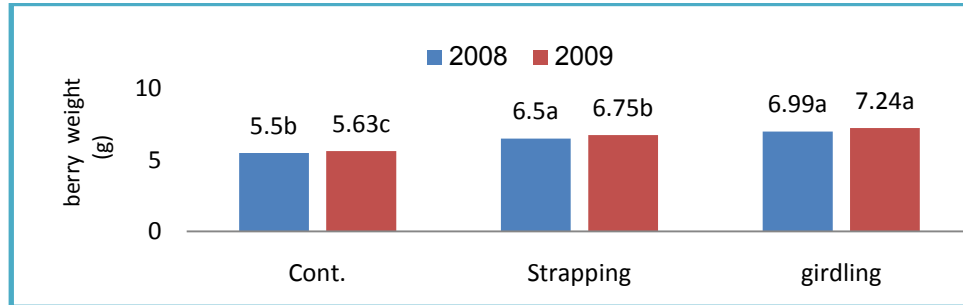


Figure (1): Effect of girdling and strapping on average berry weight of Alphonso Lavelle grape cultivar during 2008 and 2009 growing seasons

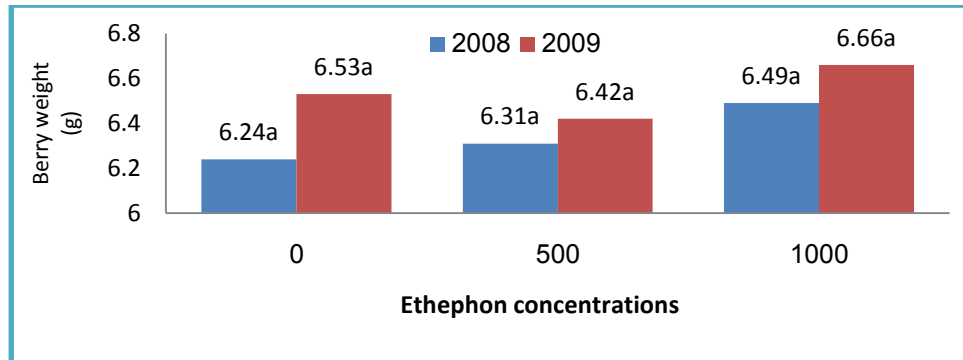


Figure (2): Effect of ethephon on average of berry weight of Alphonso Lavelle grape cultivar during 2008 and 2009 growing seasons

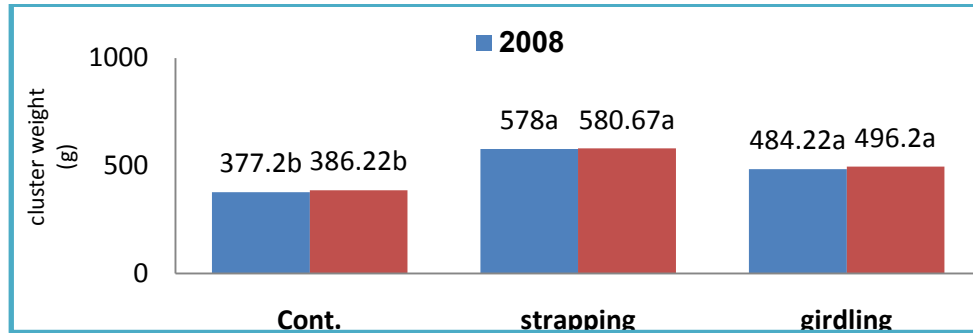


Figure (3): Effect of girddling and strapping on average cluster weight of Alphonso Lavelle grape cultivar during 2008 and 2009 growing seasons

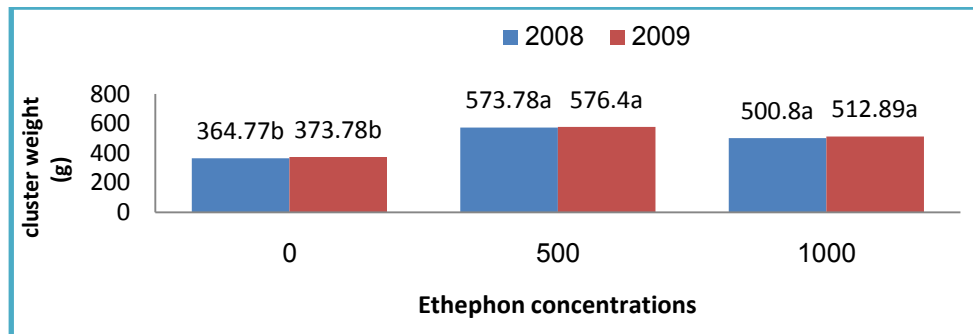


Figure (4): Effect of ethephon on average cluster weight of Alphonso Lavelle grape cultivar during 2008 and 2009 growing seasons

2. Berry Length, diameter and L/D ratio

Girdling and strapping significantly increased berry length and berry width compared to untreated control (Fig.5 and 6) in both seasons. Also ethephon, especially at 500 ppm increased significantly berry length in both seasons (Fig.7). The berry width was reduced significantly by the same concentration compare to other treatments in the first season; however, in the second one all treatments did not differ significantly (Fig. 8). Concerning the interaction effects, it was found that the highest significant values of berry length resulted from strapping and girddling

accompanied with 500 ppm ethephon in the first season and strapping accompanied with 500 ppm ethephon in the second one. The berry width was significantly increased in response to different type of girdling accompanied with ethephon at different concentrations in compare to other treatments; however the lowest values of both length and width resulted from untreated control in both seasons (Tables 1 and 2). Concerning L/D ratio, it was found that girdling and strapping have no significant effect on L/D ratio in both seasons (Fig. 9). On the other hand, ethephon at 500 ppm increased L/D ratio in the first season, however in the second one there was no significant difference among all treatments (Fig.10).The interaction effects revealed that strapping and girdling accompanied with ethephon at 500 ppm resulted in highest L/D ratio in the first season, however in the second one both strapping accompanied with ethephon at 500 ppm and girdling without ethephon gave the highest L/D ratio (Tables 1 and 2). The present results are in harmony with those previously reported by Casanova, *et al.*, (2009). The increase in berry size due to girdling may result from better carbohydrate nutrition above the girdle as the transport of sugars from leaves to the root system is effectively blocked (Roper and Williams, 1989). Different types of girdling increased the fruit L/D ratio (Khandaker *et al.*, 2011). Szyjewicz *et al.*, (1984) and Aryanpooya and Davarynejad (2009) mentioned that the effect of ethephon on fruit composition varied with cultivars, and timing, concentration, and method of application, so contradictory results have been noted about its effects.

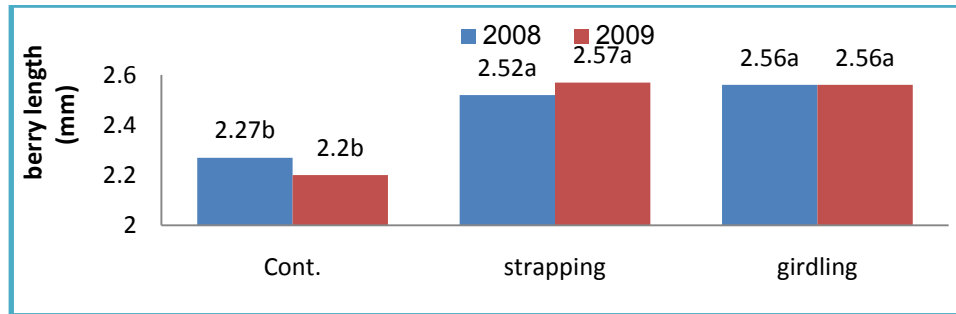


Figure (5): Effect of girdling and strapping on average berry length of Alphonso Lavelle grape cultivar during 2008 and 2009 growing seasons

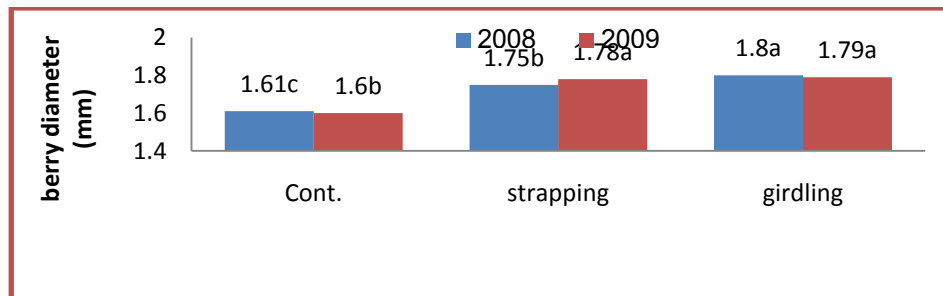


Figure (6): Effect of girdling and strapping on average berry diameter of Alphonso Lavelle grape cultivar during 2008 and 2009 growing seasons

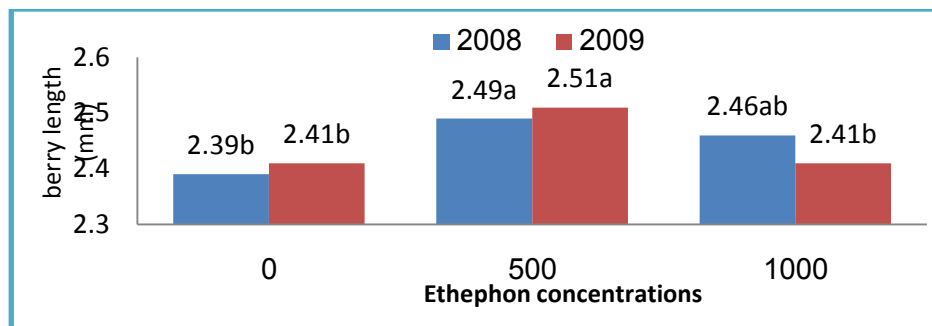


Figure (7): Effect of ethephon on average berry length of Alphonso Lavelle grape cultivar during 2008 and 2009 growing seasons

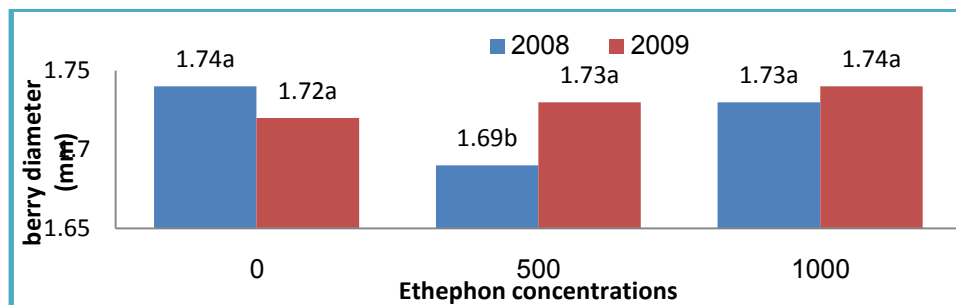


Figure (8): Effect of ethephon on average berry diameter of Alphonso Lavelle grape cultivar during 2008 and 2009 growing seasons

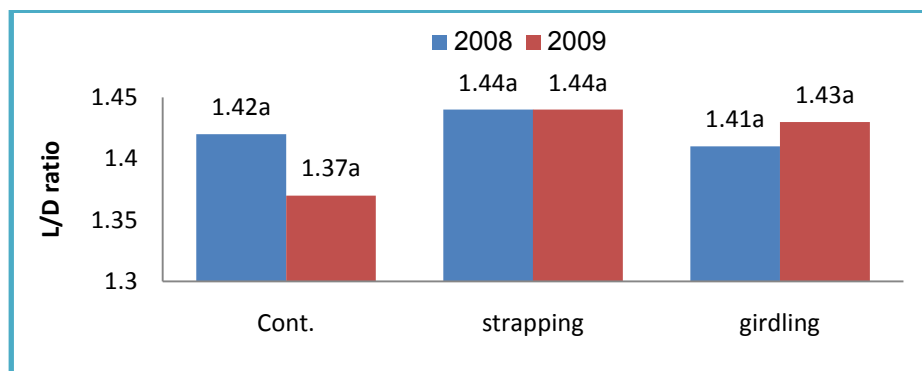


Figure (9): Effect of girdling and strapping on L/D ratio of berry of Alphonso Lavelle grape cultivar

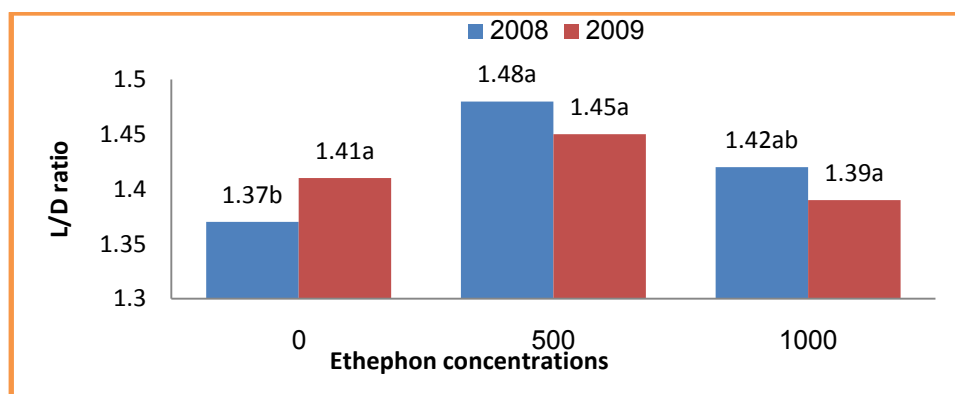


Figure (10): Effect of ethephon on L/D ratio of berry of Alphonso Lavelle grape cultivar

5. Total soluble solids (TSS %), acidity% and TSS/acid ratio:

Results in Fig. (11) Showed that two different type of girdling did not affect significantly on TSS% in both seasons .However Ethephon at 500 ppm significantly increased TSS% in both seasons in compare to untreated control (Fig. 12). In general, the interaction effects revealed that girdling or strapping accompanied with ethephon at 500 ppm significantly increased TSS % compared to the untreated control and resulted in the highest values of TSS % in both seasons (Table 3).

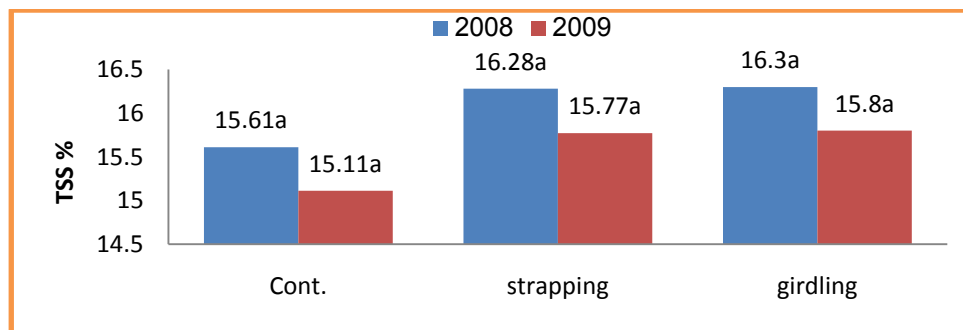


Figure (11): Effect of girdling and strapping on TSS % of berries of Alphonso Lavelle grape cultivar

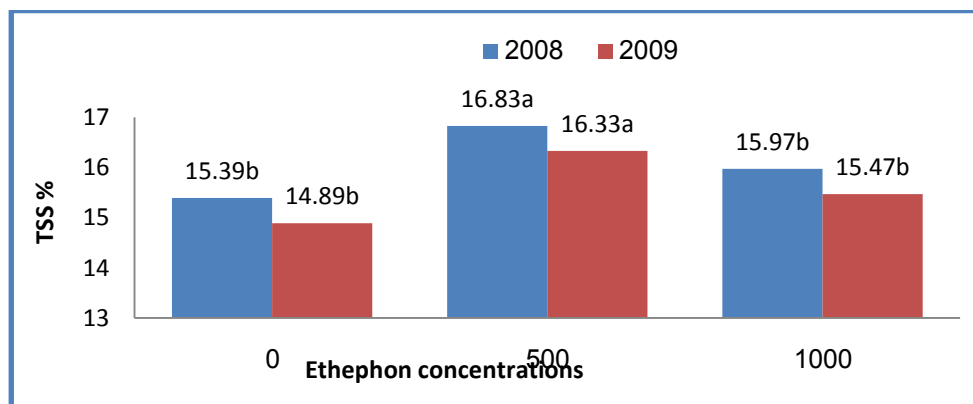


Figure (12): Effect of ethephon on TSS% of berries of Alphonso Lavelle grape cultivar

Results in Fig.(13) showed that two different types of girdling did not affect significantly acidity% in both seasons .However Ethepon at 1000 ppm increased significantly acidity % in both seasons in compare to untreated control (Fig. 14).The interaction effects have no effect on acidity % in both seasons (Table 3).

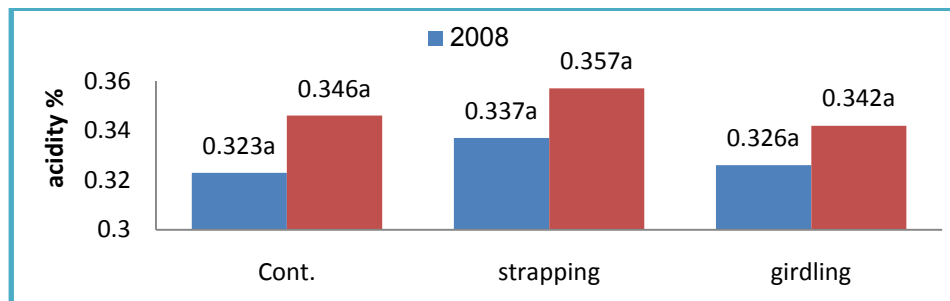


Figure (13): Effect of girdling and strapping on acidity % of berries of Alphonso Lavelle grape cultivar

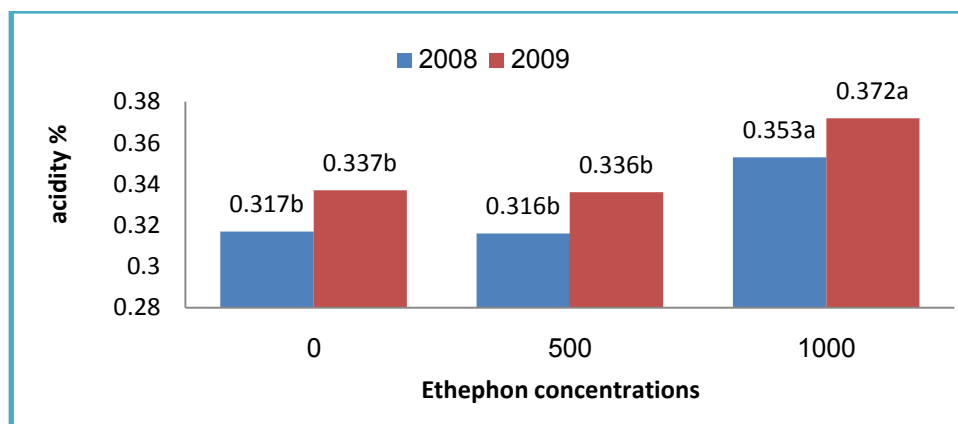


Figure (14): Effect of ethephon on acidity % of berries of Alphonso Lavelle grape cultivar

As shown in Fig. (15and16) no significant differences were found between girdling treatments in compare to untreated control in both seasons. Regarding TSS/acid ratio, however, ethephon at 1000 ppm significantly decreased TSS/acid ratio in both seasons in compare other treatments. The highest significant value of TSS/acid ratio was resulted from ethephon at 500 ppm in both seasons. The interaction effect as shown in Table (3) revealed that girdling accompanied with ethephon at 500 ppm resulted in the highest

significant values of TSS/acid ratio in both seasons in compare to the other treatments.

The present results are in harmony with those previously reported by, Hasegawa *et al.* (2009) who found that wire-girdling (strapping) increased TSS in 'Taishu' persimmon while Arakawa *et al.* (1997) found that bark removal increased TSS in apple cultivars. As girdling treatments were applied early in the season, it is possible that it did not have a significant effect on carbohydrate partitioning because carbohydrates are not translocated from the above ground parts to the roots early in the season (Theron and Steyn, 2008). However, wire-girdling for 'Taishu' persimmon one month before FB increased TSS at harvest (Hasegawa *et al.*, 2009). The present results are in harmony also with those previously reported by Hasegawa *et al.*, (2003 and 2009) and Hamada *et al.*, (2009) who reported that Strapping increased total soluble solids (TSS) as well as promote fruit maturation of persimmon. The girdling can bring about an increase in sugar content of fruits and cause them to mature a few days to a week earlier (Onguso *et al.*, 2004; Hossain *et al.*, 2007; Hossain & Boyce, 2009). Casanova *et al.* (2009) reported that scoring (one type of girdling) significantly increased the total sugar content in grape.

Our results revealed that ethephon increased TSS and TSS/acid ratio and decreased acidity especially at 500 ppm, these may disagree with other findings which reported that ethephon application stimulated the decrease in titratable acidity (TA), of rabbiteye blueberry during the growth period. While soluble solids were not significantly affected (Ban *et al.* 2007). As reported by Delgado *et al.* (2004) ethephon application decreased the SSC of 'Tempranillo' grapes also SSC was significantly lower in ethephon-treated sour cherry at harvest time in relation to the control (Khorshidi and Davarynejad, 2010).

Lombard *et al.* (2004) reported that SSC and TA levels of 'Flame Seedless' grape decreased or tended to decrease by increasing ethephon dosages above 100 mg·L⁻¹. The higher dosages having significantly lower SSC and TA levels than the control. Singh and Shafiq (2008) stated that there were no significant differences in SSC, or TA of the fruits harvested from ethrel-treated and control 'Pink Lady' apple trees, at commercial harvest. Szyjewicz, *et al.* (1984) mentioned that the effect of ethephon on fruit composition varied with cultivars, and timing, concentration, and method of application, so contradictory results have been noted about its effects on SSC, TA, and pH. Aryanpooya and Davarynejad (2009) reached the same result about pH, TA, and SSC/TA ratio in 'Érdi Jubileum' sour cherry treated with various concentrations of ethephon

which was not different from control. Titratable acidity (TA), pH and SSC/TA ratio were not affected by ethephon spray (Khorshidi and Davarynejad, 2010).

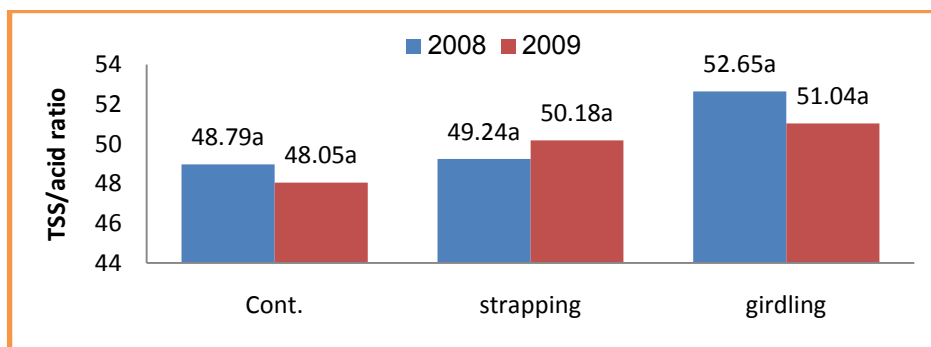


Figure (15): Effect of girdling and strapping on TSS /acid ratio of berries of Alphonso Lavelle grape cultivar

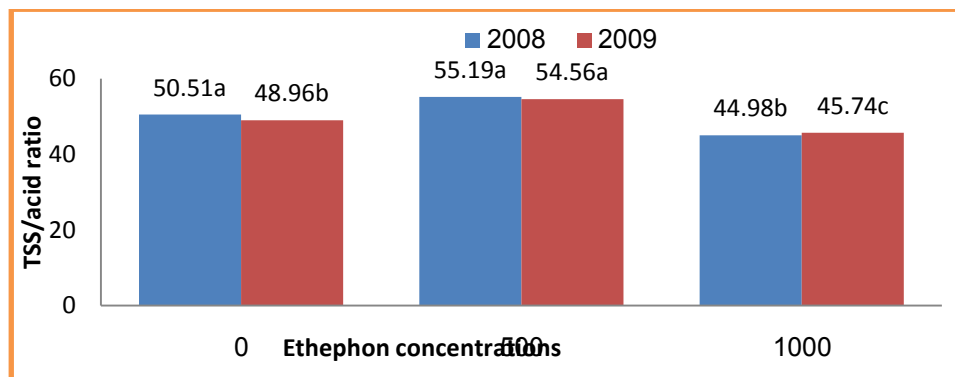


Figure (16): Effect of ethephon on TSS/ acid ratio of berries of Alphonso Lavelle grape cultivar

CONCLUSION

In conclusion, Girdling and strapping significantly increased the average bunch weight, berry weight, berry length, and berry width. Ethephon spraying increased significantly bunch weight, TSS and TSS/acid ratio, however, fruit acidity was decreased especially at 500 ppm. Girdling and strapping combined with ethephon especially at 500 ppm proved most effective in increasing all studied parameters in compare to untreated control trees. Strapping and girdling accompanied with ethephon were effective in improving fruit quality in grapevine orchards and can be recommended as tools to improve fruit maturity.

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الملخص العربي

تأثير التحليق والتحزيز والمعاملة بالإثيفون على جودة ثمار العنب صنف ألفونس لافيلية "Alphonso Lavelle"

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أجريت هذه الدراسة لتقييم تأثير كل من التحليق والتحزيز فقط او مصحوبة بالمعاملة بالإثيفون وذلك في موسمي 2008-2009 حيث أجريت التجربة على شجرات عنب صنف ألفونس لافيلية من الاصناف البذرية عمر 6 سنوات نامية بمزارع النهر الصناعي العظيم.و يعتبر هذا الصنف الاكثر انتشارا فى شمال ليبياويتميز بحجم متوسط للعنقود وحببات سوداء اللون ذات مظهر جذاب، وبالرغم من ذلك توجد بعض المشاكل والتي تتمثل فى عدم تجانس نضج حببات العنقود حيث يحتوى على حببات خضراء عند الجمع، وكذلك انخفاض محتوى الحبات من المواد الصلبة الذائبة الكلية. تم إجراء التحليق بإزالة حلقة كاملة من القلف بسمك 5مم وتم إجراء التحزيز بربط سلك معدني حول قواعد الدواير الثمرية حتى يتم إنغماسه في القلف وذلك بعد سقوط البتلات بأسبوعين و تم إزالته بعد شهر من المعاملة، في حين تركت شجيرات عنب بدون إجراء تحليق أو تحزيز. تم معاملة مجموعة من الشجيرات بالإثيفون بتركيزات (500 - 1000) جزء فى المليون وذلك مع بداية تلويين الحبات، تركت مجموعة تم رشها بالماء وذلك للمقارنة.

بينت النتائج أن المعاملة سواء بالتحليق او بالتحزيز قد أدى إلى زيادة معنوية فى متوسط وزن العنقود، وكذلك وزن وقطر وطول الحبة في حين لم تتأثر معنويا كل من المواد الصلبة الذائبة الكلية وكذلك الحموضة و النسبة بينهما.

أدت معاملة العناقيد بالإثيفون إلى زيادة معنوية فى متوسط وزن العنقود وزيادة محتوى الحبات من المواد الصلبة الذائبة الكلية ونسبة المواد الصلبة الذائبة الكلية للحموضة فى حين قللت معنويا من محتوى الحبات من الحموضة.

كان تأثير التفاعل بين التحليق أو التحزيز والمعاملة بالإثيفون خاصة عند تركيز 500 جزء فى المليون معنويا فى زيادة كل الصفات التي تم دراستها وذلك مقارنة بالعناقيد غير المعاملة فى كلا موسمي الدراسة.

تبين الدراسة ان كلا من التحليق والتحزيز مصحوبة بالمعاملة بالإثيفون بتركيز 500 جزء فى المليون وسيلة فعالة فى تحسين جودة ثمار العنب ويوصى بها للتبكير من بلوغ مرحلة اكتمال النموفى بساتين العنب.