

Thinning Intensity of 'Ace Spur Delicious' and 'Idared' Apples with Ethephon, Benzyladenine and Their Combination

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ABSTRACT

The thinning potential of ethephon and benzyladenine (BA) sprays alone or in combination as post-bloom thinners of 'Ace Spur Delicious' and 'Idared' apples grafted on MM 106 rootstock was examined in two successive seasons (2007 and 2008). The treatments included ethephon sprays of 250 and 500 ppm, BA at 100 and 200 ppm and combinations of both, in addition to unsprayed nonthinned trees. Foliar sprays were applied when the average fruitlet diameter was about 10 mm. Thinning response varied considerably with cultivar, chemical(s) used and year. 'Ace Spur Delicious' was more responsive for chemical thinners. 'Idared' was considered difficult to thin. Adequate thinning was achieved without adverse side effects with combinations of ethephon and BA on 'Ace Spur Delicious' during the two years. Ethephon when combined with BA caused further increase in fruit weight, improved total soluble solids of both cultivars of apples and increased 'Ace Spur Delicious' return bloom in the following spring with no significant influence on the fruit shape, number of seeds and fruit firmness. In absence of BA, ethephon applied at 500 ppm offers reliable fruitlet thinning and increased return bloom of 'Ace Spur Delicious'. No spray injury was observed. BA alone at 200 ppm had no significant influence on % thinning, yield, weight and shape of fruits of both cultivars. However, it increased total soluble solids and decreased seed number of 'Ace Spur Delicious' fruits. All thinning treatments did not affect % thinning, fruit weight, yield, fruit shape, seed number, firmness and return bloom of 'Idared'. Reproducibility of results between years was acceptable.

Keywords: *Malus domestica* Borkh, 'Ace Spur Delicious', 'Idared', Ethephon, Benzyladenine, Combination.

INTRODUCTION

Apple (*Malus domestica* Borkh) is a major fruit tree crop grown in the Mediterranean region (Wilkie et al., 2008). Producing larger, precocious fruit with good internal quality is the primary objective of apples and other fruit kinds. There is a great interest for obtaining satisfactory yield and better fruit quality by appropriate

methods in order to obtain a proper fruit size and healthy products. 'Ace Spur Delicious' and 'Idared' are two of the most important cultivars grown in the world. The trees of these cultivars need to be thinned because they tend to produce small fruits. Furthermore, if not thinned yearly, they will develop an alternate bearing habit, producing a heavy crop one year, then almost no crop in the next year.

Flower and fruit thinning is an established cultural practice for apple production. One problem associated with apple thinning by elimination of flowers is the increase in susceptibility to late spring frost (Wertheim, 2000). Although the incidence of late frost in

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Mediterranean region is rare, many growers are reluctant to use chemical thinners at bloom because of this problem associated with reduction in flower numbers (Bukovac et al., 1998). Chemical thinning of apples has been attempted using plant growth regulators (Bound, 2006; Stopar, 2006; Clever, 2007), insecticides (Shen and Sun, 1985) and NaCl and acetic acid (Stopar, 2004). Several plant growth regulators have been used to prevent excessive fruit set and enhance fruit size, shape, color, overall quality and biennial bearing of most apple varieties (Wertheim, 1998). Until now, there is no specific regulator that can give consistent responses as success of thinning process is influenced by sensitivity of the reproduction organs at the various developmental stages to the thinning agents as well as by the environmental conditions prevailing at the time of application. Ethephon (2-chloroethylphosphonic acid) (Koen and Jones, 1985), benzyladenine (BA) (Bound, 2006), 1-naphthaleneacetic acid (NAA) (Stopar and Lokar, 2003) and naphthaleneacetic acid amide (NAAM) (Holder et al., 1982; Jemric et al., 2005) were effectively used as postbloom thinner agents for apples.

Ethephon has been approved for use as effective agent in reducing fruit set and increasing fruit size for some apple cultivars (Jones and Koen, 1986; Knight et al., 1987; Jones et al., 1991). Previous experimental results have shown that the suitable time for apple thinning by ethephon was either at balloon blossom or at 40 days after full bloom (Koen and Jones, 1985). The thinning effectiveness of ethephon varied with cultivar, timing, concentration, location and year. Although temperature prevailing during and after application time affects both absorption and degradation of ethephon to ethylene (Flore and Bukovac, 1982), it has been reported that fruit thinning of 'Golden Delicious' apples with ethephon was not related to day/night temperature (Yuan, 2007). In contrast, there have been several

reports where ethephon being considered as an unsatisfactory thinning agent for other cultivars (Ebert and Krueze, 1988; Wertheim, 2000).

Synthetic cytokinins has been recently found to be good thinning agents and effective on enhancing apple fruit set and growth by accelerating cell division. Preliminary trials have indicated that BA and thidiazuron (TDZ) may be effective in improving fruit size of apple fruits (Greene, 1995; Stopar, 2006) as with pear fruits (Stern and Flaishman, 2003). BA sprays have been successfully used in cold climates of Jordan to increase fruit size of apples when pollinating conditions were unsatisfactory (Al-Tarawneh, 2004). However, the timing and concentration used are critical.

Considerable research applying chemical thinning has proven somewhat effective for improving apple fruit size (Yuan and Greene, 2000; Stern and Flaishman, 2003; Marini, 2004). However, such practice has not been sufficiently researched to insure adequate return bloom. In addition, much of this work has been done on typical cultivars or carried out in areas of the world that are unlike Jordan's climate. Growers are still not achieving adequate thinning effects from either ethephon or BA. The combination sprays of fruit thinning agents mostly resulted in a strong thinning response (Basak, 2006; Bound, 2006). Although its effect was inconsistent over the years, combinations of accel (BA and gibberellin) and ethephon have given excellent results in 'Redchief Delicious' apples regarding thinning percentage and fruit weight (Marini, 2004). The application of ethephon at 50 ppm plus NAA at 5 or 10 ppm improved thinning of 'Golden Delicious' apples over the untreated control but not enough to significantly improve fruit weight and size (Jones et al., 1994). Very little work has reported the joint use of ethephon and BA as postbloom thinners of apples (Elfving and Cline, 1993; Marini, 2004).

Since the proper concentration of thinning agent varies

with weather conditions, variety and other factors, the purpose of the present research was to compare the effectiveness of ethephon and benzyladenine, alone and in combination, as thinning agents, in reducing fruitlets number and improving fruit quality of 'Ace Spur Delicious' and 'Idared' apples in 2007 and 2008 under the climate and soil conditions of the southern part of Jordan.

MATERIALS AND METHODS

The experiment was conducted on 10-year-old trees of midseason 'Ace Spur Delicious' and 'Idared' apple grafted on MM 106 rootstock, growing at the apple orchard belonging to the Faculty of Agriculture- University of Mutah, Al-Karak – Jordan, during 2007 and 2008 seasons. The orchard received an annual rainfall of 308 and 290 mm in 2007 and 2008 seasons, respectively. Approximate mean daily minimum temperatures of 11 and 10°C in winter, and mean daily maximum temperatures of 23 and 24°C in summer, respectively, were recorded in 2007 and 2008 seasons, respectively. These cultivars were selected for their widespread planting in orchards and nurseries, both private and public; as promising and midseason cultivars. The trees were spaced 5m X 5m, trained in a central leader training method and received routine horticultural care. The trees were irrigated with potable water using a drip irrigation system with one emitter per plant, each delivering 4L h⁻¹. The irrigation lasted about 120 minutes per day and was applied during 2 days per week from April to October and weekly from November to March. Nitrogen was applied in urea form at a rate of 200g per tree two times per month during each season, while phosphorus was applied in the form of Triple Super Phosphate at a rate of 100g per tree. Potassium was added as potassium sulphate at rate of 100g K₂O per tree.

Two rates of ethephon (250 and 500 ppm) or benzyladenine (BA) (100 and 200 ppm) and their combinations (ethephon at 250 ppm plus BA at 100 ppm

and ethephon at 500 ppm plus BA at 200 ppm), in addition to unthinned control, were applied once on April 12, 2007, when the average fruitlet diameter was about 10 mm using a hand-held pressurised sprayer. The treatments were repeated on the same trees on April 16, 2008. The treatments were applied on non-wind days with wind speed of 2.5 and 3.4 km/hr and temperatures of 20 and 23°C in 2007 and 2008 seasons, respectively. Tween 20 (polyoxyethylene sorbitan monolaurate) at 0.1% was used as a wetting agent in all treatments. The trees sprayed with tap water supplemented with the wetting agent served as control. All the trees were sprayed to drip-point. Weather conditions during fruitlets growth were relatively stable. The treatments were applied on non-windy and sunny days with temperatures of 27 and 32 °C on April 12, 2007 and April 16, 2008, respectively.

Percentage of thinning was calculated about 45 days after full bloom using the following equation.

$$\% \text{ thinning} = \frac{\text{Initial number of fruitlets} - \text{Final number of fruits}}{\text{Initial number of fruitlets}} \times 100\%$$

Number of fruits per tree was counted. The yield per tree was estimated by multiplying the total number of fruits per tree by the average weight of harvested fruits.

At harvest, a random sample of 15 fruits was taken from each tree (plot) and transported to laboratory for quality measurements. Average fruit weight and length/diameter (L/D) ratio were measured. Fruit length and diameter were measured using Vernier caliper. Five of these fruits were used to estimate flesh firmness, soluble solids concentrations (TSS) and number of seeds. Fruit firmness was measured by a pressure tester. Readings were made on opposite sides of individual fruit with the skin removed. The fruits were juiced by a blender mixer and subsequently filtered to be used in total soluble solids. The percentage of TSS was

determined in fruit juice using a refractometer. To measure return bloom in the subsequent year (2008), the number of fruits per cm² trunk-cross sectional area was counted in April.

STATISTICAL ANALYSIS

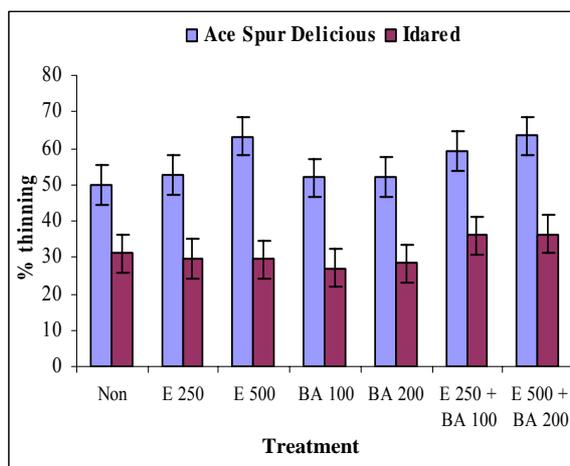
The experiment was carried out in a randomized block design with three replications of one tree each. The data were subjected to statistical analysis using MSTATC programme. Duncan's multiple range test at 5% level of significance was used for means separation. Correlation coefficients were determined between some important variables.

RESULTS

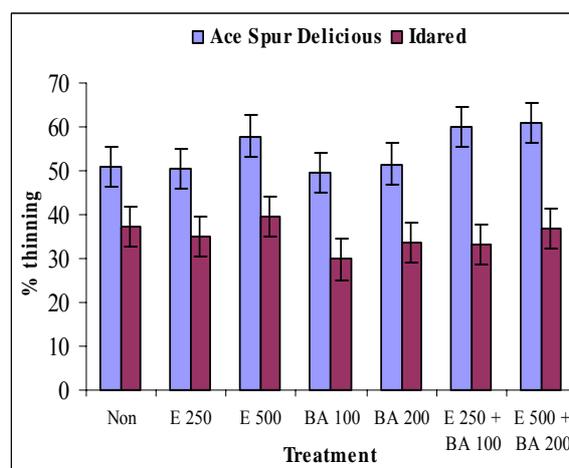
Thinning Percentage and Yield

The statistical analysis of the data showed the occurrence of significant differences among the various

thinning treatments in thinning degree of the tested cultivars in both seasons of study (Fig. 1 a and b). Mean % thinning of 'Ace Spur Delicious' was significantly higher and about two times compared to 'Idared'. When applied only in 2007 season, ethephon spray at 500 ppm significantly increased % thinning of 'Ace Spur Delicious', as compared to the unthinned control (Fig. 1). The lowest ethephon concentration (250 ppm) as well as BA alone at both concentrations did not show a significant thinning effect. The application of a mixture of both hormones increased the degree of thinning to a level comparable to that of the ethephon 500 treatment. However, in 'Idared' apples, none of the thinning treatments significantly affected % thinning, compared to the unthinned control, in both seasons. Ethephon at 250 ppm in combination with BA at 100 ppm did not give additional thinning over that achieved by ethephon 500 ppm alone.



(a)

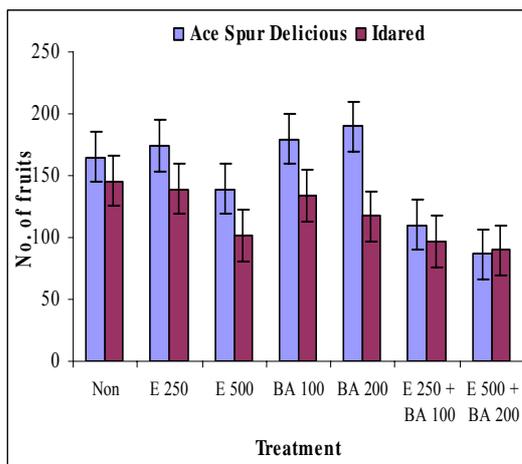


(b)

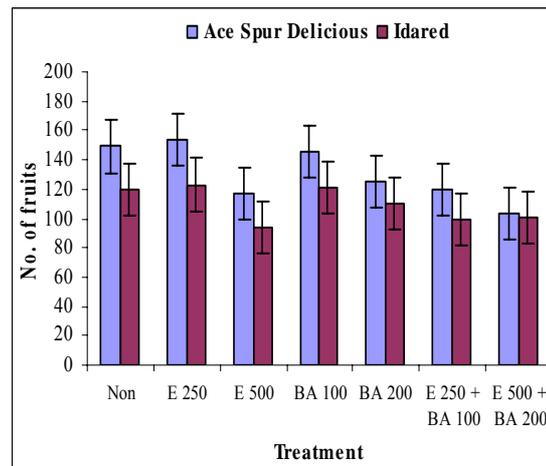
Fig. (1): Thinning intensity of 'Ace Spur Delicious' and 'Idared' apples as influenced by ethephon (E) and benzyladenine (BA) sprays alone or in combination, as post-bloom thinners, in 2007 (a) and 2008 (b) seasons.

Data of Fig. 2 a and b show that, during both 2007 and 2008 seasons, ethephon or BA alone at their concentrations were unable to significantly affect number of fruits per tree of both cultivars. In 2007, a combination of ethephon and BA, regardless of their concentrations, significantly reduced the number of 'Ace Spur Delicious' fruits per tree more than either material applied alone. The most effective treatment for 'Ace Spur Delicious' in both seasons and for 'Idared' in 2007

was a combination of ethephon at 500 ppm and BA at 200 ppm. Compared to control, this treatment significantly reduced the number of fruits per tree 39.2 and 27.1% for 'Ace Spur Delicious' and 'Idared', respectively, as the mean of both seasons. In this respect, thinning with ethephon at 500 considerably reduced the number of fruits but to a lesser extent. The results were consistent during the two seasons of the study.



(a)

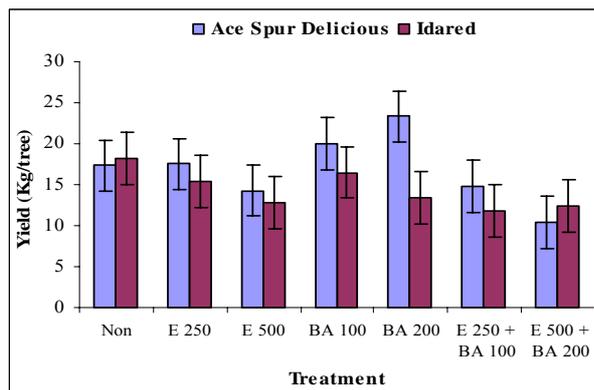


(b)

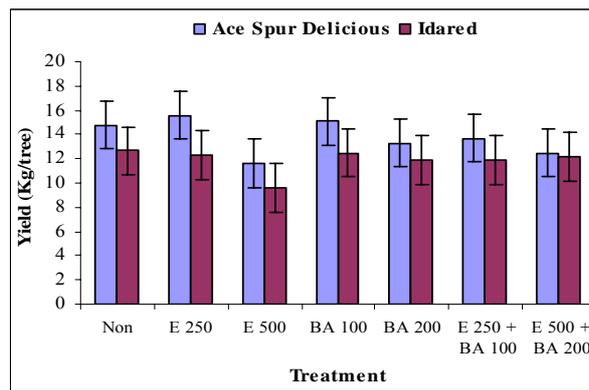
Fig. (2): Number fruits of 'Ace Spur Delicious' and 'Idared' apples as influenced by ethephon (E) and benzyladenine (BA) sprays alone or in combination, as post-bloom thinners, in 2007 (a) and 2008 (b) seasons.

The statistical analysis indicated that the interaction among apple cultivar, thinning treatment and season had a considerable effect on yield (Fig. 3 and b). Tree yield of 'Ace Spur Delicious' and 'Idared', as measured by the number of fruits multiplied by average fruit weight, showed no significant differences between the

treatments applied, compared with the control, in 2008 season. However, a significant reduction was recorded in the yield of 'Ace Spur Delicious' and 'Idared' in 2007 season as a result of application of ethephon at 500 ppm plus BA at 200 ppm and ethephon at 250 ppm plus BA at 100 ppm, respectively.



(a)



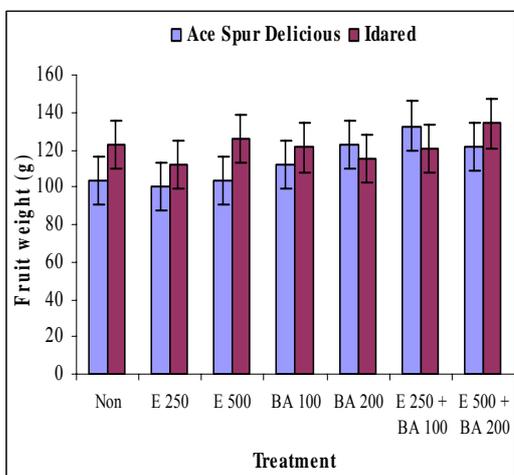
(b)

Fig. (3): Yield of 'Ace Spur Delicious' and 'Idared' apples as influenced by ethephon (E) and benzyladenine (BA) sprays alone or in combination, as post-bloom thinners, in 2007 (a) and 2008 (b) seasons.

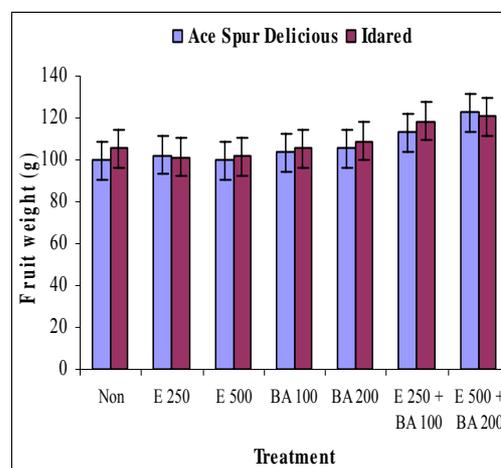
Physical Fruit Properties

The current study showed that neither ethephon nor BA at the concentrations used had an effect on average fruit weight of both apple genotypes when compared to control (Fig. 4 a and b). However, a tendency towards improving average fruit weight of 'Ace Spur Delicious' apples, as compared to control, when ethephon at 250 ppm plus BA at 100 ppm and ethephon at 500 ppm plus

BA at 200 ppm were applied in 2007 and 2008 seasons, with an increase of 17.4 and 23.0%, respectively, was obtained. Furthermore, the data indicate a positive influence of this combination on average fruit weight of 'Idared' in both seasons independently of its thinning effect. In both seasons of study, no significant variation in fruit shape of both cultivars, expressed as length/diameter ratio, could be discerned (Fig. 5 a and b).

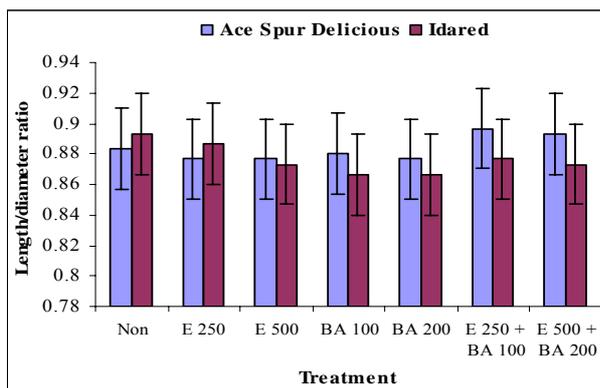


(a)

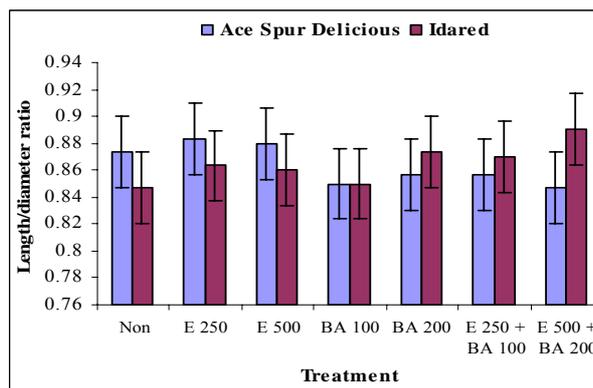


(b)

Fig. (4): Fruit weight of 'Ace Spur Delicious' and 'Idared' apples as influenced by ethephon (E) and benzyladenine (BA) sprays alone or in combination, as post-bloom thinners, in 2007 (a) and 2008 (b) seasons.



(a)

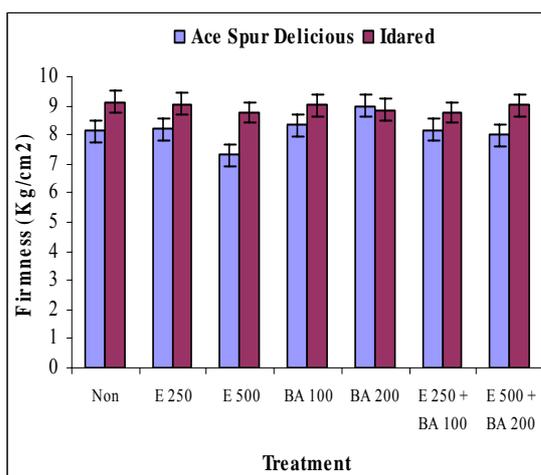


(b)

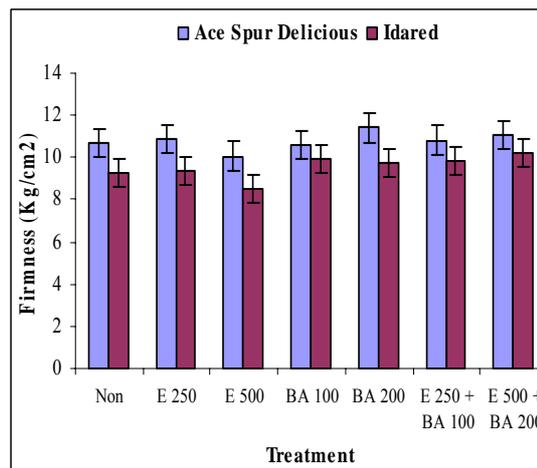
Fig. (5): Fruit length/diameter ratio of 'Ace Spur Delicious' and 'Idared' apples as influenced by ethephon (E) and benzyladenine (BA) sprays alone or in combination, as post-bloom thinners, in 2007 (a) and 2008 (b) seasons.

Compared with the control, fruit firmness of both cultivars in 2008 season was insignificantly influenced by all thinning treatments (Fig. 6 a and b). Furthermore,

in 2007, ethephon at 500 ppm significantly decreased while BA at 200 ppm increased flesh firmness of 'Ace Spur Delicious' apples.



(a)

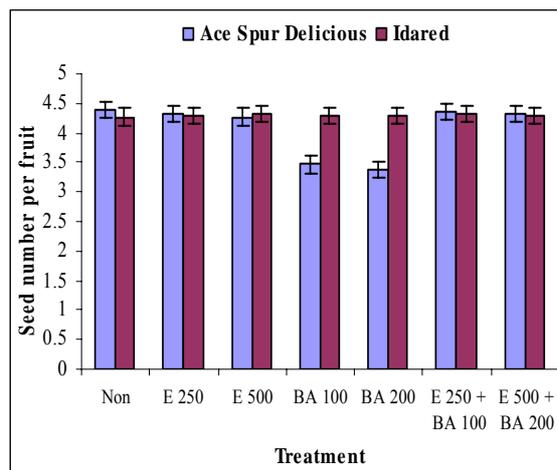


(b)

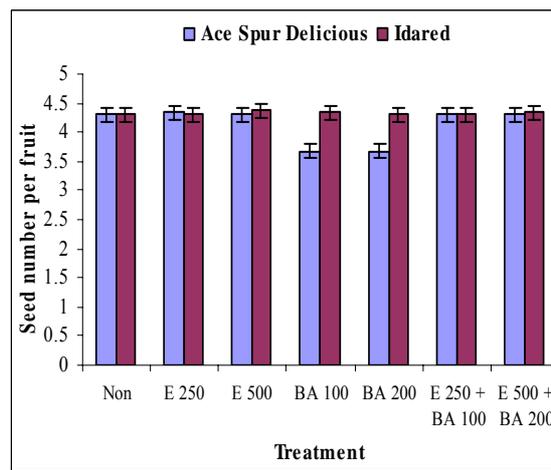
Fig. (6): Fruit flesh firmness of 'Ace Spur Delicious' and 'Idared' apples as influenced by ethephon (E) and benzyladenine (BA) sprays alone or in combination, as post-bloom thinners, in 2007 (a) and 2008 (b) seasons.

BA at both concentrations used significantly decreased 'Ace Spur Delicious' average seed number per fruit in 2007 (3.47 and 3.38 for 100 and 200 ppm, respectively) and 2008 (3.67 and 3.67 for 100 and 200 ppm, respectively), when compared to the control (4.40

in 2007 and 4.30 in 2008) (Fig. 7 a and b). Other thinning treatments had no significant influence on average seed number. However, average seed number of 'Idared' fruits in both seasons of the study was not influenced by all thinning treatments.



(a)

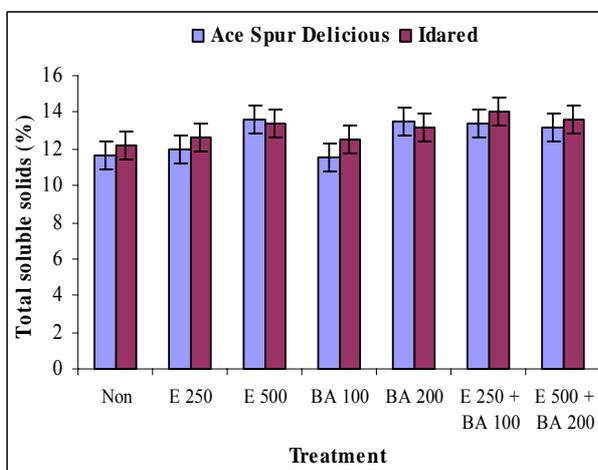


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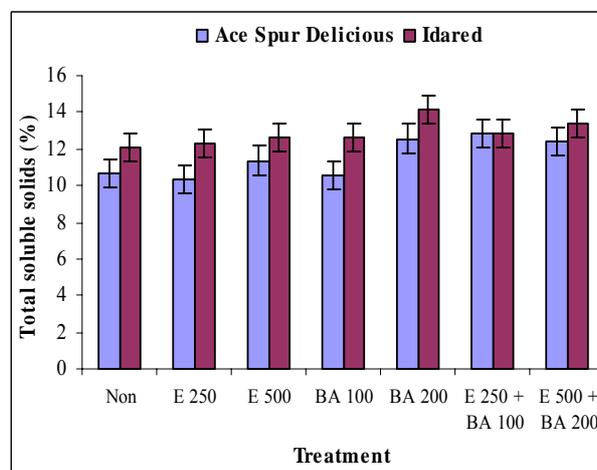
Fig. (7): Seed number per fruit in 'Ace Spur Delicious' and 'Idared' apples as influenced by ethephon (E) and benzyladenine (BA) sprays alone or in combination, as post-bloom thinners, in 2007 (a) and 2008 (b) seasons.

Regarding 'Ace Spur Delicious', BA at 200 ppm (in 2007 and 2008) or ethephon at 500 ppm (in 2007) significantly increased total soluble solids % (TSS) of fruits (Fig. 8 a). Combination of ethephon and BA, regardless of their concentrations, significantly increased TSS% in 2008, while a combination of ethephon at 250

ppm and BA at 100 ppm significantly increased TSS% in 2007. However, ethephon at 250 ppm plus BA at 100 ppm (in 2007) and BA at 200 ppm (in 2008) treatments were able to significantly increase TSS% of 'Idared' fruits (Fig. 8 b). A positive correlation ($r = + 0.27$) existed between weight increment and TSS in thinned fruits.



(a)



(b)

Fig. (8): Total soluble solids (%) of 'Ace Spur Delicious' and 'Idared' apples as influenced by ethephon (E) and benzyladenine (BA) sprays alone or in combination, as post-bloom thinners, in 2007 (a) and 2008 (b) seasons.

Return Bloom

Return bloom of ‘Ace Spur Delicious’ was significantly increased by the application of ethephon at 500 ppm in absence or presence of BA at 200 ppm (Fig.

9). Other treatments had no significant influence. On the other hand, return bloom of ‘Idared’ was insignificantly affected by all thinning treatments.

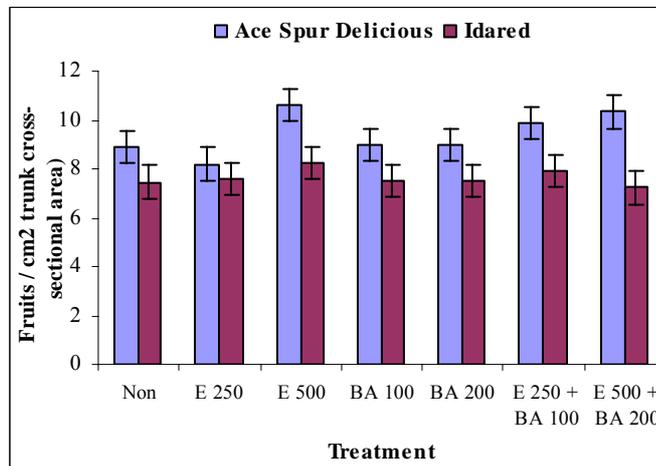


Fig. (9): Return bloom, expressed as number of fruits per cm² trunk- cross sectional area in 2008 season, of ‘Ace Spur Delicious’ and ‘Idared’ apples as influenced by ethephon (E) and benzyladenine (BA) sprays alone or in combination, as post-bloom thinners.

DISCUSSION

Under the conditions of the present study, it was observed that ethephon, BA and their combination varied in their thinning effect depending on apple cultivar, chemical concentration and season. In this respect, while ethephon at 500 ppm effectively thinned ‘Ace Spur Delicious’ in 2007 season only as compared with the control, it had no additional thinning effect over unthinned ‘Idared’ trees in either 2007 or 2008 seasons with no increases in fruit weight. In addition, ethephon at 250 ppm as well as BA at the concentrations used were not effective in thinning of both cultivars. Ethephon has been reported for good thinning when applied at 100 ppm or more (Jones et al., 1994). The results presented here indicate that ethephon at 500 ppm in presence or absence of BA may be a viable approach

to achieve good thinning activity for ‘Ace Spur Delicious’. It may be noted that the lowest rate of ethephon (250 ppm) is well below the effective concentration that was used by others on various cultivars (Marini, 2004), while the highest rate effectively reduced the number of ‘Ace Spur Delicious’ fruits. This indicates the variability among various cultivars to this growth regulator and also highlights one of the main problems facing the use of these chemicals. The reduction in the number of ‘Ace Spur Delicious’ fruits in response to ethephon treatment is consistent with results from previous work (Jones et al., 1994; Marini, 1996). The effectiveness of ethephon as a thinning agent was observed in ‘Golden Delicious’ and ‘Northern Spy’ (Walsh et al., 1979) in which the influence of ethephon was mediated by ethylene release

within the tissues. Ethephon has been reported to reduce photosynthesis in the leaves for 2-3 days following the treatment (Mavrodiev and Monolov, 1987) and markedly increase cellulase activity in abscission zones of apples as well as ethylene production (Iwahori and Oohata, 1976). Previously, it has been shown that BA may stimulate fruitlet abscission of easy to thin cultivars by strengthening the sink activity of the vegetative part of the plant (Dal Cin et al., 2007). The negligible influence of BA applied alone on thinning response in the current study was explained previously by Dal Cin et al. (2007) and attributed to the limited growth of both cultivars. Furthermore, it could be suggested that lack of response of BA is due to the inability of the used concentrations to restrict photosynthate movement into the fruits (Yuan and Greene, 2000). Although it is recognized that each ethephon or BA alone was effective in thinning some cultivars of apples, there are no information about the thinning response of 'Ace Spur Delicious' and 'Idared' to the combination of both growth regulators. A combination of ethephon and BA was effective in thinning 'Ace Spur Delicious' and ineffective in 'Idared'. However, its effectiveness depended on the concentrations of both growth regulators and varied from year to year. Although the mechanism of action of BA remains not fully known at the present time, it has been proposed that the increase in ethylene biosynthesis in leaves and fruits as a result of increasing BA concentration is not large enough to be the primary cause of thinning (Bound, 2006). The partial inconsistent results observed with the fruit thinners in 2007 season versus 2008 season may be attributed to the variation in the prevailing environmental conditions, mainly temperature and relative humidity, during and after the plant growth regulators were applied. The temperature dependence of ethephon and BA as thinning agents for apples has subsequently been confirmed in the

work of Jones and Koen (1985) and Buban (200), respectively.

The average fruit weight followed the crop load pattern. It improved as thinning % increased. Despite ethephon at 500 ppm consistently increased fruitlet abscission of 'Ace Spur Delicious' in 2007, there was no concomitant increase in average fruit weight. Combination of ethephon at 250 ppm plus BA at 100 ppm significantly increased 'Ace Spur Delicious' fruit weight in the absence of thinning in 2007. Moreover, combination of ethephon at 500 ppm plus BA at 200 ppm increased 'Ace Spur Delicious' fruit weight in the presence of thinning in 2008. Fruit weight of 'Ace Spur Delicious' was weakly correlated with % thinning in 2007 (+0.19). The failure of combination of ethephon at 500 ppm plus BA at 200 ppm to increase fruit weight of 'Ace Spur Delicious' in 2007, compared with the control, despite the heavy thinning, could be a result of high dosage of both growth regulators adversely affecting fruit growth. Fruit weight of 'Idared' in 2007 and 2008 was not influenced by all thinning treatments. Ethephon alone and BA at both concentrations used here were ineffective in improving fruit weight. Steven and Wells (1995) reported that ethephon at 200 and 400 ppm was effective in removing fruitlets of pear, higher concentrations were not advised as they can cause substantial reductions in both fruit size and storage life.

In fact, fruit weight would normally be expected to increase with an increase in leaf:fruit ratio. Apple fruit weight has been positively correlated with shoot vigor and rate of cell division in the fruit cortex (Wismer et al., 1995). The lack of size response of 'Idared' to thinning treatments has been described in pear in earlier works (Burge et al., 1991).

Fruit shape of both cultivars, represented as length/diameter ratio, was not influenced by any of the thinning treatments in 2007 and 2008. The length/ diameter ratio

of the studied cultivars was about the same (0.85 – 0.89), indicating that they respond similarly to treatments. Elfving and Cline (1993) found that ethephon and BA increased length/ diameter ratio of 'Empire' apples.

None of the thinning treatments affected flesh firmness of 'Ace Spur Delicious' in 2008 and 'Idared' in both seasons of the study. The only treatments to show a decrease or an increase in flesh firmness of 'Ace Spur Delicious' over the controls in 2007 were ethephon at 400 ppm and BA at 200 ppm, respectively. Generally, flesh firmness was clearly lower with light cropping trees than with heavy ones. It was negatively correlated with mean fruit weight. This result is supported by earlier work of Bound (2006) who found that flesh firmness was highly affected by thinning treatment and varied according to cultivar.

Total soluble solids % (TSS) in this trial was consistently increased in 'Ace Spur Delicious' by the application of ethephon at 500 ppm, BA at 200 ppm and combination of ethephon at 250 ppm and BA at 100 ppm in 2007; and by BA at 200 ppm as well as when both ethephon and BA combined together in 2008 season. However, in 'Idared', combinations of ethephon at 250 ppm and BA at 100 ppm in 2007 and BA at 200 ppm in 2008 were able to significantly increase TSS. While this result agrees with the findings of Bound (2006), who found that BA increased TSS of 'Fuji' apples, it is in disagreement with those of Al-Tarawneh (2004) on 'Starking' apples.

In the current study, the number of seeds per fruit is cultivar dependent. In this respect, average number of seeds per 'Ace Spur Delicious' and 'Idared' fruits in the two seasons was 4.10 and 3.31, respectively. These numbers are in the ranges obtained by many researchers (Yuan and Greene, 2000; Al-Tarawneh, 2004; Bound, 2006). Although Al-Tarawneh (2004) found that BA did not affect seed numbers of 'Golden Delicious' and

'Starking' apples, in this work the effect of BA on seed number appears to be related to both cultivar and thinning treatment. The seed number per 'Ace Spur Delicious' fruit in 2007 and 2008 was significantly lower in BA-treated trees than in control and other thinning treatments. However, there was no treatment effect on seed number of 'Idared' fruit in both seasons. The current results agree with the findings of Yuan and Greene (2000) who found that BA reduced the number of normal seeds and increased the number of aborted seeds of 'McIntosh' apples.

The effect of ethephon upon return bloom was significant on 'Ace Spur Delicious'. In comparison with the control, ethephon at 500 ppm in absence or presence of BA at 200 ppm significantly increased the number of fruits per cm² trunk cross sectional area. A positive correlation ($r = 0.23$) existed between intensity of fruitlet thinning and fruitlet retention. The result of this study was in agreement with that of Stopar and Lokar (2003) who reported that ethephon, BA and their combination significantly increased flower bud retention of 'Summerred' apples.

CONCLUSION

In conclusion, the study showed that the response of 'Ace Spur Delicious' and 'Idared' apples to thinning treatments was very variable both from season to season and between cultivars. 'Ace Spur Delicious' was more responsive for chemical thinners than 'Idared'. In general, an acceptable thinning response was achieved in 'Ace Spur Delicious' with 500 ppm ethephon in presence or absence of BA. BA in absence of ethephon had no significant effect on thinning intensity, yield, average fruit weight, shape and firmness of both cultivars. Ethephon plus BA significantly reduced number of fruits, fruit weight and total soluble solids of 'Ace Spur Delicious' in both seasons. There were no

significant effects for all treatments on thinning %, fruit weight, shape (length/diameter), seed number per fruit and firmness of 'Idared' in both seasons of the study. The current results emphasize the need for further

studies of using a wide range of concentrations of both growth regulators to elucidate further the response of apples to them.

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