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The Influence of Fruit Thinning on the Apricot Cultivar Gerdi

L. Taghipour and M. Rahemi
Department of Horticultural Science, Faculty of Agriculture,
Shiraz University, Shiraz, Iran

Abstract: An experiment was conducted to study the effects of naphthaleneacetic acid at (10, 20 and 40 mg L^{-1}) and naphthaleneacetamide at (20, 40 and 80 mg L^{-1}), ethephon at (50, 100 and 200 mg L^{-1}) and urea at (0.2, 0.4 and 0.6%) 2 weeks After Full Bloom (AFB) in the commercial orchard in Neyriz, Fars Province in 2007 Iran. The factorial experiment was arranged in randomized complete block design with four replications. Some criteria were analyzed like percent of fruit thinning, fruit weight, volume, length, diameter, total soluble solids, total acidity, dry matter content and leaf area. The results showed that all chemicals except naphthaleneacetamide at 20 mg L^{-1} significantly increased percent of fruit thinning. All chemicals except ethephon had significant effect on fruit volume. The effect of naphthaleneacetic acid, naphthaleneacetamide at 40 and 80 mg L^{-1} and urea at 0.2 and 0.4% were significant on fruit weight. Total soluble solids were affected with chemicals and the highest level of total soluble solids obtained by naphthaleneacetic acid at 40 mg L^{-1}. Total soluble solids/total acidity ratio significantly increased with naphthaleneacetic acid at 40 mg L^{-1}, all concentrations of naphthaleneacetamide, ethephon at 50 and 100 mg L^{-1} and urea at 0.2%. The NAA at 40 mg L^{-1}, NAD at 40 and 80 mg L^{-1}, all concentrations of ethephon and urea at 0.4 and 0.6% significantly increased dry matter content of fruits and NAA, NAD and urea, increased leaf area.

Key words: Apricot, fruit drop, naphthaleneacetic acid, naphthaleneacetamide

INTRODUCTION

Flower and fruit tinning of prunus are commercially able to have maximize crop price by optimizing fruit size, color and increase fruit quality (Byers *et al*., 2003). Chemical thinning gradually was used instead of hand and mechanical thinning, because they are slow, expensive and the results are variable (Mitra *et al*., 1991). A large number of chemicals have been attempted to thinning prunus (Stembridge and Gambrell, 1971; Martin *et al*., 1975; Young and Edgerton, 1979; Zilkah *et al*., 1988; Bolat and Karlidage, 1999; Green *et al*., 2001; Son, 2004; Osborne *et al*., 2005).

Thinning results of apricot are often differing, because the trees are affected by Spring frosts after treatment. Thomas (1982) said that if we want to have successful thinning, NAA must spray 14-18 days after full bloom. The NAD at 15 mg L^{-1} regulates fruit load and increasing fruit size on Conference and Rosad pear (Bonghi *et al*., 2002). Researcher has been reported that 25-75 mg L^{-1} and 50-100 mg L^{-1} of NAA are the best dosages to fruit thinning

Corresponding Author: Leila Taghipour, Department of Horticultural Science, Faculty of Agriculture, Shiraz University, Shiraz, Iran
Tel: 00989177186647

of Hungarian best and Rose apricot. Bolat and Karlidag (1999) concluded that the application of (NAA) affected percent of thinning and fruit quality. Early application of ethephon at the beginning of flowering did not reduce fruit set on Conference pear (Wertheim, 2000). Ethephon is a follow up thinner when prior chemical thinning agents have unsuccessful to thinning sufficiently (Byers, 2003). Ethephon at 37.5 to 150 mg L^{-1} caused peaches thinning (Young and Edgerton, 1979). Stopak and Lokar (2003) said that application of ethephon and NAA on apple reduced final fruit number but did not increase fruit weight. On the other hand, Basak (2006) reported that ethephon did not, reduced final fruit set but remaining fruits were larger. Sprayed of ethephon to the branch of pistachio increased fruit thinning and floral bud retention (Rahemi and Ramezanian, 2007). When Ban *et al.* (2007) sprayed ethephon on blueberry they found, ethephon decreased fruit acidity but not effected on fruit length and weight. Gerdi apricot is an early ripening cultivar and has a large fruit set. T_o improve fruit size and quality, fruit thinning is necessary. The objectives of this study are to find out the suitable chemicals for thinning and improve fruit quality on Gerdi cultivar.

MATERIALS AND METHODS

The experiment was conducted on apricot trees spaced at 5×5 m at Neyriz, Fars State, 2050 m above sea level, in 2007. Ten-year-old cultivar of Gerdi was chosen for chemical thinning. The treatments were applied 2 weeks After Full Bloom (AFB) when the fruits had about 12 mm length (4 April 2007). The treatments details are as follows; naphthaleneacetic acid at (10, 20 and 40 mg L^{-1}) and naphthaleneacetamide at (20, 40 and 80 mg L^{-1}), ethephon at (50, 100 and 200 mg L^{-1}) and urea at (0.2, 0.4 and 0.6%). The factorial experiment was arranged in randomized complete block design with four replications. Four branches of uniform vigor of trees were selected for foliar spray. The numbers of fruit on marked shoots were recorded before application and before harvesting. The fruits were harvested at the end of May (31 May 2007) and the characters relating to fruit size like, fruit weight, volume, length and diameter were measured. The TSS was measured with used of hand reflactometer. Total Acidity (TA) was evaluated by 0.2 N NaOH. Leaf area was determined by leaf area meter.

Statistical Analysis System Software for PC (SAS 9.1.2, SAS Institute Inc, 2004, Cary, NC) was used to analyzed on data and using the LSD test, at, $p = 0.05$.

RESULTS

All the thinning agents except NAD at 20 mg L^{-1} significantly increased percent of fruit thinning on 14 days after spraying and at harvesting time, only ethephon at 200 mg L^{-1} affected the fruit drop (Table 1).

The results showed that except ethephon, other chemicals had significantly effect on fruit volume (Table 2). Also all concentrations of NAA, NAD at 40 and 80 mg L^{-1} and urea at 0.2 and 0.4% significantly increased fruit weight (Table 2).

Fruit length significantly increased with urea at 0.4% that improved fruit length from control (4.03 cm) to urea at 0.4% (4.42 cm) (Table 3). There was a significant increase in the fruit diameter with NAA at 40 mg L^{-1}, NAD at 80 mg L^{-1} and urea at 0.2 and 0.4%. The highest fruit diameter was arrived with urea at 0.4% (Table 3).

Effect of chemicals on fruit TA showed that ethephon at 200 mg L^{-1} and urea at 0.6% significantly increased TA (Table 4). Fruit TSS were significantly affected by NAA at 20 and

Table 1: Effect of chemical thinning agents on fruit thinning of apricot, 2 weeks after sprayed and at harvest

	Fruit thinning (%)	
Treatments	2 week after sprayed	At harvest
Control	53.62e	69.31bcd
Naphthalenacetic acid (10 mg L^{-1})	67.21cd	69.45bcd
Naphthalenacetic acid (20 mg L^{-1})	67.43bcd	75.58a-d
Naphthalenacetic acid (40 mg L^{-1})	72.39abc	80.84abc
Naphthaleneacetamid (20 mg L^{-1})	61.88de	64.97d
Naphthaleneacetamid (40 mg L^{-1})	64.04cd	68.28dc
Naphthaleneacetamid (80 mg L^{-1})	66.43cd	72.65a-d
Ethephon (50 mg L^{-1})	67.84bcd	82.55ab
Ethephon (100 mg L^{-1})	76.24ab	82.78ab
Ethephon (200 mg L^{-1})	77.69a	84.09a
Urea 0.2 (%)	64.32cd	74.37a-d
Urea 0.4 (%)	67.13cd	76.64a-d
Urea 0.6 (%)	66.35cd	74.79a-d

Within each column, same letter indicates no significant difference between treatments (LSD, $p<0.05$)

Table 2: Effect of chemical thinning agents on fruit weight and volume

Treatments	Weight (g)	Volume (cm^3)
Control	26.55de	26.70e
Naphthalenacetic acid (10 mg L^{-1})	33.9bc	33.50ab
Naphthalenacetic acid (20 mg L^{-1})	35.26abc	35.25ab
Naphthalenacetic acid (40 mg L^{-1})	35.92abc	35.25ab
Naphthaleneacetamid (20 mg L^{-1})	31.93cd	32.70b
Naphthaleneacetamid (40 mg L^{-1})	34.87bc	34.50ab
Naphthaleneacetamid (80 mg L^{-1})	35.13abc	34.65ab
Ethephon (50 mg L^{-1})	24.13e	25.00c
Ethephon (100 mg L^{-1})	22.48e	23.04c
Ethephon (200 mg L^{-1})	22.45e	21.75c
Urea 0.2 (%)	38.41ab	38.19ab
Urea 0.4 (%)	40.83a	39.23a
Urea 0.6 (%)	32.38cd	34.13ab

Within each column, same letter indicates no significant difference between treatments (LSD, $p<0.05$)

Table 3: Effect of chemical thinning agents on fruit length and diameter

Treatments	Length (cm)	Diameter (cm)
Control	4.03b-e	3.53cde
Naphthalenacetic acid (10 mg L^{-1})	4.18ab	3.72bcd
Naphthalenacetic acid (20 mg L^{-1})	4.23ab	3.77abc
Naphthalenacetic acid (40 mg L^{-1})	4.18ab	3.91ab
Naphthaleneacetamid (20 mg L^{-1})	4.11bcd	3.69bcd
Naphthaleneacetamid (40 mg L^{-1})	4.15bc	3.8abc
Naphthaleneacetamid (80 mg L^{-1})	4.26ab	3.83ab
Ethephon (50 mg L^{-1})	3.88ed	3.89e
Ethephon (100 mg L^{-1})	3.92cde	3.45de
Ethephon (200 mg L^{-1})	3.78e	3.35e
Urea 0.2 (%)	4.27ab	3.84ab
Urea 0.4 (%)	4.42a	4.03a
Urea 0.6 (%)	4.19ab	3.68bcd

Within each column, same letter indicates no significant difference between treatments (LSD, $p<0.05$)

40 mg L^{-1}, NAD at 40 and 80 mg L^{-1}, urea at 0.2 and 0.4%, ethephon at 50, 100 mg L^{-1} (Table 4). The NAA at 40 mg L^{-1}, all concentrations of NAD, ethephon at 50 and 100 mg L^{-1} and urea at 0.2% significantly increased TSS/TA ratio (Table 4).

The NAA at 40 mg L^{-1}, NAD at 40 and 80 mg L^{-1}, all concentrations of ethephon and urea at 0.4 and 0.6% significantly increased dry matter content of fruits (Table 5).

With increased in concentrations of NAA, NAD and urea, increased leaf area but ethephon had no effect on leaf area.

Table 4: Effect of chemicals on fruit TSS, TA and TSS/TA ratio

Treatments	TA (mg/100 mL fruit juice)	TSS (%)	TSS/TA ratio
Control	1.65bcd	6.29c	3.83e
Naphthalenacetic acid (10 mg L^{-1})	1.7ab	7.38abc	4.37b-e
Naphthalenacetic acid (20 mg L^{-1})	1.64abc	7.63ab	4.65a-e
Naphthalenacetic acid (40 mg L^{-1})	1.7ab	8.5a	5.03ab
Naphthaleneacetamid (20 mg L^{-1})	1.55bc	7.38abc	4.78a-d
Naphthaleneacetamid (40 mg L^{-1})	1.48c	7.7ab	5.27ab
Naphthaleneacetamid (80 mg L^{-1})	1.48c	8.13ab	5.49a
Ethephon (50 mg L^{-1})	1.63abc	7.88ab	4.91abc
Ethephon (100 mg L^{-1})	1.56bc	7.5ab	4.86a-d
Ethephon (200 mg L^{-1})	1.78a	7.13bc	4.0ed
Urea 0.2 (%)	1.64abc	7.75ab	4.76a-d
Urea 0.4 (%)	1.67ab	7.63ab	4.57b-e
Urea 0.6 (%)	1.73a	7.0bc	4.07cde

Within each column, same letter indicates no significant difference between treatments (LSD, $p<0.05$)

Table 5: Effect of chemicals on fruit dry matter (%) and leaf area (cm^2)

Treatments	Dry matter (%)	Leaf area (cm^2)
Control	7.0d	52.79g
Naphthalenacetic acid (10 mg L^{-1})	8.0bcd	58.01d-g
Naphthalenacetic acid (20 mg L^{-1})	8.0bcvd	62.53b-e
Naphthalenacetic acid (40 mg L^{-1})	8.38abc	64.81bcd
Naphthaleneacetamid (20 mg L^{-1})	7.99bcd	70.04ab
Naphthaleneacetamid (40 mg L^{-1})	8.3abc	72.98a
Naphthaleneacetamid (80 mg L^{-1})	8.59ab	73.09a
Ethephon (50 mg L^{-1})	9.23a	55.5efg
Ethephon (100 mg L^{-1})	9.06ab	55 efg
Ethephon (200 mg L^{-1})	8.41abc	53.49fg
Urea 0.2 (%)	7.42cd	61.04c-f
Urea 0.4 (%)	8.27abc	66.36abc
Urea 0.6 (%)	8.29bc	68.86ab

Within each column, same letter indicates no significant difference between treatments (LSD, $p<0.05$)

DISCUSSION

According to Table 1, all chemicals except NAD at 20 mg L^{-1} significantly increased percent of fruit thinning on 2 weeks after spraying, but at harvest time just ethephon at 200 mg L^{-1} significantly increased fruit drop. Among the treatments, ethephon 200 mg L^{-1} had the highest level of thinning 77.69% on 2 weeks after spraying. This was followed by ethephon at 100 mg L^{-1} (76.24%). In addition, ethephon 200 mg L^{-1} was found to be the highest level of thinning on harvest time. According to our results, Bolat and Karlidag (1999) concluded that NAA induced fruit thinning on apricot trees. Zilkah *et al.* (1988) reported that urea reduced fruit set of peaches while increased final fruit weight.

Auxins (NAA and NAD) and urea stimulate ethylene production and induce fruit abscission (Dennis, 2000).

The analysis of fruits reveled that all treatments except ethephon increased fruit volume, weight and diameter. In addition, urea at 0.4% improved fruit length. Ethephon had the least fruit volume and weight and with increased in ethephon concentration from 50 to 200 mg L^{-1} decreased fruit volume (25 to 21.27 cm^3) and weight (24.23 to 22.45 g). The increase in fruit size by NAA, NAD and urea may be attributed to thinning effects. These chemicals induced fruit thinning and with decrease comparison within remain fruits, increased leaf-fruit ratio, thus, give higher photosynthesis substance to fruit for better growth.

Ethephon against significant fruit thinning had no significant effect on these characters. Observation in this experiment showed that ethephon had some leaf abscission but limb gummosis was not produced. This is in agreement with the findings of Stembridge and Gambrell (1971) on peach trees.

We concluded that there was no enough leaves for nutrition of retained fruits. The effects of ethephon on fruit thinning and growth of apple has been reported but, results were variable.

Researchers reported that ethephon decreased fruit set and increased fruit weight (cited in Mcartney and Wells, 1995). On the other hand, Ebert and Bender (1986) concluded that ethephon increased fruit set and decreased fruit weight. Present results in lime with findings of Kim *et al.* (1987) that reported ethephon decreased fruit set and weight of apples. These results showed that the main problem in using of ethephon to thin is the variation in response from site to site and from season to season.

Ethephon at 200 mg L^{-1} and urea at 0.2% significantly increased TA of fruits (Table 3). Data showed that NAA, NAD, ethephon and urea affected fruit TSS and TSS/TA ratio. Chemicals improved fruit TSS from control (6.29%) to NAA 40 mg L^{-1} (8.5%). The highest level of TSS/TA ratio was obtained by NAD 80 mg L^{-1} (5.489), although, there were no significantly differences between NAD and NAA 40 and 80 mg L^{-1}, ethephon at 50 and 100 mg L^{-1} and urea 0.2%. Son (2004) indicated that NAA mg L^{-1} significantly increased fruit acidity of apricot. In our experiment, we found that ethephon increased TSS. It was may be associated to reduced fruit volume. Other treatments increased fruit TSS with enhanced leaf-fruit ratio and declined comparison among fruits. In agreement with our finding. Mcartney and Wells (1995) showed that ethephon significantly decreased fruit set and weight, but increased fruit TSS.

In this trial, NAA at 40 mg L^{-1}, NAD at 40 and 80 mg L^{-1}, ethephon at all concentrations and urea at 0.4 and 0.6% increased dry matter content. The ranged of dry matter content was from control (7) to ethephon 50 mg L^{-1} (9.23). This effect probably cased by thinning effect of chemicals. We found that with increased in concentrations of NAA, NAD and urea, increased leaf area but ethephon had no effect on leaf area.

In our trials, we found that ethephon had no significant effect on fruit weight and volume. We suggested that, lower concentration of ethephon must be use in future study due to these concentrations enhanced leaf abscission. Results of NAA, NAD and urea were useful for fruitlet thinning of Gerdi apricot and suggested that use in other cultivars in other place.

CONCLUSION

We concluded that application of all chemical agents except ethephon had beneficial effects on fruit abscission and improve fruit quality. The NAA in all concentrations, NAD 40 and 80 mg L^{-1} and all concentrations of urea, especially at 0.2 and 0.4% can suggested for fruit thinning of Gerdi apricots.

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