Scoring and Girdling, but not GA₃, Increase Yield without Decreasing Return Bloom in ‘Triumph’ Persimmon

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Abstract. The persimmon (*Diospyros kaki* Thunb.) cultivar Triumph is prone to poor fruit set, particularly in young orchards, in both Israel and South Africa where it is mostly grown. Two applications of 20 mg·L⁻¹ gibberellic acid (GA₃) at 30% and 70% full bloom (FB) are recommended as the industry norm to increase fruit set, but results obtained are often unsatisfactory. We conducted experiments during the 2005–06 and 2006–07 seasons in a young orchard (less than 5 years old) and a full-bearing orchard to determine the efficacy of GA₃ application and scoring or girdling during FB to increase fruit set and yield in ‘Triumph’ persimmon. We also established the effect of 2005–06 treatments on return bloom in 2006–07. Although GA₃ treatments were ineffective in increasing fruit set and reduced cumulative yield over the two seasons as a result of a reduction in return bloom, scoring increased the cumulative yield by 50% compared with the untreated control and by 92% compared with GA₃ application in the young orchard. In the full-bearing orchard, scoring or girdling increased the cumulative yield over the 2005–06 and 2006–07 seasons by 52% compared with the industry standard GA₃ application and by 22% compared with trees that received scoring/girdling in addition to GA₃. Hence, scoring or girdling did not entirely offset the negative effect of GA₃ application on return bloom. The increase in fruit numbers in response to fruit set treatment brought about a reduction in fruit mass. In conclusion, the ineffectiveness of GA₃ in increasing fruit set and its negative effect on return bloom do not justify its further use to improve fruit set in young or full-bearing ‘Triumph’ orchards in South Africa. Either scoring or girdling can be used to increase yield but will need to be accompanied by pruning and thinning strategies to achieve adequate fruit size and to prevent the onset of alternate bearing resulting from overcropping.

Persimmon cultivation in South Africa is expanding rapidly as a result of lucrative marketing opportunities that exist in the northern hemisphere for out-of-season southern hemisphere fruit (Rabe, 2003). Since 1998, ≈750 ha of the astringent Triumph cultivar has been planted. ‘Triumph’, like many important persimmon cultivars, is dioecious

and orchards consist entirely of female trees (Kitagawa and Glucina, 1984). Parthenocarpic fruit set in persimmons may vary considerably from year to year (Yamada et al., 1987) and poor fruit set is a major limitation to the early onset of regular, high production (George et al., 1997). Gibberellins (GAs) stimulate fruit set in various fruit species, i.e., peach (Stutte and Gage, 1990), ‘Clementine’ mandarin (Talon et al., 1992), apple (Bangerth and Schröder, 1994), and pear (Deckers and Schoofs, 2002). Application of GA₃ during or shortly after anthesis increases parthenocarpic fruit set in various persimmon cultivars (George et al., 1997; Yamamura et al., 1989). In South Africa, application of 20 mg·L⁻¹ GA₃ at 30% and 70% full bloom (FB) is the recommended industry standard treatment to increase parthenocarpic fruit set in ‘Triumph’.

Despite rigorous application of GA₃, parthenocarpic fruit set in ‘Triumph’ is erratic under South African conditions and producers have struggled to obtain regular high yields. Young ‘Triumph’ orchards are also late to come into production despite prolific flowering (Hodgson, 1938) and the use of GA₃ in Israel (Blumenfeld, 1981). In addition, there is concern that GA₃ application

may reduce return bloom. A decrease in flower initiation in response to GAs has been reported for various fruit species (Bangerth, 2006; Goldschmidt et al., 1997), including persimmon (Yamamura et al., 1989). This decrease in return bloom may decrease cumulative yields and induce the onset of alternate bearing.

As a result of the apparent ineffectiveness and perceived shortcomings of GA₃, producers are considering scoring or girdling (a knife-cut through the phloem and cambium or the removal of a 2-mm strip of phloem and cambium to the depth of the secondary xylem in a complete circle around the trunk, respectively) as a possible substitute to increase fruit set and yield in ‘Triumph’. Girdling during flowering has been shown to improve fruit set in various fruit species (Goren et al., 2004), including persimmons (Hasegawa et al., 2003; Hodgson, 1938). In addition, girdling and scoring may have a lesser effect on return bloom compared with GA₃ through its stimulating effect on flower initiation (Goren et al., 2004; Hodgson, 1938). Blumenfeld (1981) reports that a combination of girdling and GA₃ application was the most effective treatment to increase fruit set in young ‘Triumph’ orchards in Israel.

Scoring and girdling were equally effective in decreasing vegetative growth in apple (Autio and Greene, 1994) and increasing fruit size in peach and nectarine (Agustí et al., 1998) and loquat (Agustí et al., 2005). However, the potential for adverse effects on tree health is much less with scoring. Girdling may impair tree health if callusing is slow or inadequate (Fernandez-Escobar et al., 1987). Because the rate of wound repair is related to girdling width (Fernandez-Escobar et al., 1987), vascular connectivity is re-established much faster after scoring than after girdling (Furr et al., 1945). Furthermore, girdling with a hand saw carries the risk of cutting into the secondary xylem, resulting in severe water stress, abscission of all the fruit on affected trees, and even tree death (personal observation).

The research reported here evaluated the effect of GA₃ application during FB, scoring or girdling during FB, and interactions between GA₃ and girdling or scoring on fruit set, yield, return bloom, and fruit mass in ‘Triumph’ persimmon. The ultimate aims of this work are to develop guidelines for South African producers to improve fruit set of ‘Triumph’ persimmon and to obtain early and regular high yields of good-quality fruit.

Materials and Methods

Experimental sites. Experiments were conducted in a young orchard at Simondium (lat. 33°3′ S, long. 19°9′ E) and in a full-bearing orchard at Vyeboom (lat. 34°3′ S, long. 19°9′ E) in the Western Cape Province (Mediterranean climate) of South Africa on ‘Triumph’ persimmon grafted on *Diospyros virginiana* L. seedling rootstock. Trees were planted in 2002 at Simondium and in 1999 at Vyeboom at a spacing of 5 × 2 m at both sites and trained to a central leader form.

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Treatments. The effects of GA₃ (Valent BioSciences Co., Libertyville, IL), scoring with girdling pliers (Optima Products, Paarl, South Africa) developed for use on citrus, girdling with a tree saw (Felco600, Felco SA, Switzerland), and treatment combinations were evaluated on fruit set, yield, fruit mass, and return bloom. Both scoring and girdling were applied in a complete circle around the trunk ≈10 cm above the graft union. Scoring entailed a knife cut through the phloem and cambium, whereas girdling entailed the removal of a 2-mm ring of phloem and cambium to the depth of the secondary xylem. A total of 20 mg·L⁻¹ or 40 mg·L⁻¹ GA₃ was applied at 30% FB or 30% and 70% FB on windless mornings with a truck-mounted motorized sprayer until drip-off. A nonionic surfactant, Break-Thru, a.i. polyether-polymethylsiloxane-copolymer (Western Farm Service, Inc., Fresno, CA) was added (0.5 mL·L⁻¹) to spray treatments in all experiments. Treatments were applied to single tree plots. Guard trees and rows were left between treatment plots and rows.

In 2005–06 at Simondium, scoring (30% FB) and GA₃ (20 or 40 mg·L⁻¹ at 30% FB or 30% and 70% FB) treatments were randomized in 15 blocks. The same treatments were repeated on the same trees in 2006–07. In a second experiment in 2005–06 at Vyeboom, the recommended commercial standard GA₃ applications (20 mg·L⁻¹ at 30% and 70% FB) were applied to trees of five out of a total of nine treatments. In addition to the GA₃ application, trees of four of these five treatments were either scored or girdled at 30% FB or 30% and 70% FB. These scoring and girdling applications were repeated in a further four treatments that did not receive GA₃. Treatments were randomized in 15 blocks. The producer applied GA₃ (20 mg·L⁻¹) at 30% and 70% FB and girdling at 30% FB to all the treatment trees in 2006–07.

Data collection. Fruit set, fruit number and yield per tree, fruit mass, return bloom, and the cumulative yield per tree over the two seasons were determined. To determine fruit set, three ≈30-cm long, 1-year-old shoots per tree were randomly selected before flowering. Remaining peduncles and fruit were counted during Feb. 2006 and 2007 to assess fruit set. Peduncles persist on the tree for 3 months or more after flower abscission allowing the determination of initial flower number at this late date. All the fruit per tree were harvested in up to three harvests during April and May and weighed to determine yield in kg/tree. A 20-fruit sample per plot was used to determine average fruit mass. The total fruit mass per tree was divided by the average fruit mass of the 20-fruit sample to estimate fruit number per tree. Return bloom was assessed by counting flower peduncles and fruit during February on three randomly selected 1-year-old shoots per tree.

Statistical analysis. Data of all experiments were analyzed with the General Linear Models procedure in the SAS (Statistical Analysis System) computer program (SAS Enterprise Guide 3.0; SAS Institute,

Cary, NC). Means were separated by least significant difference (5%) following a significant F test. Initial flower number was used as a covariate to amend for differences in flower number before application of treatments and adjusted means used where applicable.

Results

Young trees. Because there were no clear or consistent differences between the various timings and rates of GA₃ application, the data of these treatments were pooled. Statistical analyses were subsequently performed for the treatments, untreated control, GA₃ application, and scoring.

Scoring increased fruit set, fruit number per tree, and yield per tree compared with the untreated control and GA₃ application in 2005–06 (Fig. 1A–C). Scoring also increased fruit number per tree and yield per tree compared with GA₃ application in 2006–07 (Fig. 1A–C). In contrast, GA₃ application had no beneficial effect on fruit set, fruit number, or yield compared with the untreated control in either season (Fig. 1A–C). In fact, GA₃ application decreased fruit number and yield per tree (Fig. 1B–C) compared with the untreated control and scoring in 2006–07 as a result of a reduction in return bloom (Fig. 1D). Scoring increased the cumulative yield over the 2005–06 and 2006–07 seasons by 14 t·ha⁻¹ (50%) compared with the untreated control and by 20 t·ha⁻¹ (92%) compared with GA₃ treatment (Fig. 1C).

GA₃ application and scoring significantly decreased fruit size compared with the control in 2005–06 (Fig. 1E). In the case of scoring, the decrease in fruit size can be attributed to the increase in fruit numbers (Fig. 1B). Despite a reduction in yield and fruit numbers in 2006–07 in trees that received GA₃, fruit mass was not increased (Fig. 1E).

Full-bearing trees. Because there were no clear or consistent differences in the effectiveness of scoring compared with girdling or in scoring/girdling once compared with twice for any of the measured variables in either 2005–06 or 2006–07, the data of these treatments were pooled. The resulting three treatments, namely, the industry standard application of 20 mg·L⁻¹ GA₃ at 30% and 70% FB, scoring/girdling, and a combination of scoring/girdling with the industry standard GA₃ application, were compared statistically by means of analysis of variance.

Scoring/girdling in combination with the industry standard GA₃ application increased fruit set in 2005–06 compared with either GA₃ application or scoring/girdling on their own (Fig. 2A). Combining girdling/scoring with GA₃ application also increased the fruit number per tree compared with the industry standard GA₃ application (Fig. 2B). Scoring/girdling alone or in combination with GA₃ increased the yield per tree compared with the industry standard GA₃ application (Fig. 2C). Scoring/girdling in combination with

GA₃ decreased fruit size compared with scoring/girdling on its own (Fig. 2D).

Trees that received GA₃ in 2005–06 showed decreased return bloom in 2006–07 compared with trees that were only scored or girdled (Fig. 2D). This decrease further related to a decrease in fruit set of trees that received GA₃ compared with trees that were only scored or girdled and into a decrease in the number of fruit and yield per tree at harvest (Fig. 2A–C). The increase in yield was at the expense of fruit size (Fig. 2E). Scoring/girdling increased the cumulative yield over two seasons by 35 t·ha⁻¹ (52%) compared with trees that received the industry standard GA₃ application in 2005–06 and by 18.5 t·ha⁻¹ (22%) compared with trees that were scored or girdled in addition to receiving GA₃ (Fig. 2C).

Discussion

GAs are widely used to induce parthenocarpic fruit set in various fruit species, including persimmon (George et al., 1997; Yamamura et al., 1989). However, our results show that GA₃ application during FB does not improve fruit set and yield in young and full-bearing ‘Triumph’ persimmon trees in South Africa. This concurs with the poor fruit set often observed in full-bearing trees in South Africa and with the difficulty to induce early production in young orchards despite the rigorous application of 20 mg·L⁻¹ GA₃ at 30% and 70% FB as the industry standard. Considering that GA₃ application at FB increased yields by up to 400% in ‘Triumph’ in Israel (Blumenfeld, 1981), the ineffectiveness of GA₃ in South Africa is difficult to explain but may relate to differences in climatic conditions.

In addition to its ineffectiveness with regard to fruit set, GA₃ application significantly reduced return bloom and yield in the subsequent season in both young and full-bearing ‘Triumph’ trees. The effect of GA₃ on return bloom suggests that trees effectively absorbed GA₃. The negative effect of endogenous GAs as well as GA application on flower induction in various fruit species is well established (Bangerth, 2006; Goldschmidt et al., 1997). Yamamura et al. (1989) found a considerable reduction in return bloom in ‘Saijo’ and ‘Fuyu’ persimmons in response to the relatively low GA₃ concentration of 25 mg·L⁻¹ applied ≈10 d after FB.

In contrast to GA₃, scoring improved fruit set, the number of fruit, and yield per tree in young ‘Triumph’ trees in 2005–06. This is in agreement with previous research in persimmon (George et al., 1997; Hasegawa et al., 2003; Hodgson, 1938) and various other fruit species (Goren et al., 2004; Rivas et al., 2006). In contrast, scoring had no effect on fruit set in young trees in 2006–07 possibly relating to the generally much better fruit set attained in this season. The response to girdling was found to be less pronounced in “on” compared with “off” years in avocado (Lahav et al., 1971), in high-yielding

Fig. 1. Effect of gibberellic acid application and scoring during full bloom in 2005–06 and 2006–07 on (A) fruit set, (B) fruit number per tree, (C) yield per tree for each season as well as cumulative yield over the two seasons, (D) return bloom in 2006–07, and (E) average fruit mass of young (less than 5 years old) ‘Triumph’ persimmon trees. Mean separation within a year by least significant difference (5%) following significant F test with *, **, *** at $P \leq 0.05$, 0.01, or 0.001, respectively. NS = nonsignificant.

compared with low-yielding avocado cultivars (Lahav et al., 1971), and in high-yielding compared with low-yielding orchards of ‘Fortune’ mandarin (Rivas et al., 2006). The increase in yield of young trees in response to scoring in 2005–06 did not reduce return bloom in 2006–07. High fruit numbers during

“on” years is considered to be the most important cause of yield alternation in various fruits (Monselise and Goldschmidt, 1982). The negative effect of the high fruit numbers was probably offset by a positive effect of scoring or girdling on flower initiation as has been observed in various fruit

species (Goren et al., 2004), including persimmon (Hodgson, 1938).

Combining GA₃ application with scoring/girdling in 2005–06 increased fruit set in mature ‘Triumph’ trees and gave rise to a yield increase above the industry standard GA₃ treatment, suggesting a synergistic effect between these treatments. This is in agreement with Blumenfeld (1981) who found that combining GA₃ and girdling was the most effective treatment to increase fruit set in young persimmon trees in Israel. Scoring/girdling alone without GA₃ application slightly increased fruit set, fruit number per tree, and average fruit mass compared the industry standard GA₃ treatment. Although not statistically significant, these slight increases added up to result in a significant yield increase for scoring/girdling over the industry standard treatment. Mature trees that received GA₃ in 2005–06 showed decreased fruit set, fruit number, and yield per tree in 2006–07 compared with trees that were scored or girdled but did not receive GA₃. Because all the mature trees received the same fruit set treatment in 2006–07 (girdling at 30% FB and GA₃ application at 30% and 70% FB), treatment differences in 2006–07 can be attributed to a carryover effect of treatments applied in 2005–06. Hence, the reduction in fruit set in 2006–07 in response to GA₃ application in 2005–06 suggests that in addition to its negative effect on flower induction, GA₃ also had a negative effect on flower quality.

An increase in fruit numbers in young and mature ‘Triumph’ trees in response to fruit set treatments resulted in a reduction in average fruit mass. This is in agreement with Hasegawa and Nakajima (1990) who found that an increase in fruit set in ‘Jiro’ persimmon in response to GA₃ application was accompanied by a decrease in fruit size. Interestingly enough, GA₃ application in 2005–06 decreased the average fruit mass in young ‘Triumph’ trees despite having no effect on fruit set or yield. Trees that received GA₃ in 2005–06 showed a significant reduction in fruit number per tree in 2006–07, but this did not have a positive effect on fruit size. These results suggest that GA₃ application may reduce fruit size in young trees independent of the effect of fruit load. GA₃ applied 10 d before the onset of harvest reduced persimmon fruit growth for ≈ 2 weeks (Gross et al., 1984). It is possible that GA₃ application at FB may have a similar effect on fruit growth. GA₃ may also reduce fruit size by stimulating shoot growth. The marked effect of GAs on shoot elongation is well established (Salisbury and Ross, 1992). Unfortunately, shoot growth was not measured in this study. In the case of girdling or scoring, the negative effect of an increase in fruit load on fruit size may be partially offset by the increase in photosynthates above the girdle available for fruit growth (Goren et al., 2004; Hasegawa et al., 2003). Girdling generally has a positive effect on fruit size if not accompanied by an increase in fruit number (Goren et al., 2004). In ‘Matsumotowase

Fig. 2. Effect of scoring/girdling during full bloom (FB), alone or in combination with the industry standard (IS) gibberellic acid (GA₃) application (20 mg·L⁻¹, 30% and 70% FB) in 2005–06, on (A) fruit set, (B) fruit number per tree, (C) yield per tree for each season as well as cumulative yield over the two seasons, (D) return bloom in 2006–07, and (E) average fruit mass of full bearing ‘Triumph’ persimmon trees. All trees received the same fruit set treatment in 2006–07 (girdling at 30% FB and IS GA₃ application). Mean separation within a year by least significant difference (5%) following significant F test with *, **, *** at $P \leq 0.05$, 0.01, or 0.001, respectively.

Fuyu’ persimmon, trunk strapping with wire (resulting in partial girdling) increased fruit size despite increasing fruit set (Hasegawa et al., 2003).

The data presented here provide producers with a set of tools to increase and regulate fruit set and production of ‘Triumph’ persimmon. The yields reported compare

favorably with the average yield of 30 t·ha⁻¹ reported for full-bearing ‘Triumph’ persimmon orchards in Israel (Llácer and Badenes, 2002). However, it is evident that South African producers receive no benefit from GA₃ application, but actually achieve reduced return bloom and lower cumulative yields. Combining scoring or girdling with GA₃ did not offset the negative effect of GA₃ on return bloom. Hence, there seems to be no justification for the further use of GA₃ to improve fruit set in ‘Triumph’ under South African conditions. The practice of applying GA₃ shortly before harvest to increase the storability of ‘Triumph’ fruit should also be reassessed in light of the negative effect of GA₃ on return bloom.

It seems that either scoring or girdling will suffice for the goal of increasing fruit set and yield and to induce early production. This is in agreement with the equal effectiveness of scoring and girdling in increasing fruit size in loquat (Agustí et al., 2005), peach and nectarine (Agustí et al., 1998). However, it is possibly prudent to restrict the use of girdling to full-bearing and more vigorous orchards because of the greater risk involved with its use. Longer-term studies are needed to establish whether repeated scoring or girdling over a number of seasons may have adverse effects on the performance and health of ‘Triumph’ persimmon trees. It is also sensible to apply scoring and girdling judiciously because heavy cropping may be undesirable in young orchards that still need to fill their allotted space. Excessive yields may also result in the onset of alternate bearing by decreasing vegetative growth and thereby decreasing bearing positions for the next season (Hodgson, 1938). Hence, pruning and thinning strategies to regulate yield and to ensure the formation of sufficient bearing wood should form part of further research to develop strategies for the attainment of early, regular high yield of high-quality fruit in ‘Triumph’ persimmon.

Literature Cited

- Agustí, M., I. Andreu, M. Juan, V. Almela, and L. Zacarias. 1998. Effects of ringing branches on fruit size and maturity of peach and nectarine cultivars. *J. Hort. Sci. Biotechnol.* 73:537–540.
- Agustí, M., N. Gariglio, M. Juan, V. Almela, C. Mesejo, and A. Martínez-Fuentes. 2005. Effect of branch scoring on fruit development in loquat. *J. Hort. Sci. Biotechnol.* 80:370–374.
- Autio, W.R. and D.W. Greene. 1994. Effects of growth retarding treatments on apple tree growth, fruit maturation and fruit abscission. *J. Hort. Sci.* 69:653–664.
- Bangerth, F. 2006. Flower induction in perennial fruit trees: Still an enigma? *Acta Hort.* 727:177–195.
- Bangerth, F. and M. Schröder. 1994. Strong synergistic effects of gibberellins with the synthetic cytokinin N-(2-chloro-4-pyridyl)-N-phenylurea on parthenocarpic fruit set and some other fruit characteristics of apple. *Plant Growth Regulat.* 15:293–302.
- Blumenfeld, A. 1981. Increasing persimmon yields with gibberellic acid. *Acta Hort.* 120:237.
- Deckers, T. and H. Schoofs. 2002. Improvement of fruit set on young pear trees cultivar Conference with gibberellins. *Acta Hort.* 596:735–743.

- Fernandez-Escobar, R., R. Martin, P. Lopez-Rivares, and M. Paz Suarez. 1987. Girdling as a means of increasing fruit size and earliness in peach and nectarine cultivars. *J. Hort. Sci.* 62: 463–468.
- Furr, J.R., P.C. Reece, and G. Hrniciar. 1945. Nitrogen absorption of ringed orange trees in sand culture. *Proc. Amer. Soc. Hort. Sci.* 46: 51–54.
- George, A.P., A.D. Mowat, R.J. Collins, and M. Morley-Bunker. 1997. The pattern and control of reproductive development in non-astringent persimmon (*Diospyros kaki* L.): A review. *Scientia Hort.* 70:93–122.
- Goldschmidt, E.E., M. Tamim, and R. Goren. 1997. Gibberellins and flowering in citrus and other fruit trees: A critical review. *Acta Hort.* 463:201–208.
- Goren, R., M. Huberman, and E.E. Goldschmidt. 2004. Girdling: Physiological and horticultural aspects. *Hort. Rev. (Amer. Soc. Hort. Sci.)* 30:1–36.
- Gross, J., H. Bazak, A. Blumenfeld, and R. Ben-Arie. 1984. Changes in chlorophyll and carotenoid pigments in the peel of Triumph persimmon induced by preharvest gibberellin (GA₃) treatment. *Scientia Hort.* 24:305–314.
- Hasegawa, K., M. Matsushita, and A. Kitajima. 2003. Effect of trunk strapping time on fruit set and quality in persimmon cv. Matsumotowase Fuyu. *Acta Hort.* 601:95–97.
- Hasegawa, K. and Y. Nakajima. 1990. Effects of bloom date, seediness, GA treatment and location of fruits in the foliar canopy on the fruit quality of persimmon (*Diospyros kaki* Thunb.) [in Japanese with abstract in English]. *J. Jpn. Soc. Hort. Sci.* 59:263–270.
- Hodgson, R.W. 1938. Girdling to reduce fruit drop in the Hachiya persimmon. *Proc. Amer. Soc. Hort. Sci.* 36:405–409.
- Kitagawa, H. and P.G. Glucina. 1984. Persimmon culture in New Zealand. Government Printer, Wellington, New Zealand.
- Lahav, E., B. Gefen, and D. Zamet. 1971. The effect of girdling on the productivity of the avocado. *J. Amer. Soc. Hort. Sci.* 96:396–398.
- Llácer, G. and M.L. Badenes. 2002. Persimmon production and market, p. 9–21. In: Bellini, E. and E. Giordani (eds.). First Mediterranean symposium on persimmon. Zaragoza, CIHEAM-IAMZ.
- Monselise, S.P. and E.E. Goldschmidt. 1982. Alternate bearing in fruit trees. *Hort. Rev. (Amer. Soc. Hort. Sci.)* 4:128–173.
- Rabe, E. 2003. The new South African persimmon industry: Rationale and proposed systems. *Acta Hort.* 601:159–162.
- Rivas, F., Y. Erner, E. Alós, M. Juan, V. Almela, and M. Agustí. 2006. Girdling increases carbohydrate availability and fruit-set in citrus cultivars irrespective of parthenocarpic ability. *J. Hort. Sci. Biotechnol.* 81:289–295.
- Salisbury, F.B. and C.W. Ross. 1992. Plant physiology. 4th Ed. Wadsworth, Inc., Belmont, CA.
- Stutte, G.W. and J. Gage. 1990. Gibberellins inhibit fruit abscission following seed abortion in peach. *J. Amer. Soc. Hort. Sci.* 115:107–110.
- Talon, M., L. Zarcarias, and E. Primo-Millo. 1992. Gibberellins and parthenocarpic ability in developing ovaries of seedless mandarins. *Plant Physiol.* 99:1575–1581.
- Yamada, M., A. Kurihara, and T. Sumi. 1987. Varietal differences in fruit bearing in Japanese persimmon (*Diospyros kaki* Thunb.) and their yearly fluctuations [in Japanese with abstract in English]. *J. Jpn. Soc. Hort. Sci.* 56:293–299.
- Yamamura, H., K. Matsui, and T. Matsumoto. 1989. Effects of gibberellins on fruit set and flower-bud formation in unpollinated persimmons (*Diospyros kaki*). *Scientia Hort.* 38:77–86.