Research Updates

Commercial-scale Use of Hydrogen Cyanamide for Apple and Peach Blossom Thinning

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SUMMARY. Hydrogen cyanamide (Dormex, 50% a.i.) for blossom thinning 'Early Spur Rome' and 'Law Rome' apple (*Malus* ×*domestica* Borkh.) and 'Flavorcrest' peach (*Prunus persica* L.) was applied with air-blast sprayers on a commercial scale. Full-bloom applications of hydrogen cyanamide at 4 pts formulation per 200 gal/acre (1288 mg·L^{-1}) and 5 pts formulation per 200 gal/acre (1610 mg·L^{-1}) significantly reduced fruit set in apple and peach. In 'Early Spur Rome', a postbloom application of carbaryl [Sevin XLR Plus, 4 lb a.i./gal (0.48 kg·L^{-1})] following a full-bloom spray of hydrogen cyanamide increased fruit thinning with a significant increase in fruit size compared to an application of hydrogen cyanamide alone. In 'Law Rome', trees receiving a full-bloom application of hydrogen cyanamide followed by a postbloom application of 1-naphthyl-*N*-methylcarbamate (carbaryl) + naphthalene acetic acid (NAA) had significantly lower fruit set and larger fruit than those in the carbaryl + NAA treatment. Apples or peaches were not marked by hydrogen cyanamide.

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Early thinning of apples is important because of its impact on fruit size and next season's flower bud initiation. In the past, apple cultivars were often sprayed with the blossom thinner sodium dinitro-ortho-cresol (Elgetol, 19% a.i.) during full bloom, followed by a postbloom application of a fruit thinner such as 1-naphthyl-*N*-methylcarbamate (carbaryl) with or without naphthalene acetic acid (NAA) (Williams and Edgerton, 1981). Carbaryl and NAA are effective postbloom fruit thinners for 4 to 5 weeks after full bloom (Byers et al., 1990; Byers and Carbaugh, 1991; Williams and Edgerton, 1981). Gibberellin A_{4+7} and 6-benzylamino purine are also effective postbloom fruit thinners for 'Delicious' apples (Byers and Carbaugh, 1991; Ferree, 1996; Greene, 1984; Greene and Lord, 1985). Elgetol was removed from the market in 1989 because of the high cost of reregistration. Full-bloom sprays of sulfcarbamide (Wilthin, 79% a.i.), pelargonic acid (Thinex), and endothalic acid (Endothal), or petal-fall applications of carbaryl (Sevin XLR Plus) were developed as replacements for Elgetol, and were reported to result in a satisfactory thinning and fruit set in 'Delicious' (Williams, 1993, 1994) and 'Rome' apples (Fallahi, 1997; Fallahi et al., 1997).

Hydrogen cyanamide and other chemicals have been used to reduce chilling requirements of peaches grown under warm desert conditions of southwest Arizona (Fallahi et al., 1990). Hydrogen cyanamide applied at pink bloom reduced the number of open blossoms. Based on this observation, hydrogen cyanamide was sprayed at different concentrations prebloom and full bloom on 'Florda Prince' peach in southwest Arizona (Fallahi et al., 1990). Results indicated that hydrogen cyanamide at 8 pts formulation/100 gal (5152 mg·L^{-1}) applied at full bloom significantly reduced fruit set. In later studies, hydrogen cyanamide was also found to be an effective blossom thinner for plums (Fallahi et al., 1992), apples (Fallahi, 1997; Fallahi et al., 1997), and peaches (Fallahi, 1997) in Idaho. Fallahi (1997) reported that, although hydrogen cyanamide, endothalic acid, and pelargonic acid were all, to some extent, effective for blossom thinning of apple and peach, hydrogen cyanamide showed more consistent results from year to year.

The objective of these experiments was to follow up small-scale trials with commercial-scale applications of hydrogen cyanamide on 'Early Spur Rome' and 'Law Rome' apples and 'Flavorcrest' peach and to measure its effects on blossom thinning and fruit quality.

Materials and methods

Hydrogen cyanamide (Dormex, 50% a.i.; D.K. International, Inc., Marietta, Ga.) was applied as a blossom thinner to 'Early Spur Rome' and 'Law Rome' apples and 'Flavorcrest' peach in 1997. Modified phthalic glycerol alkyd resin (Latron B-1956, a.i. 77%) was used with all hydrogen cyanamide treatments as a surfactant at the rate described in Tables 1–3. Polyoxyethylenepolypropoxypropanol (Regulaid, 90.6% a.i.) was mixed with all treatments that included a postbloom thinner in apple experiments at the rate described in Tables 1 and 2.

APPLE THINNING TRIALS

'EARLY SPUR ROME'. This trial consisted of very uniform 6-year-old 'Early Spur Rome' apple trees on M.26 EMLA rootstock spaced at 9 × 18 ft (2.7 × 5.5 m) in a commercial orchard near Sunnyslope in Canyon County, Idaho. Trees were in full production without any blossom freeze damage. Temperatures during application were 46.4 to 50.4 °F (8 to 10 °C). Except for blossom and fruit thinning, cultural practices in this orchard were similar to those of commercial orchards. Two adjacent rows consisting of 60 trees each were used for unthinned control, hand thinning alone, hydrogen cyanamide alone or in combination with carbaryl with and without hand thinning. Each row was divided into three sections. Two sections were sprayed with two rates of hydrogen cyanamide with or without a postbloom thinner. The third section was used for control (unthinned) and hand-thinned treatments. Two additional adjacent rows (four rows away from the previously mentioned two rows) were selected for carbaryl treatments with or without hand thinning. The experimental design was a completely randomized design with seven one-tree replications per treatment. On different sides of each tree, four 5.9-ft (1.8-m) limbs were arbitrarily selected and tagged, and total number of flower buds (mixed buds) were counted ≈2 weeks before bloom (before any treatment application). The total number of fruit on the tagged limbs were counted after June drop, and number of fruit per 100 flower clusters was calculated.

Treatments for this trial are listed in Table 1. Full-bloom treatments were applied when 90% to 95% of blooms on the main tree canopy were open on 30 Apr. 1997. At this time, blooms on 1-year-old shoots were not completely open. Control trees received no chemical or hand thinning. In the hand-thinned treatment (no chemical thinning) and in all treatments that included hand thinning (see Table 1), fruit were hand thinned to one fruit per cluster when the fruit diameter was ≈0.39 to 0.55 inches (10 to 14 mm) on 5 June 1997. Fruit set in the hand-thinned treatment was determined after hand thinning. In treatments with postbloom fruit thinners, fruit were thinned with a postbloom application of carbaryl [Sevin XLR Plus, 4 lb a.i./gal (0.48 $kg \cdot L^{-1}$)], as described in Table 1, on 15 May 1997. Hydrogen cyanamide treatments were applied with an air-blast sprayer calibrated to deliver 200 gal of liquid per acre (1871 $L \cdot ha^{-1}$). Postbloom spray was applied at a rate of 400 gal of liquid per acre. Although applications were made during calm days, only trees from the midsection of each treatment were selected for various measurements to avoid any possible drift effects.

'Law Rome'. This experiment was conducted in a commercial orchard of 12-year-old 'Law Rome Beauty' apple trees on MM 106 rootstock spaced at 9 × 18 ft (2.7 × 5.5 m) near Fruitland, Idaho.

Trees were in full production, and blossoms had no freeze damage. Full-bloom (≈90% blooms open) treatments were applied on 28 Apr. 1997. Temperatures during treatment applications were 43.7 to 46.4 °F (6.5 to 8 °C). Trees were very uniform in size and shape. Two rows of 45 trees each were used for the hydrogen cyanamide plus postbloom thinner treatments. A third row (four rows away from the previously mentioned two rows) was selected for the postbloom treatment alone. Each of the two selected rows was divided in two sections, and each section was sprayed with one of the two rates of hydrogen cyanamide, as described in Table 2, using an air-blast sprayer calibrated to deliver 200 gal of liquid per acre. In each section, seven trees were hand-thinned to one fruit per cluster after June drop. All of the trees in this orchard, including the ones which received hydrogen cyanamide, were sprayed with a combination of carbaryl (Sevin 4 F) and NAA-200 as a postbloom thinner at the rates described in Table 2 on 19 May 1997. Fruit set of trees in the carbaryl + NAA and hand thinned treatment (Table 2) was calculated before hand thinning to determine the effects of postbloom thinners alone. The experimental design was a completely randomized design with seven one-tree replications per treatment. The procedures for flower bud and fruit counts for determination of fruit set were similar to those of 'Early Spur Rome'.

'Gala' and 'Delicious'. Eight-year-old 'Royal Gala' apple trees on MM 106 rootstock spaced at 9 × 18 ft (2.7 × 5.5 m) in two commercial orchards in Washington were used for this experiment. One was near George and the other near Sunnyside. At each of the two 'Gala' orchards, two partial sections (50 trees) of each row were sprayed with hydrogen cyanamide at rates of 4 or 5 pts per 200 gal/acre (4676 or 5846 mL formulation per 1871 $L \cdot ha^{-1}$ or 1288 or 1610 $mg \cdot L^{-1}$) with an air-blast sprayer, while adjacent sets of rows received either no thinning, or hand thinning 2 months after bloom.

Twelve-year-old 'Redspur Delicious' apple trees on M7 rootstock spaced at 10 × 20 ft (3 × 6 m) located at the University

Table 1. Commercial-scale blossom thinning of 'Early Spur Rome' with hydrogen cyanamide (HC) in Sunnyslope, Idaho.

Treatment[y]	HC rate[z] (a.i./L)	Fruit set (no. fruit/ 100 clusters)	Fruit wt at harvest (g)	Yield (kg/tree)	Fruit russet (%)
Control	---	140.5 a[x]	168.0 i	35.2 abc	7.2 b
Hand thinned	---	52.4 d	226.7 ef	30.1 bcd	5.3 b
HC	4 (1288 mg)	117.3 b	191.8 h	44.3 a	5.2 b
HC	5 (1610 mg)	101.7 b	195.0 gh	35.3 abc	9.7 ab
Carbaryl	---	98.8 b	218.3 fg	43.6 a	11.2 ab
HC + Carbaryl	4 (1288 mg)	74.6 c	230.6 def	31.9 bcd	10.2 ab
HC + Carbaryl	5 (1610 mg)	71.9 c	231.7 def	27.2 cd	8.5 b
HC + hand thinned	4 (1288 mg)	---	275.0 ab	23.7 d	7.0 b
HC + hand thinned	5 (1610 mg)	---	257.2 bc	25.5 cd	5.7 b
HC + Carbaryl + hand thinned	4 (1288 mg)	---	294.6 a	25.5 cd	17.3 a
HC + Carbaryl + hand thinned	5 (1610 mg)	---	252.0 bcd	25.5 cd	10.2 ab
Carbaryl + hand thinned	---	---	242.2 cde	37.9 ab	11.3 ab

[z]Values out of parentheses are pints/200 gal/acre; values in parentheses are a.i./L.
[y]HC (when used) was mixed with Latron B-1956 as a surfactant at a rate of 1 pt/100 gal (1.25 $mL \cdot L^{-1}$). Carbaryl (Sevin XLR Plus), when used, was applied at the rate 0.75 pts/100 gal (0.94 $mL \cdot L^{-1}$) mixed with Regulaid at the rate of 0.75 pts/100 gal (0.94 $mL \cdot L^{-1}$) sprayed at 400 gal/acre (3742 $L \cdot ha^{-1}$). Hand thinning (when applied) was done after June drop to result in one fruit per cluster.
[x]Mean separation within columns by LSD at 5% level.

Table 2. Commercial-scale blossom thinning of 'Law Rome' with hydrogen cyanamide (HC) in Fruitland, Idaho[z].

Treatment[x]	HC rate[y] (a.i./L)	Fruit set[z] (no. fruit/ 100 clusters)	Fruit wt at harvest (g)	Yield (kg/tree)
Carbaryl + NAA + hand thinned	---	139.7 a[w]	178.1 d	170.5 b
HC + Carbaryl + NAA	4 (1288 mg)	76.4 b	194.7 c	196.6 a
HC + Carbaryl + NAA	5 (1610 mg)	62.4 c	215.1 b	175.3 ab
HC + Carbaryl + NAA + hand thinned	4 (1288 mg)	---	222.2 b	172.4 b
HC + Carbaryl + NAA + hand thinned	5 (1610 mg)	---	237.4 a	166.6 b

[z]For Carbaryl + NAA + hand-thinned treatment, fruit set was determined before hand thinning.
[y]Values out of parentheses are pints/200 gal/acre; values in parentheses are a.i./L.
[x]HC (when used) was mixed with Latron B-1956, as a surfactant, at a rate of 1 pt/100 gal (1.25 $mL \cdot L^{-1}$). Carbaryl (Sevin 4 F) + NAA, when used, was consisted of Sevin 4 F at the rate 1.25 pts /100 gal (1.56 $mL \cdot L^{-1}$) plus 2 oz NAA, 200/100 gal (0.156 $mL \cdot L^{-1}$) mixed with Regulaid at the rate of 1 pt/100 gal (1.25 $mL \cdot L^{-1}$), sprayed at 200 gal/acre (1871 $L \cdot ha^{-1}$). Hand thinning (when applied) was done after June drop to result in one fruit per cluster.
[w]Mean separation within columns by LSD at 5% level.

of Idaho Parma Research and Extension Center near Parma were sprayed using an air-blast sprayer with hydrogen cyanamide at the rates of 2 or 2.5 pts per 200 gal/acre (2338 or 2923 mL per 1871 $L \cdot ha^{-1}$). Two rows consisting of 36 trees each were used for each rate of hydrogen cyanamide, while adjacent sets of rows received no thinning. No data were collected from the 'Gala' or 'Delicious' experiments, but the treated areas were visually compared with the unsprayed trees.

Peach thinning trial

This study was conducted on 12-year-old 'Flavorcrest' peach trees on peach seedling rootstock spaced at 10×18 ft (3.0 × 5.5 m) in a commercial orchard in Canyon County, near Caldwell, Idaho. Trees had minor freeze damage before blossom thinning, but they still had heavy bloom. Trees were in full-bloom on 3 Apr. 1997. Except for the blossom and hand thinning, other cultural practices in this experiment were similar to those of commercial orchards. Two rows, consisting of 46 trees each, were used for the hydrogen cyanamide treatments. In each row, two rates of hydrogen cyanamide (as described in Table 3) were applied at full bloom (≈75% to 100% of all blooms open) on separate sections of row with an air-blast sprayer calibrated to deliver 200 gal of liquid/acre. Temperatures during application were 42.3 to 49.9 °F (5.7 to 9.9 °C). Four rows away from sprayed rows, trees on two rows received either no thinning, or hand thinning on 14 May or 3 June (at the beginning of pit hardening). The May and June hand-thinned treatments were conducted to maintain ≈7 inches (17.8 cm) between fruit on 14 May or 3 June 1997 (beginning of pit hardening), respectively. As in commercial practice, these treatments did not receive any blossom thinner. In the hydrogen cyanamide and hand-thinned treatments (Table 3), in addition to hydrogen cyanamide application at full-bloom, fruit were hand thinned to 7 inches on 3 June 1997. Seven trees were randomly selected for each treatment as shown in Table 3. The experimental design, therefore, was a completely randomized design with seven one-tree replications per treatment.

On different sides of each tree, four 4.9-ft (1.5-m) long limbs were tagged, and total number of flower buds were counted ≈12 d before bloom (before any treatment application). The total number of fruit on the tagged limbs were counted after June drop on 3 June 1997. Fruit set was calculated based on the number of remaining fruit per 100 flowers.

Fruit yield and quality evaluation

Yield per tree for both apple and peach was recorded. About 50 fruit per tree were sampled, cleaned, and evaluated for russetting (fruit marks). Thirty of these fruit were used for weight and color measurements. Fruit color was measured with similar procedures as described by Fallahi and Simons (1993). Fruit weight is used throughout the manuscript to also indicate fruit size.

Results and discussion

Apple trials

'Early Spur Rome'. Hydrogen cyanamide at both rates significantly reduced fruit set compared to the

Table 3. Commercial-scale blossom thinning of 'Flavorcrest' Peach with hydrogen cyanamide (HC) in Sunnyslope, Idaho.

Treatment[y]	HC rate[z] (a.i./L)	Fruit set before June hand thinning (fruit no/100 flowers)	Fruit set after June hand thinning (fruit no/100 flowers)	No. of hand-thinned fruit/tree	Fruit wt in June (g)	Fruit wt at harvest (g)	Yield (kg/tree)	% Split
Control	---	34.2 a[x]	34.2 a	---	22.5 c	113.2 d	50.3 ab	6.7 d
May hand thinned	---	13.1 c	13.1 b	---	29.7 a	202.0 a	35.2 b	29.0 ab
June hand thinned	---	36.1 a	11.3 bc	80 a	26.1 b	171.8 b	33.8 b	33.4 a
HC	4 (1288 mg)	22.8 b	8.8 c	50 b	25.6 b	130.2 cd	60.2 a	10.8 cd
HC	5 (1610 mg)	19.5 bc	8.9 c	31 b	26.6 b	155.5 bc	58.2 a	21.0 bc
HC + hand thinned	4 (1288 mg)	---	---	---	---	176.3 ab	51.2 ab	21.6 b
HC + hand thinned	5 (1610 mg)	---	---	---	---	174.6 ab	40.5 ab	21.2 bc

[z]Values out of parentheses are pints/200 gal/acre; values in parentheses are a.i./L.
[y]HC (when used) was mixed with Latron B-1956, as a surfactant, at a rate of 1 pt/100 gal (1.25 $mL \cdot L^{-1}$). When hand thinning was done, fruit were thinned to be 7 inches (17.8 cm) apart from each other.
[x]Mean separation within column by LSD at 5%.

unthinned control (Table 1). A postbloom application of carbaryl alone also significantly reduced fruit set at a magnitude statistically similar to that of hydrogen cyanamide alone (Table 1). However, when carbaryl was proceeded by full-bloom applications of hydrogen cyanamide, fruit set was significantly lower and fruit size was significantly greater than when hydrogen cyanamide treatments were applied alone.

The hand-thinned treatment had significantly lower fruit set than all other treatments. This indicates that trees receiving hydrogen cyanamide at full bloom and a postbloom thinner still needed additional thinning to reach the optimal fruit spacing that could be achieved by hand thinning alone. However, the time and cost required for chemical thinning in trees with hydrogen cyanamide and carbaryl was lower than for hand-thinned trees.

Untreated control trees had significantly smaller fruit than all other treatments (Table 1). Any treatment that included hand thinning always had larger fruit than the same treatment without hand thinning (Table 1). Trees that received a full-bloom application of hydrogen cyanamide and a postbloom application of carbaryl had significantly larger fruit than those receiving hydrogen cyanamide alone (Table 1). However, when a hand thinning was included with the above-mentioned treatments, fruit weight differences were substantially smaller. A significant reduction in the number of fruit led to a higher leaf-to-fruit ratio, resulting in larger fruit. Yield varied with fruit size and total number of fruit remaining on the trees (Table 1). Obviously, trees with larger fruit had a greater number of marketable fruit.

Trees sprayed with hydrogen cyanamide showed symptoms of leaf burning and chlorosis on spur leaves a few days after application. Most symptoms dissipated as the foliage grew, and only minor symptoms were visible on spur leaves at the time of harvest. These symptoms did not have an adverse effect on yield or fruit size. Hydrogen cyanamide did not cause any fruit marks. Fruit from many of the treatments that included carbaryl tended to have more russetting (Table 1).

'Law Rome'. Trees receiving a full-bloom application of hydrogen cyanamide followed by a postbloom carbaryl + NAA had significantly lower fruit set than those with the carbaryl + NAA and hand-thinned treatment (Table 2). In the latter-mentioned treatment, fruit set was determined before hand thinning, so the fruit set reflects the effect of carbaryl + NAA alone. This result is consistent with our observation with 'Early Spur Rome' (Table 1).

Trees receiving treatments that included a hydrogen cyanamide application had significantly larger fruit than those receiving carbaryl + NAA and hand-thinned treatment alone (Table 2). Fruit from the trees that received hydrogen cyanamide at 5 pts per 200 gal/acre followed by a carbaryl + NAA and hand thinning were significantly larger than fruit from all other treatments (Table 2).

Yields from tree that received hydrogen cyanamide at either 4 or 5 pts formulation per 200 gal/acre followed by a postbloom carbaryl + NAA and hand thinning were similar to those in trees with carbaryl + NAA and hand thinning (Table 2).

Overall, hydrogen cyanamide at 4 and 5 pts formulation per 200 gal/acre followed by a postbloom fruit and hand thinning showed excellent results for effective thinning and increased fruit size. The 5-pt formulation rate might be preferred for greater thinning and larger fruit.

Other than initial minor phytotoxicity symptoms, which dissipated by harvest time, no foliage damage or fruit russetting was observed in 'Law Rome' apple.

'Gala' and 'Delicious'. Applying 4 and 5 pts of hydrogen cyanamide formulation per 200 gal/acre provided satisfactory thinning in 'Gala' apple at both Washington locations (data not shown). In 'Gala', differences in fruit size between the two rates of hydrogen cyanamide were indistinguishable, but treated areas had visually larger fruit than the untreated area and the area that was hand-thinned 2 months postbloom. Other than initial minor phytotoxicity symptoms, which dissipated by harvest time, no foliage damage or fruit russetting was observed in 'Gala ' apple.

Hydrogen cyanamide at 2.5 pts per 200 gal/acre was effective in thinning 'Redspur Delicious' apple (data not shown). Leaves showed signs of cupping and minor injury, but the symptoms were not visible at harvest. Fruit from treated trees appeared to be larger than those from control trees (data not shown). In 'Delicious' apple, applying hydrogen cyanamide with a hand-gun sprayer at ≥2 pts/100gal caused considerable leaf cupping and phytotoxicity; thus, one should be cautious (personal experience).

Peach trial

Peach trees in this experiment remained in bloom (70% to 100%) longer than usual because of unseasonably cold temperatures for several days. Some blossoms were lost due to freeze damage, but fruit set was sufficient to result in nearly full production. Full-bloom applications of hydrogen cyanamide at 4 pts and 5 pts formulation per 200gal/acre significantly reduced fruit set (Table 3). Therefore, the number of fruit that needed to be hand thinned was significantly lower in the hydrogen cyanamide-treated trees (Table 3). Fruit size in June was larger than the unthinned control when fruit were hand-thinned in May (early hand thinning) or when hydrogen cyanamide was applied (Table 3), because of early reduction of fruit-to-fruit competition. Except for the hydrogen cyanamide at 4 pts formulation per 200 gal/acre treatment alone, all treatments significantly increased fruit size at harvest. Trees that were hand-thinned in May had significantly larger fruit at harvest than those that were hand thinned in June or sprayed with hydrogen cyanamide without further hand thinning (Table 3). Trees that received hydrogen cyanamide at either 4 or 5 pts formulation per 200 gal/acre followed by a hand thinning had similar fruit size and yield compared to those that were hand thinned in May or June. However, the time required for hand thinning was less for trees that received hydrogen cyanamide, and was less for trees that received hydrogen cyanamide at 5 vs. 4 pts formulation per 200 gal/acre (data not shown).

Fruit of trees that received chemical or hand-thinning treatment split more than those of the unthinned control, and the degree of split was proportional to fruit size (Table 3). Flavorcrest peach fruit have a tendency to split, and the problem is not related to hydrogen cyanamide application. This problem is related to fruit size and is usually more severe in larger fruit. Fruit from unthinned control trees were smaller than fruit from other treatments, and thus showed only 6.7% split (Table 3). Applying hydrogen cyanamide did not cause any phytotoxicity or fruit marks in peach.

General comments

Thinned trees had fruit with better quality attributes than unthinned trees. Fruit color in all treatments that included hand thinning was improved compared to those without hand thinning (data not shown) because of less fruit-to-fruit contact and better light distribution around the fruit.

Time and temperature are important factors influencing the effectiveness of blossom thinning in apple and peach. It is essential that hydrogen cyanamide is applied when some, but not all, flower fertilization has occurred. Also, the severity of freeze damage must be considered before applying or determining rates of any chemical blossom thinner. Temperature affects bee activity and, subsequently, the number of fertilized flowers. Temperature also affects the chemical characteristics and the effectiveness of blossom thinners, including hydrogen cyanamide. Therefore, the effect of these blossom thinners should be tested for each geographical region and for each cultivar.

The University of Idaho has conducted hydrogen cyanamide residue tests through IR-4 Program for 2 years. No detectable residue has been found in apple, plum, prune, or peach fruit. This chemical is not registered for blossom thinning at this time, but it is in the process of registration under D.K. International, Georgia, and SKW Germany.

Conclusion

Under conditions of this study, hydrogen cyanamide was an effective blossom thinner for 'Early Spur Rome', 'Law Rome', and perhaps 'Gala' and 'Delicious' apples and 'Flavorcrest' peach. Based on this commercial-scale test and previous reports (Fallahi, 1997; Fallahi et al., 1997), hydrogen cyanamide should be applied at rates of 4 to 5 pts formulation per 200 gal/acre, depending on the level of thinning desired. Application of a postbloom fruit thinner or hand thinning, in addition to a full-bloom spray of hydrogen cyanamide, is recommended in apples. Application of hydrogen cyanamide reduces time and labor needed for hand thinning in apple and peach. A complete coverage of the whole fruiting surface throughout the tree canopy is advised. Fruit marking or major phytotoxicity is unlikely if hydrogen cyanamide is sprayed at the recommended rates.

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Seed Treatment and Cultural Practices Influence Seedling Growth of Hydroponic Lettuce

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SUMMARY. Raw, pelleted or germinated seeds of 'Cortina' lettuce (*Lactuca sativa* L.) were sown in phenolic foam cubes preplant soaked in water or full-strength nutrient solution (2 mmho·cm^{-1}, 2 dS·m^{-1}). The seeds were left uncovered or covered with fine vermiculite (grade 5), and seedling emergence characteristics were subsequently determined. Shoot fresh masses and their coefficients of variation (CV) by 9 days after planting (1 or 2 true leaves) and by 31 days after planting (4 or 5 true leaves) also were determined. Soaking the cubes in nutrient solution rather than water increased seedling emergence percentage and rate, and increased shoot fresh masses by 9 or 31 days after planting. This increased shoot fresh mass was accompanied by lower CV of shoot fresh mass by 9 days after planting, but not by 31 days after planting. Covering seeds with vermiculite decreased

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