Effects of Damaged Levels and Pruning of Peach and Japanese Apricot Trees by Hailstorms on the Performance

Byeong-Sam Kim 1, Hye-Sung Cho 1, Kyung-Chul Cho 1, Hyo-Jung Kim 1, Bo-Bae Lee 1, Mengmeng Gu 2 and Hyun-Sug Choi 3,*

1 Fruit Research Institute, Jeollanam-do Agricultural Research & Extension Services, Hae-nam 59021, Korea; kbs863033@korea.kr (B.-S.K.); cometcho@korea.kr (H.-S.C.); chokc@korea.kr (K.-C.C.); plantmaniac@korea.kr (H.-J.K.); lbb0509@korea.kr (B.-B.L.)
2 Department of Horticultural Sciences, Texas A&M University AgriLife Extension, College Station, TX 77843, USA; mgu@exchange.tamu.edu
3 Department of Horticulture, Daegu Catholic University, Gyeongsan-si 38430, Korea

Abstract: Defoliation (DF) on peach (Prunus persica L.) and Japanese apricot (Prunus mume Sieb. et Zucc.) trees caused by a hailstorm in 2017, year 1, was investigated for its effects on growth and fruit yield in South Korea over four years, comparing with recovery effects of the DF trees treated with repeated immediate pruning (IP) right after the storm. Treatments included 0–10, 10–40, 40–70, and 70–100% of DF trees, with 0–10, 10–40, 40–70, and 70–100% of DF + IP trees. The hailstorms increased the damages to shoots for peaches and to shoots and scaffold for Japanese apricot trees in year 1, with fruit yield reduced more than 80% observed on 10–100 DF of both fruit species. The IP treatment increased the number of new shoots in years 2–4 but reduced shoot length and diameter of peach and Japanese apricot trees. Tree canopy in years 2–4 was reduced on 40–100 DF of peach trees and on 70–100 of DF and DF + IP of Japanese apricot trees. The 40–100 DF Japanese apricot trees resulted in a fruit yield index of less than 90% for years 2–4, which was observed on 40–100 DF+IP trees only in year 2 due to balanced tree vegetative and reproductive growth.

Keywords: climate; fruit yield; hailstorm; recovery; stone fruit

1. Introduction

White-fleshed peach (Prunus persica L.) fruits contain less acidity, taste sweeter, and have a unique flavor, which generated the highest net profit margin at 8.3% from the years 1980 to 2018 amongst the 17 primary fruit and vegetable crops in South Korea [1]. Japanese apricot (Prunus mume Sieb. et Zucc.) trees are commonly grown as landscape plants in S. Korea and many other Asian countries. Japanese apricot is also a popular summer fruit due to its high antioxidant contents for health benefits and is used for processed food [2,3]. The trees mostly grow well at annual average temperatures higher than 11 °C and are grown extensively in arable temperate regions in S. Korea despite temperature rising from climate change [3,4]. However, this area is subjected to late freezes accompanied by hailstorms early in the growing season as peach and Japanese apricot are some of the least cold-resistant stone fruits [2–6] as well as frost-yuzu trees [7].

Hailstones are referred to as solid precipitation with a diameter of 5.0 mm or greater and irregular shapes forming from the freezing of supercooled liquid water in strong updraft winds [8]. This created considerable impacts on early flowering fruit species, such as stone fruits, and they are mostly harvested between June and August [4,6]. Hail may cause damage to leaves, stems, and flowers, and defects of bruising and deep deformation of the fruits, which could become potential infection sites for fruit bacterial diseases [9]. The recent frequent hailstorms are particularly impactful for Japanese apricot trees with a weak mechanical framework, open-center form, and weak recovery of the wounded tissues.
and mechanical stress [10,11]. There are few published papers focusing on functional characteristics of the canned and dried fruit of the Japanese apricot trees and no papers on mechanical stress physiology.

Hail nets are typically used in orchards to prevent hailstone damage, but the effect is inconsistent, causing difficulty to maintain fruit productivity [9,12,13]. Pruning is typically employed to retrain damaged trees and reduce strong regrowth of vegetative shoots after hail events but could result in the slow recovery of tree growth and fruit yield depending on the timing and type of pruning [14] or alternate bearing and significant economic loss [15], with no scientific information available across the entire Prunus genus. Stone fruit growth was related to the 30-day temperature after full bloom due to the limited resources and should be pruned earlier to increase fruit size [16]. Therefore, it is critical to evaluate fruit trees right after a hailstorm since the levels of damage can soon be obscured by subsequent growth that is responsible for the flower bud formation and sustainable fruit production in the following years.

Peach and Japanese apricot trees defoliated (DF) from a hailstorm event in 2017 were investigated on growth and fruit yield over four years (2017–2020), comparing with the sustainable fruit production in the following years.

2. Materials and Methods

2.1. Orchard Layout

Twelve-year-old ‘Gyeongbong’ peach (Prunus persica L.) and ‘Chunmae’ Japanese apricot (P. mume Sieb. et Zucc.) trees were grown with a density of 5 m × 5 m and 5 m × 4 m, respectively, at a private orchard in Suncheon, South Korea (35° N, 128° E) in the year 2017. The monthly average temperature, minimum average temperature, and amount of precipitation from January to May were presented in Figure 1 [17]. Irrigation had not been installed on the ground surface in the orchard. All trees were pruned to maintain an open center shape with three or four primary scaffold branches, widely used for Prunus trees in S. Korea. The soil type between 0–30 cm depth of the root zone was mainly sandy loam.

![Figure 1. Monthly temperature and precipitation of peach and Japanese apricot orchards in Suncheon, Korea from January to May.](image)

The experimental plots had been naturally managed with perennial cover crops on the orchard floor, which were annually mown three to four times to reduce competition of water and mineral nutrients between trees and the cover crops. Oil cake (4.6% T-N, 1.4% P, 1.0% K, organic matter 70%, Chamjoa, Farmhannong Co., Seoul, Korea), an organic fertilizer, had been applied as a basal fertilizer, with an additional chemical soluble fertilizer applied according to the mineral nutrient requirements of each fruit tree species [18]. Flowering dates of peach trees were between 5–7 April from 2017 to 2020 and for Japanese apricot trees between 19–22 March. Peach fruits were harvested between 20–28 July from 2017 to 2020, and between 2–10 June for Japanese apricot fruits.
2.2. Treatment

Hailstorms with hailstones ranging from 0.5 to 5.0 cm in diameter occurred on 31 May 2017 at approximately 20° of the slope of the orchard. The damaged fruit trees were categorized into four groups, 0–10% of defoliation (0–10 DF), 10–40% DF (10–40 DF), 40–70% DF (40–70 DF), and 70–100% DF (70–100 DF) on each tree species based on the hail damage levels in forest stands [19]. 0–10, 10–40, 40–70, and 70–100 of DF on each tree species were mostly observed at 200–250 m altitude, 300–350 m altitude, 400–450 m altitude, and 500–550 m altitude, respectively. Foliar applications of fungicide were then made to the wound area on the damaged trees once with trifloxystrobin (A+, Farmhannong Co., Seoul, Korea) in early June and with thidiazuron (Delan, Samgong Co., Seoul, Korea) in mid-June, 2017. The regional average temperature and the amount of precipitation in 2017 were 18.8 °C and 28.0 mm for May, respectively, and 21.1 °C and 41.8 mm for June, respectively. The average temperature and the amount of precipitation in the last 30 years from 1981 to 2010 were 17.4 °C and 119.8 mm for May, respectively, and 20.8 °C and 91.3 mm for June, respectively [17].

Headings cut as summer pruning was conducted on all the DF trees two months after the hail event in 2017. Half of the DF trees in each category (0–10, 10–40, 40–70, and 70–100) were immediately pruned (IP) with heading and thinning cut on each tree three times, immediately one month and two months after the hail event, categorizing with 0–10 DF + IP, 10–40 DF + IP, 40–70 DF + IP, and 70–100 DF + IP as additional treatment plots. Winter pruning was also performed for both DF and DF + IP trees as part of regular orchard management from the years 2017 to 2020.

2.3. Tree Growth and Yield

Hail-damaged shoot and scaffold branches were evaluated when the xylem tissues were exposed after hailstorms in 2017. The whole number of new shoots, average new shoot length, shoot base diameter, tree canopy (largest width × perpendicular width), and the number of fruits were recorded in early September in each of the four years when shoot growth was stopped.

The whole number of fruits and fresh weight (FW) of each fruit species were measured to calculate the fruit yield index as the ratio of each 10–40, 40–70, 70–100 of DF or DF + IP trees divided by fruit yield of 0–10 DF or DF + IP trees, respectively.

2.4. Statistical Analysis

The experiment was a split-plot design with DF (four levels, 0–10, 10–40, 40–70, 70–100) being the whole plot and IP (two levels, pruned or not pruned) as split-plot. Pruning treatments were randomly assigned to a single-fruit tree experimental unit, and each treatment had three trees (three replications) for each fruit tree species with a similar trunk size. So, for each tree species, there were 24 trees by 4 DF × 2 IP × 3 replications. Data analysis was performed by ANOVA using Minitab Software Version 14.1 (Minitab, Inc., State College, PA, USA). Means were separated by Duncan’s multiple range test (DMRT) at \( p \leq 0.05 \).

3. Results and Discussion

3.1. Hail Damage in Year 1

Seasonal hail events during the last 30 years mostly occurred in spring between March–May and in winter between November–January, with a fewer number of hailstorms observed in the summer and fall seasons in S. Korea [13,17,19] (Figure 2A). The total number of hail days was 15 for the 30 years from 1981 to 2010 and 10 for the 10 years from 2009 to 2018 (Figure 2B). Similarly, the number of hail days also significantly increased in Europe in the last three decades [20]. Severe DF on peach and Japanese apricot trees was very visible at higher elevations (data not presented), possibly due to lower temperatures compared to lower elevations reported in Switzerland over the last four decades [21].
Damage caused by the hailstorms was observed on 0.0%, 56.6%, 75.8%, and 100.0% of all shoots on average, respectively, for 0–10, 10–40, 40–70, and 70–100 peach trees, with extended shoot length observed for 70–100 DF trees (Table 1). The scaffold damage was not considerably visible for 0–70 DF trees. The 0–10 DF on each peach tree produced 25.3 tons per ha, while it was less than 5.0 tons per ha for 10–100 DF trees with very poor marketability. Hail-induced shoot damage was recorded at 0.0%, 86.8%, 95.3%, and 100.0%, respectively, with 0–10, 10–40, 40–70, and 70–100 DF of Japanese apricot trees (Table 1).

The 70–100 DF of Japanese apricot trees increased their shoot length similarly shown for peach trees, which was previously reported for increasing secondary growth of shoots in apple trees severely damaged from the hail [13]. Over 80% of damage occurred on primary scaffold branches for 10–100 DF on the Japanese apricot trees. The branches of Japanese apricot trees were not strongly established to support mature fruit load and broke, which did not happen to 10–70 DF of peach trees that developed with dominant scaffold structure [2,3,22]. Fruit yield and marketable fruit were remarkably reduced for all DFs of Japanese apricot trees as observed on the damaged peach trees. In addition to the hail event, a warm and dry condition was prolonged throughout May and June 2017 (Figure 1) and would have considerably affected the deformation of each fruit tree species, which was previously reported for open-center form on a steep slope of about 20% [9,16,19,21,22].

### Table 1. Tree growth and fruit yield as affected by levels of hailstorms of peach and Japanese apricot trees in year 2017.

| Damage Levels (%) | Shoot Damage (%) | Shoot Length (cm) | Scaffold Damage (%) | Fruit Yield (ton/ha) | Marketable Fruit (%) |
|-------------------|------------------|-------------------|---------------------|----------------------|----------------------|
| 0–10              | 0.0 d            | 56.4 b            | 0.0 d               | 25.3 a (100)         | 88.4 a               |
| 10–40             | 56.6 c           | 45.6 c            | 7.8 c               | 4.5 b (18)           | 10.6 a               |
| 40–70             | 75.8 b           | 55.2 b            | 8.3 b               | 1.3 c (5)            | 4.9 c                |
| 70–100            | 100.0 a          | 63.8 a            | 100.0 a             | 0.0 d (0)            | 0.0 d                |

Means comparisons among treatments within a column by Duncan’s new multiple range test; means followed by different letters are significantly different (a–d), 5% level.

#### 3.2. Subsequent Tree Damage

The number of annual shoots was increased by 0–10 DF + IP, 10–40 DF + IP, and 40–70 DF + IP of peach trees in years 2–4, which was significantly affected by immediate...
pruning (IP) (Table 2). Higher damaged levels were likely to stimulate shoot formations in year 2 but were not observed in the following years. Shoot length was relatively short for 0–10 DF + IP, 10–40 DF + IP, and 40–70 DF + IP trees in year 2, probably due to many new shoots forming on each tree but did not appear in the following years. Shoot diameter was mostly increased for 0–40 DF and 0–10 DF + IP trees in years 2–4. Increased damaged levels substantially lead to reduced shoot diameter in years 2–4. Previous studies reported that recovery of the shoot growth of peach and apple fruit trees or pine trees was not completely occurred with leaf injury over 50% from hail in the following season due to the reduced synthesis of assimilates from lack of sources [16,23,24].

Table 2. Shoot growth as affected by levels of hailstorms of peach trees.

| Treatment            | Number | Year 2 | Year 3 | Year 4 | Year 2 | Year 3 | Year 4 | Year 2 | Year 3 | Year 4 | Year 2 | Year 3 | Year 4 | p value | Level | Method |
|----------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|-------|--------|
| 0–10 DF              | 353 c  | 336 c  | 325 c  | 63 a   | 61 a   | 62 a   | 7.7 a  | 7.5 a  | 7.4 ab |
| 0–10 DF + IP         | 425 a  | 407 a  | 346 a  | 53 d   | 56 b   | 62 a   | 6.9 b  | 7.2 b  | 7.6 a  |
| 10–40 DF             | 336 d  | 330 c  | 331 bc | 62 a   | 56 b   | 62 a   | 7.5 a  | 7.1 b  | 7.3 ab |
| 10–40 DF + IP        | 377 b  | 395 a  | 343 ab | 56 c   | 53 c   | 62 a   | 6.5 c  | 6.8 c  | 7.4 ab |
| 40–70 DF             | 325 ef | 325 cd | 325 c  | 59 b   | 53 c   | 63 a   | 6.9 b  | 6.8 c  | 7.1 cd |
| 40–70 DF + IP        | 360 c  | 365 b  | 340 ab | 55 c   | 57 b   | 56 b   | 5.6 e  | 6.6 cd | 7.2 bcd|
| 70–100 DF            | 316 ef | 316 d  | 324 c  | 57 c   | 52 c   | 61 a   | 6.6 c  | 6.2 e  | 7.1 cd |
| 70–100 DF + IP       | 310 f  | 332 c  | 332 bc | 63 a   | 56 b   | 54 c   | 5.8 d  | 6.4 de | 7.0 d  |

Means comparisons among treatments within a column by Duncan’s new multiple range test; means followed by different letters are significantly different (a–f), with ns indicating for no significant difference at 5% level. DF: defoliation, DF + IP: defoliation + immediate pruning.

The number of shoots and shoot length of Japanese apricot trees showed similar trends to the peach trees, responding to the levels of DF and DF + IP in years 2–4 (Table 3). Shoot diameter was significantly reduced in the 0–70 DF + IP trees in years 2 and 3 and slightly reduced in the 70–100 DF + IP trees occurring for the least number of shoots. DF trees with repeated IP in year 1 would have attributed to more formation of vegetative organs, resulting in less available nutrients and carbohydrates partitioned in the existing shoots of the trees based on the previous pruning research of peach trees [22,25–27].

Table 3. Shoot growth as affected by levels of hailstorms of Japanese apricot trees.

| Treatment            | Shoot Per Tree | Number | Year 2 | Year 3 | Year 4 | Year 2 | Year 3 | Year 4 | Year 2 | Year 3 | Year 4 | Year 2 | Year 3 | Year 4 | p value | Level | Method |
|----------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|-------|--------|
| 0–10 DF              | 320 c          | 343 bcd| 316 cd | 69 a   | 72 a   | 71 a   | 6.7 a  | 6.6 a  | 6.8 a  |
| 0–10 DF + IP         | 362 a          | 375 a  | 351 a  | 44 f   | 50 e   | 69 ab  | 5.8 d  | 5.2 e  | 6.6 a  |
| 10–40 DF             | 311 cd         | 336 cde| 311 cd | 65 b   | 66 b   | 67 ab  | 6.6 a  | 6.5 a  | 6.6 a  |
| 10–40 DF + IP        | 336 b          | 353 b  | 348 a  | 46 e   | 49 ef  | 63 abc | 5.6 e  | 5.5 de | 6.7 a  |
| 40–70 DF             | 305 cd         | 325 de | 308 d  | 64 b   | 60 c   | 66 ab  | 6.4 b  | 6.2 b  | 6.3 ab |
| 40–70 DF + IP        | 320 c          | 344 bc | 345 a  | 48 e   | 47 f   | 62 bc  | 5.2 f  | 5.3 e  | 6.3 ab |
| 70–100 DF            | 301 cd         | 321 ef | 309 d  | 60 c   | 53 d   | 64 abc | 6.1 c  | 5.7 cd | 5.9 c  |
| 70–100 DF + IP       | 270 d          | 310 f  | 336 b  | 52 d   | 51 e   | 57 c   | 5.9 c  | 5.9 c  | 6.0 bc |

Means comparisons among treatments within a column by Duncan’s new multiple range test; means followed by different letters are significantly different (a–f), with ns indicating for no significant difference at 5% level. DF: defoliation, DF + IP: defoliation + Immediate pruning.
The canopy area was greatly expanded in 0–70 DF + IP of peach trees in years 2 and 3 and not clearly showed for treatment effects in year 4 (Table 4). However, in year 3, canopy recovery of the 70–100 DF + IP trees was around 90% of the 0–10 DF trees. A canopy area of less than 13.0 m$^2$ was observed on 70–100 of DF and DF + IP of Japanese apricot trees in year 2 (Table 5) due to significant damage of the scaffold forming the tree frame, and trees in both treatments recovered over 80% in years 3 and 4.

### Table 4. Tree canopy area and number of fruiting as affected by levels of hailstorms of peach trees.

| Treatment       | Tree Canopy (m$^2$) | Number of Fruiting |
|-----------------|---------------------|--------------------|
|                 | Year 2   | Year 3   | Year 4   | Year 2 | Year 3 | Year 4 |
| 0–10 DF         | 21.2 cd  | 22.3 d   | 22.5 a   | 288 a  | 265 a  | 236 a  |
| 0–10 DF + IP    | 24.6 a   | 25.4 a   | 22.6 a   | 288 a  | 265 a  | 215 c  |
| 10–40 DF        | 21.0 d   | 22.0 e   | 22.2 a   | 288 a  | 262 a  | 228 b  |
| 10–40 DF + IP   | 23.8 b   | 24.2 b   | 22.4 a   | 276 b  | 250 bc | 212 c  |
| 40–70 DF        | 19.4 e   | 21.5de   | 21.8 ab  | 250 d  | 245 c  | 235 a  |
| 40–70 DF + IP   | 22.5 c   | 23.2 c   | 22.3 a   | 263 c  | 256 ab | 209 cd |
| 70–100 DF       | 18.2 f   | 20.6 e   | 21.5 b   | 180 e  | 220 d  | 227 b  |
| 70–100 DF + IP  | 20.6 de  | 22.6 cd  | 21.8 ab  | 258 c  | 262 a  | 205 d  |

**p value**
- Level: <0.01
- Method: <0.001

Means comparisons among treatments within a column by Duncan’s new multiple range test; means followed by different letters are significantly different (a–f), with ns indicating for no significant difference at 5% level. DF: defoliation, DF + IP: defoliation + immediate pruning.

### Table 5. Tree canopy area and number of fruiting as affected by levels of hailstorms of Japanese apricot trees.

| Treatment       | Tree Canopy (m$^2$) | Number of Fruiting |
|-----------------|---------------------|--------------------|
|                 | Year 2   | Year 3 | Year 4 | Year 2 | Year 3 | Year 4 |
| 0–10 DF         | 18.6 a   | 19.1 a  | 20.4 a  | 1650 ab | 1580 bc | 1650 a  |
| 0–10 DF + IP    | 18.2 a   | 18.5 b  | 19.2 b  | 1760 a  | 1650 a  | 1602 b  |
| 10–40 DF        | 18.2 a   | 18.8 ab | 20.1 a  | 1620 b  | 1550 c  | 1640 a  |
| 10–40 DF + IP   | 17.0 b   | 16.6 d  | 19.1 b  | 1660 ab | 1620 ab | 1580 c  |
| 40–70 DF        | 15.8 c   | 17.7 c  | 18.4 bc | 1260 e  | 1380 d  | 1530 d  |
| 40–70 DF + IP   | 16.5 b   | 16.4 d  | 18.0 c  | 1500 c  | 1610 b  | 1560 d  |
| 70–100 DF       | 12.6 d   | 16.5 d  | 17.6 cd | 1030 f  | 1230 e  | 1510 e  |
| 70–100 DF + IP  | 12.8 d   | 15.2 e  | 17.1 d  | 1320 d  | 1580 bc | 1520 e  |

**p value**
- Level: <0.001
- Method: <0.001

Means comparisons among treatments within a column by Duncan’s new multiple range test; means followed by different letters are significantly different (a–f), with ns indicating for no significant difference at 5% level. DF: defoliation, DF + IP: defoliation + immediate pruning.

The amount of fruiting was dramatically reduced in 40–100 DF peach trees in years 2 and 3 while mostly recovering in years 2 and 3 but not in year 4 (Table 4), presumably due to the alternate bearing of peaches. The amount of fruiting of Japanese apricot trees showed similar trends to the peach trees, responding to the 40–100 DF and DF + IP in years 2 and 3 (Table 5). Previous research mentioned that continuous warm and dried weather associated with strong storms, as observed in this study, stimulated secondary vegetative growth and reduced water loss, nutrient reserves, mineral nutrients, amino acids, and organic compounds in the existing organs, during the growing season [11,16,21,24,28–30]. This would have reduced reproductive growth in the current and following seasons on the severe DF levels of trees.

Fruit yield index in year 2 was considerably reduced to 60.3% for 70–100 of DF of peach trees but was more than 80% on the 40–100 DF + IP trees (Figure 3A,B). The yield index in year 3 also recovered to 81.2% on 70–100 DF trees and 94.3% on 70–100% DF + IP
trees. The yield index for all trees recovered to above 90% in year 4. The recovery of the Japanese apricot yield index sharply declined to 53.2% for 70–100 DF trees in year 2 and to 73.7% in year 3, with 66.0% in year 2 and 89.3% in year 3 observed on 70–100 DF+IP trees (Figure 4A,B). Larger hailstones within the updraft winds descended at least 140 m/s to the ground without melting as bearing thunderstorms and strong winds [8,28], which would considerably affect the weak frame of severe DF trees, Japanese apricot trees. The 40–100 DF trees were observed on the recovery lower than 90.0% in year 4 compared to 40–100 DF + IP trees.

![Figure 3](image_url) **Figure 3.** Fruit yield index as affected by levels of hailstorms of peach trees with DF (defoliation; (A)) and DF + IP (defoliation + immediate pruning; (B)).

![Figure 4](image_url) **Figure 4.** Fruit yield index as affected by levels of hailstorms of Japanese apricot trees with DF (defoliation; (A)) and DF + IP (defoliation + immediate pruning; (B)).

4. Conclusions

Hail is not a frequent abiotic stress but has increased in the weather events documented in Europe, the USA, and many Asian countries, including S. Korea since the year 2000. It has often been reported in the last ten years on steep hillsides, commonly planted in S. Korean orchards, but the damage levels on stone fruit tree performance in the following seasons has not been scientifically reported on. In summary, Japanese apricot trees that responded to DF levels showed comparably decreased vegetative growth compared to those of the peach trees in year 1, which would continuously have reduced canopy area and fruit productivity in years 2 and 3. The IP treatment was not recommended for peach trees but for Japanese apricot trees as mostly removing strong apical dominance and advancing tree recovery in the following season of the hailstorm through balanced tree vegetative and reproductive growth. However, there were study limitations for understanding the
physiological responses of the trees to provide best management practices, which should be needed to increase sample size and experimental areas with the long-term seasons.

**Author Contributions:** Conceptualization, B.-S.K.; Data curation, H.-S.C. (Hyung-Sung Cho) and H.-J.K.; Formal analysis, H.-S.C. (Hyung-Sung Cho), K.-C.C., H.-J.K. and B.-B.L.; Funding acquisition, B.-S.K.; Investigation, K.-C.C., H.-J.K. and B.-B.L.; Methodology, H.-S.C. (Hyung-Sung Cho); Project administration, B.-S.K.; Resources, B.-B.L.; Software, H.-S.C. (Hyung-Sung Cho); Writing – original draft, H.-S.C. (Hyung-Sung Cho); Writing – review & editing, M.G. All authors have read and agreed to the published version of the manuscript.

**Funding:** This work was provided by the Jeollanam-do Agricultural Research & Extension Services, Republic of Korea (Development of recovery and damage analysis method of Chonnam specialized fruit tree according to degree of hail damage, PJ0135540).

**Data Availability Statement:** Not applicable.

**Acknowledgments:** This research was supported by Department of Horticulture, Daegu Catholic University, Gyeongsan-si, Republic of Korea for providing financial assistance.

**Conflicts of Interest:** The authors declare no conflict of interest.

**References**

1. KREI. *Agricultural Outlook*; Korea Rural Economic Institute: Seoul, Korea, 2019.
2. Bailly, C. Anticancer properties of Prunus mume extracts (Chinese plum, Japanese apricot). *J. Ethnopharmacol.* 2020, 246, 112215. [CrossRef] [PubMed]
3. Lim, Y.J. *Special Fruit Science*; Hangmungsa Publishing: Seoul, Korea, 2016.
4. Seo, Y.-H.; Park, Y.-S.; Cho, B.-O.; Kang, A.-S.; Jeong, B.-C.; Jung, Y.-S. Regional distribution of peach freezing damage and chilling days in 2010 in Gangwon province. *Korean J. Agric. For. Meteorol.* 2010, 12, 225–231. [CrossRef]
5. Gu, L.; Hanson, P.J.; Post, W.M.; Kaiser, D.P.; Yang, B.; Nemani, R.; Pallardy, S.G.; Meyers, T. The 2007 eastern US spring freeze: Increased cold damage in a warming world? *BioScience* 2008, 58, 253–262. [CrossRef]
6. Miranda, C.; Santesteban, L.G.; Royo, J.B. Variability in the relationship between frost temperature and injury level for some cultivated Prunus species. *HortScience* 2005, 40, 357–361. [CrossRef]
7. Kim, B.S.; Lee, B.B.; Jung, S.K.; Choi, H.S. Pilot study to evaluate performance of frost-yuzu fruit trees under protected cultivation. *Agriculture* 2021, 11, 660. [CrossRef]
8. WMO. *Technical Regulations: Basic Documents No. 2*; World Meteorological Organization: Geneva, Switzerland, 2018.
9. Bogo, A.; Casa, R.T.; Agostineto, L.; Gonçalves, M.J.; Rufato, L. Effect of hail protection nets on apple scab in ‘Royal Gala’ and ‘Fuji’ apple cultivars. *Crop Prot.* 2012, 38, 49–52. [CrossRef]
10. Biddington, N.L.; Dearman, A.S. The effects of mechanically-induced stress and plant growth regulators on the growth of lettuce, cauliflower and bean (*Phaseolus vulgaris* L.) plants. *Plant Growth Regul.* 1987, 5, 183–194. [CrossRef]
11. Tartachnyk, I.; Blanke, M.M. Effect of mechanically-simulated hail on photosynthesis, dark respiration and transpiration of apple leaves. *Environ. Exp. Bot.* 2002, 48, 169–175. [CrossRef]
12. Bosco, L.C.; Bergamaschi, H.; Cardoso, L.S.; de Paula, V.A.; Marodin, G.A.B.; Brauner, P.C. Microclimate alterations caused by agricultural hail net coverage and effects on apple tree yield in subtropical climate of Southern Brazil. *Bragantia* 2018, 77, 181–192. [CrossRef]
13. Kim, J.S.; Yoon, J.T.; Cho, D.H.; Choi, B.S.; Lee, W.S.; Oh, J.Y. Survey of the hailstorm damages on apple trees in Kyungbuk area in 1992. *Korean J. Hortic. Sci. Technol.* 1994, 35, 345–350.
14. Neely, D. Healing of wounds on trees. *J. Am. Soc. Hortic. Sci.* 1970, 95, 536–540.
15. Krasniqi, A.-L.; Blanke, M.; Kunz, A.; Damerow, L.; Lakso, A.; Meland, M. Alternate bearing in fruit tree crops: Past, present and future. *Acta Hortic.* 2017, 1177, 241–248. [CrossRef]
16. Minas, I.S.; Tanou, G.; Molassiotis, A. Environmental and orchard bases of peach fruit quality. *Sci. Hortic.* 2018, 235, 307–322. [CrossRef]
17. KMA. *Statistical Analysis of Climate*; Korea Meteorological Administration: Seoul, Korea, 2019.
18. RDA. *Criteria of Fertilizer Application in Crops*; Rural Development Administration; Sammi Press: Wanju, Korea, 2011.
19. Lim, J.H.; Kim, E.S.; Lee, B.R.; Kim, S.H.; Jang, K.C. An analysis of the hail damages to Korean forests in 2017 by meteorology, species and topography. *Korean J. Agric. For. Meteorol.* 2017, 19, 280–292.
20. Punge, H.J.; Kunz, M. Hail observations and hailstorm characteristics in Europe: A review. *Atmos. Res.* 2016, 176, 159–184. [CrossRef]
21. Vitasse, Y.; Schneider, L.; Rixen, C.; Christen, D.; Rebetez, M. Increase in the risk of exposure of forest and fruit trees to spring frosts at higher elevations in Switzerland over the last four decades. *Agric. For. Meteorol.* 2018, 248, 60–69. [CrossRef]
22. Bussi, C.; Genard, M. Thinning and pruning to overcome alternate bearing in peach trees. *Eur. J. Hortic. Sci.* 2014, 79, 313–317.
23. Dobbs, R.C.; McMinn, R.G. Hail damage to a new white spruce and lodgepole pine plantation in central British Columbia. *For. Chron.* 1973, 49, 174–175. [CrossRef]

24. Sound, S.A. The influence of severity and time of foliar damage on yield and fruit quality in apple (*Malus domestica* Borkh.). *Eur. J. Hortic. Sci.* 2021, 86, 270–279.

25. Demirtas, M.N.; Bolat, I.; Ercisli, S.; Ikinci, A.; Olmez, H.A.; Sahin, M.; Altindag, M.; Celik, B. The effects of different pruning treatments on the growth, fruit quality and yield of ‘Hacihaliloglu’ apricot. *Acta Sci. Pol. Hortorum Cultus* 2010, 9, 183–192.

26. Grossman, Y.L.; Dejong, T.M. Training and pruning system effects on vegetative growth potential, light interception, and cropping efficiency in peach trees. *J. Am. Soc. Hortic. Sci.* 1998, 123, 1058–1064. [CrossRef]

27. Kumar, M.; Rawat, V.; Rawat, J.; Tomar, Y. Effect of pruning intensity on peach yield and fruit quality. *Sci. Hortic.* 2010, 125, 218–221. [CrossRef]

28. Charrier, G.; Ngao, J.; Saudreau, M.; Améglio, T. Effects of environmental factors and management practices on microclimate, winter physiology, and frost resistance in trees. *Front. Plant Sci.* 2015, 6, 259. [CrossRef] [PubMed]

29. Kreuzwieser, J.; Gessler, A. Global climate change and tree nutrition: Influence of water availability. *Tree Physiol.* 2010, 30, 1221–1234. [CrossRef] [PubMed]

30. Smith, M.W.; Rohla, C.T. Pecan orchard damage and recovery from ice storms. *HortTechnology* 2009, 19, 83–90. [CrossRef]