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A McIntosh blossom cluster collected in May 1981 showing severe leaf crinkling due to eight successive freezes during April. Of the five blossoms in this cluster, only one has advanced to the pink stage of development, while the other four, including the king blossom, have been killed by freezing temperatures of 19° to 21° F. recorded on April 13, 15, 21, and 22.

Low-Temperature Injury to Apples in the Champlain Valley, 1980-81

by F. J. McNicholas and C. G. Forshey*

Weather Summary, Winter 1980-81

December 1980 was one of the coldest in the last 50 years for most of New York State. The northern portion of the state was especially cold, with the monthly average temperature 6.4 to 8.0 degrees (F.) below normal. Following a period of relatively mild temperatures in the early third of the month, with daytime highs in the upper 40s and 50s (° F.), severe cold entered the state by December 10 and remained for a steady two-week period between the 11th and 28th. During this period, temperatures in the upstate areas averaged more than 12 degrees (F.) below normal. An extreme temperature drop was recorded in the 16-hour period between late afternoon December 24 and early morning December 25. Temperature changes of 45 to 65 degrees (F.) were recorded at some weather stations. In Peru, New York, the temperature dropped 50 degrees during this period, from 24° F.

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in the afternoon of December 24 to -26° F. in the morning of December 25. Coupled with the extreme cold was a light snow cover, amounting to only 64 percent of normal for Peru for the month.

January 1981 was noted for three weeks of extremely cold weather, with the coldest temperature (-28° F.) recorded on January 4 at Peru. January averaged 7.7 to 8.4 degrees (F.) colder than normal in the Champlain Valley and was the coldest since 1970. Lake Champlain was completely frozen over on January 8, the earliest date that this has occurred since the winter of 1886-87. Precipitation was extremely light during January, amounting to only 0.66 inches melted or 43 percent of normal for Peru.

February 1981 was a sharp contrast to the two previous months. For much of northern New York, February temperatures were the warmest recorded since 1890. The early half of February was marked by seasonable temperatures. In Peru, the warm spell began on the 16th and lasted for 10 days, during which temperatures averaged 20 degrees (F.) or more above normal, reaching highs of 60° F. on the 19th and 63° F. on the 22nd. Precipitation during the month was more than an inch above normal.

April 1981 was also abnormal at Peru, with eight minimum readings below freezing between April 12 and 23 as buds were developing from the half-inch green stage to the early tight cluster stage. The lowest official readings (19° F.) were recorded on April 21-22, but even lower temperatures were recorded on orchard thermometers.

In May, as buds expanded from tight cluster toward bloom, four light freezes were recorded on the 1st, 3rd, 4th, and 7th. The temperature dropped again, to 26° F., on May 18, about six days after full bloom for McIntosh. The bloom period was very lengthy, spanning a three-week period from first blossom opening to petal drop.

Official maximum and minimum temperature data for Peru, New York, for December 1980 and January, February, March, April, and May 1981 are reproduced in Table 1. The minimum readings during these months had a significant influence on the extent of the injury to trees and the apple crop in 1981.

The December cold periods caused considerable injury to the blossom spurs of several apple cultivars in the Champlain Valley and killed some Delicious (Fig. I).[1]

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[1]Original sections and photographs of spurs courtesy of Charlotte Pratt, now retired, New York State Experiment Station, Geneva, New York.

Fig. 1. Low-temperature injury to McIntosh buds. Upper pair of buds are from Peru, New York. (Left) Spur-type McIntosh; (right) Rogers McIntosh. Lower buds are from Geneva, New York. (Left) Spur-type McIntosh; (right) Imperial McIntosh. Note the extensive browning of conductive tissues and of the base of the embryonic flower cluster pedicels in the Peru buds compared with those from Geneva.

Fig. 2. Low-temperature injury to Delicious buds. Upper pair of buds are from Peru, New York. (Left) nonspur Delicious; (right) Spur-type. Lower pair of buds are from Geneva, New York. (Left) Spur-type Delicious; (right) nonspur.

Table 1. Maximum and minimum temperatures (° F.) at Peru, New York, for December 1980 through May 1981 (Earl H. Everett, weather service observer).

December 1980

Date	Max.	Min.
1	48	32
2	52	30
3	52	16
4	20	6
5	26	5
6	26	6
7	33	8
8	51	30
9	42	30
10	33	-15
11	32	-5
12	22	-7
13	32	20
14	23	-1
15	7	-15
16	10	-4
17	13	-8
18	27	-8
19	27	-9
20	11	-15
21	15	-12
22	20	-14
23	30	10
24	33	22
25	-10	-26
26	11	-22
27	27	2
28	35	-5
29	40	31
30	15	4
31	10	-5

January 1981

Date	Max.	Min.
1	11	-13
2	25	3
3	12	-25
4	-13	-28
5	10	-22
6	22	-10
7	30	15
8	15	-7
9	17	-4
10	20	3
11	20	-5
12	7	-12
13	7	-21
14	10	-20
15	19	-12
16	13	-7
17	15	4
18	20	-2
19	38	20
20	34	-2
21	19	-10
22	30	2
23	30	17
24	30	15
25	30	5
26	45	24
27	48	34
28	35	12
29	19	5
30	16	2
31	-	-

February 1981

Date	Max.	Min.
1	35	1
2	44	30
3	33	8
4	17	0
5	15	-2
6	25	22
7	33	18
8	34	22
9	32	20
10	33	5
11	54	30
12	54	8
13	24	1
14	35	8
15	38	16
16	50	28
17	57	37
18	59	44
19	60	33
20	58	47
21	57	44
22	63	38
23	55	38
24	48	42
25	45	32
26	38	32
27	38	28
28	34	20

March 1981

Date	Max.	Min.
1	15	-9
2	13	-10
3	28	-8
4	41	13
5	38	23
6	38	21
7	35	22
8	31	25
9	39	24
10	43	16
11	42	24
12	27	5
13	27	0
14	29	21
15	28	19
16	30	5
17	54	12
18	50	31
19	41	25
20	56	23
21	51	33
22	48	34
23	48	26
24	43	37
25	46	33
26	45	32
27	48	32
28	55	27
29	50	32
30	50	35
31	51	26

April 1981

Date	Max.	Min.
1	67	50
2	64	41
3	78	27
4	78	55
5	74	50
6	51	33
7	60	32
8	74	30
9	71	46
10	65	36
11	60	45
12	59	26
13	59	21
14	55	36
15	35	20
16	50	28
17	50	35
18	63	46
19	50	29
20	40	31
21	38	19
22	50	19
23	47	24
24	45	34
25	45	38
26	61	42
27	64	39
28	63	45
29	63	46
30	63	42

May 1981

Date	Max.	Min.
1	63	30
2	58	37
3	63	29
4	73	32
5	80	41
6	78	40
7	57	30
8	69	38
9	70	40
10	77	50
11	65	47
12	72	56
13	63	42
14	70	42
15	77	41
16	70	54
17	58	37
18	53	26
19	65	34
20	68	41
21	75	42
22	72	45
23	70	45
24	78	37
25	82	55
26	81	61
27	79	57
28	82	58
29	69	60
30	76	55
31	68	55

Tree Injury

Some five-to-seven-year-old McIntosh trees on various rootstocks were severely injured (loss of leaders or scaffold limbs) or killed during the winter of 1980-81. This injury appeared to be related to the December 1980 cold period and was more extensive because of the very cold period in early January. Some of these trees had grown too late into the fall and had not hardened sufficiently to withstand the abrupt temperature drop in December.

Fig. 3. Seven-year-old Spur-type McIntosh on M7 rootstock, showing the extent of low-temperature injury. These trees are on sandy loam soil of varying depth over clay. The soil terrain is slightly undulating. Generally, trees in low areas showed greatest mortality. Nearby Spur-type McIntosh on MM 106 rootstock also were severely damaged, while adjacent trees on MM111 were largely uninjured.

In other locations Rogers McIntosh of the same age on seedling rootstock showed similar injury. The soil was a moderately well-drained Bombay loam.

Fig. 4. A lateral scaffold branch showing the extent to which cambium, phloem, and xylem tissues were killed. Blackening of extensive areas of the outer bark are also visible.

Fig. 5. An injured branch, which grew late into the fall, with leaf petioles still attached in May 1981. Note the three blossom buds that have not started to grow and the very weak, dwarfed bud in the center of the photograph. In contrast, a leaf bud on an adjacent noninjured branch (just out of view) showed 2 to 3 centimeters of growth.

Fig. 6. A transverse section through the spur of the dwarfed bud in Figure 5, showing severe browning of conductive tissues. This bud could not develop to set fruit. Eventually, such buds dried up and sloughed off.

Fig. 7. A lateral flower bud on a branch of a late-growing tree, showing many petioles and leaf remnants attached. Growth had not yet begun when the photograph was taken in May 1981.

Fig. 8. A knife cut from the base of the flower bud in Figure 7 into the spur, showing browning and killing of conductive tissues. In addition, vital flower parts in the bud may have been killed as a result of the low temperatures during December 1980.

Fig. 9. A Mclntosh flower cluster showing severe leaf distortion caused by eight successive days of freezing temperatures during April 1981. One flower appears to have developed normally and is in the late pink stage, but is surrounded by dwarfed and distorted flowers. These buds sloughed off during the bloom period.

Fig. 10. A Mclntosh flower cluster showing varying lengths of blossom pedicels as a result of injury. The king blossom in this cluster was killed early in April (visible as a tiny, dwarfed remnant under magnification). Many blossoms that survived the April freezes had very short stems and produced small misshapen and scarred apples at harvest time.

Fig. 11. Petal singeing of Cortland blossoms due to a bloom-time freeze of 26° F. recorded on May 18, 1981, approximately six days after full bloom of McIntosh. Also visible in this photograph are empty clusters from which dead flowers have sloughed away and from which vigorous terminal shoots are developing.

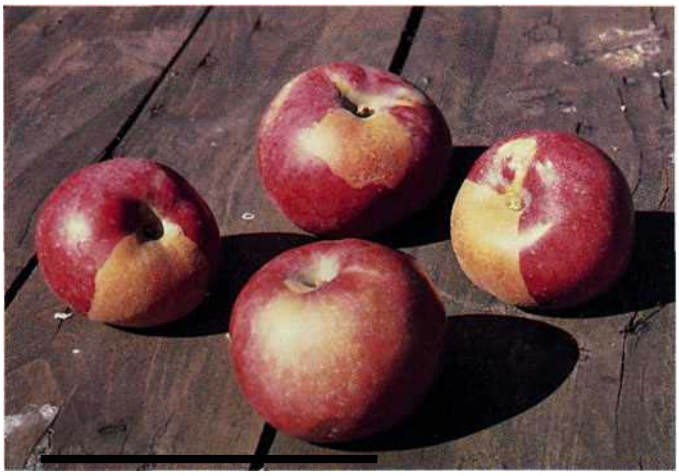

Fig. 12. Scarring and uneven development of McIntosh apples, photographed in September 1981 during harvest. Scarring occurred over 35 percent or more of the surface of the apples. Unlike the more familiar horizontal "frost rings" from bloom freezes, this scarring was more extensive and was mostly on the cheek area from stem to calyx. This injury probably occurred during the tight cluster stage. Scarring varied from block to block, from a low of 5 to 10 percent to a high of 40 to 50 percent. Some of the less severely scarred fruit was marketable. In addition, some weak side flowers produced apples that were very small and misshapen, many with a low seed count. From 10 to 20 percent of the apples produced in 1981 were of this type.

Postscript

The 1981 apple crop in the Champlain Valley was only 38 percent of the previous year's total. Although the extent of the damage caused by the April and May freezes varied from orchard to orchard, the loss to orchardists of Clinton County alone was estimated at $4.5 million and to the total community at as much as S13.5 million.

December 1981 was mild compared to December 1980 when 15 of the minimum temperatures recorded were below 0° F. and the average minimum temperature for the month was 3.6° F. In December 1981 the lowest temperature recorded at Peru was 0° F. and the average minimum temperature was 20° F., 16.4 degrees higher!

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