

Fluorine Levels in Crops of The Dalles Area in 1964



(Special Report) 204
December 1965

Agricultural Experiment Station
Oregon State University
Corvallis

Fluorine Levels in Crops of The Dalles Area in 1964

O. C. Compton, L. F. Remmert, and W. M. Mellenthin*

Summary

In 1964 the fluorine content of sweet cherry leaf samples collected July 1-9 ranged from 4 to 31 ppm, averaging 11 ppm, while those collected September 17-18 contained from 6 to 52 ppm, averaging 19 ppm. The data for peach trees were similar to those for cherry trees.

Variety differences in leaf fluorine contents were small and not significant for both cherries and peaches.

Fluorine in air samples varied from none to $2.5 \mu\text{g F/M}^3$ (micrograms fluorine per cubic meter of air).

Introduction

Previous reports (1,2) in this series have presented data on the fluorine content of foliage of seven crops grown in The Dalles area before and after operation of a local aluminum reduction factory. Other reports have presented the fluorine contents of ponderosa pine needles (3), that of various crops grown in the area from 1961 to 1963 and of fluorine in air samples collected in the same vicinity in 1963 (4,5). Only cherry and peach tree foliage was sampled in 1964 while air samples were collected at several representative locations. The fluorine contents of these samples and the observations made are presented in this report.

* Horticulturist, Chemist, and Superintendent of the Mid-Columbia Experiment Station, respectively, Oregon Agricultural Experiment Station.

Methods

Methods of sample collection and preparation and of analysis for fluorine contents have been reported previously (1). The orchards and sites sampled in past years were sampled again in 1964. However, all trees and plots were re-examined critically and appropriate changes were made when necessary, care being taken to ensure that all trees in a plot were of the same variety. The plots were then mapped. The locations of the sampling sites are shown on the map in Figure 1.

Foliage samples of sweet cherry and peach trees were collected July 1-9 and September 17-18 in the survey program. In addition, foliage samples of Bing, Lambert, and Royal Ann cherry trees and Elberta and J. H. Hale peach trees were collected from a few of these orchards at approximately monthly intervals from July 1 to October 16 to determine the seasonal trend in leaf fluorine.

Between April 24 and June 11 air samples were collected daily at the Curtiss (No. 24), Daniels (No. 36), Ellett (No. 15), High Rolls (No. 33), and Meyers (No. 19) orchards and from April 24 to July 9 at the Elton (No. 43), Gilbert (No. 51), Hendricks (No. 13), and Kroon (No. 5) orchards. Impinger-type fluoride absorbers (5) were used with 0.001 N sodium hydroxide solution as the absorbing medium.

Plant samples similar to those from The Dalles area were collected near Corvallis.

Results and Discussion

Fluorine content of foliage samples

Survey

Data on the fluorine contents of cherry and peach leaf samples from the 45 sampling stations in The Dalles area are presented in Table 1. The 42 cherry orchards and 13 peach orchards supplied 66 samples in July and again in September. The average fluorine contents of Bing, Lambert, and Royal Ann cherry leaves as presented in Table 2 were 10.4, 13.1, and 10.7 ppm, respectively, in July and 20.7, 27.4, and 17.6 ppm, respectively, in September. Elberta and J. H. Hale peach leaves contained similar amounts, 10.8 and 13.7 ppm, respectively, in July and 15.7 and 23.9 ppm, respectively, in September. The highest fluorine content found (aside from that at Station 2 which is a door yard planting) was 52.3 ppm in Royal Ann cherry leaves from Station 5. This orchard is located one mile SW of the aluminum reduction factory. In 1962 samples from these same trees contained 232 ppm in early October and 51.8 ppm in September 1963.

The summaries in Tables 9 and 10 show that the average fluorine contents of leaves of cherry and peach trees were about the same in July 1964 as in August 1953, July 1957, and June 1958, before the aluminum factory started operating.

The fluorine contents of cherry leaves collected in 1964 at different distances and directions from the aluminum factory are presented in Table 3 and summarized in Table 4. Table 5 shows the average contents at various distances from the factory while similar data for peach leaves are presented in Table 6. Some of these fluorine contents do not differ appreciably from those found prior to the operation of the factory in July 1958.

Even though the fluorine levels in 1964 were much lower than in 1960-62 the effect of distance and direction from the aluminum reduction factory on the fluorine contents of these samples is evident. A similar trend was evident in 1963 (5). There was no discernible trend in fluorine levels because of location within The Dalles area prior to the operation of the factory (1).

Seasonal trend

The data on the seasonal trend in fluorine content of sweet cherry and peach leaf samples are presented in Table 7. The data for Bing and Royal Ann cherry leaves collected at Stations 11, 13, and 37 are presented graphically in Figure 2 and for Elberta and J. H. Hale peach leaves from Stations 11 and 21 in Figure 3. Differences in fluorine content because of variety were small and insignificant. Royal Ann leaves at Station 11 contained slightly more fluorine than Bing leaves most of the season, but, at Station 13, only one-half mile away, the varieties were reversed. A somewhat similar situation prevailed with the Elberta and J. H. Hale varieties at Stations 11 and 21. There was little or no effect of variety on fluorine content of peach leaves. At Station 11 the average leaf fluorine increased 4 times from July 2 to September 17, 15.5 ppm to 60.3 ppm, respectively. Peach leaves at Station 21 showed no net increase in fluorine content for the season.

Fluorine content of air samples

The data on the fluorine contents of air samples are presented in Table 8. There were 4 periods between April 24 and July 8 when the average daily fluorine level at one or more of the stations was $0.5 \mu\text{g F}/\text{M}^3$ (micrograms fluorine per cubic meter of air) or greater. These were April 27; May 14, 15, 16; May 26, 27; and May 30, 31. The highest average

daily fluorine concentration was $2.5 \mu\text{g F/M}^3$ on May 26 at Station 19. There was 1 period of 8 days (May 2-9) when no fluorine was detected at any station. There were other similar periods of shorter duration.

Fluorine in the air at the Kroon Orchard (No. 5), 1 mile SW of the factory, exceeded $0.4 \mu\text{g F/M}^3$ 9 times between April 24 and July 8. Conversely, air fluorine exceeded $0.1 \mu\text{g F/M}^3$ only once at the Elton Orchard (No. 43), $5\frac{1}{2}$ miles SSE of the factory. Usually, there was no detectable fluorine in the air at this orchard. With the exception of the Kroon Orchard and once at the Elton Orchard all air fluorine concentrations above $0.4 \mu\text{g F/M}^3$ occurred at the Ellett (No. 15), Hendricks (No. 13), and Meyer (No. 19) orchards which are all in the Cherry Heights area.

The relationship between the fluorine in air and in foliage of Royal Ann cherry trees is shown in Table 8. These data show that the higher the air fluorine the greater was the leaf fluorine content. This relationship is exemplified by data from the Gilbert and Kroon Orchards, both of which have shown elevated leaf and air fluorine levels in the past (5). Royal Ann cherry leaf fluorine contents for July 7, 1964, were 14.8 and 30.6 ppm, respectively, while the total cumulated air fluorine from April 24 to June 10 was $3.2 \mu\text{g F/M}^3$ at the Gilbert Orchard and $11.7 \mu\text{g F/M}^3$ at the Kroon Orchard. Similar data for the other orchards show the same relationship.

Range and average fluorine levels, 1953-1964

The data for cherry and peach leaf samples obtained since 1953 in The Dalles area are summarized in Tables 9 and 10. Prior to the operation of the aluminum reduction factory^{1/} near The Dalles the average fluorine

¹ Aluminum factory started operating July 26, 1958.

contents of cherry and peach samples collected in 1953, 1957, and 1958 did not exceed 13 ppm. Similar samples collected after start of factory operation averaged from 23 to 96 ppm fluorine at the June or July (1959-1962) sampling and from 69 to 196 ppm at the second sampling (1958-1962) in late summer or fall. In 1964 the average for both crops, cherry and peach, was 11 ppm in July and 19 ppm in September, results almost identical with those obtained in 1963.

Literature Cited

1. Compton, O. C., L. F. Remmert, and W. M. Mellenthin. 1960. Comparison of fluorine levels in crops before and after aluminum factory operations in The Dalles area. Ore. Agr. Exp. Sta. Misc. Paper 95.
2. Compton, O. C., L. F. Remmert, and W. M. Mellenthin. 1961. Fluorine levels in 1960 crops of The Dalles area. Ore. Agr. Exp. Sta. Misc. Paper 119.
3. Compton, O. C., L. F. Remmert, J. A. Rudinsky, L. L. McDowell, F. E. Ellertson, W. M. Mellenthin, and P. O. Ritcher. 1961. Needle scorch and condition of Ponderosa pine trees in The Dalles area. Ore. Agr. Exp. Sta. Misc. Paper 120.
4. Compton, O. C., L. F. Remmert, and W. M. Mellenthin. 1963. Fluorine levels in 1961 crops of The Dalles area. Ore. Agr. Exp. Sta. Spec. Rpt. 153.
5. Compton, O. C., L. F. Remmert, and W. M. Mellenthin. 1965. Fluorine levels in crops of The Dalles area in 1962 and 1963. Ore. Agr. Exp. Sta. Spec. Rpt. 187.

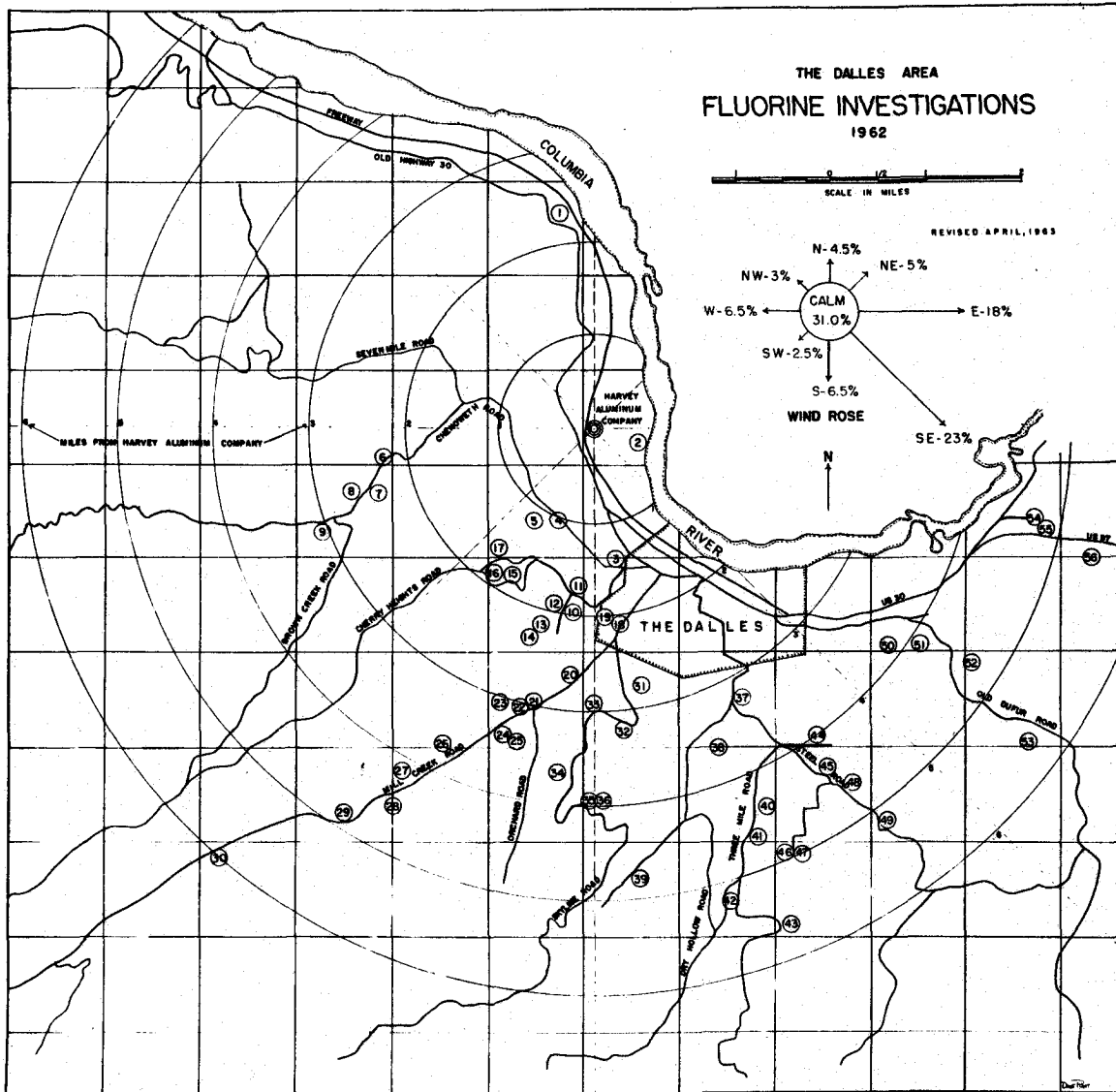


Figure 1. Geographical distribution of sampling locations, 1964

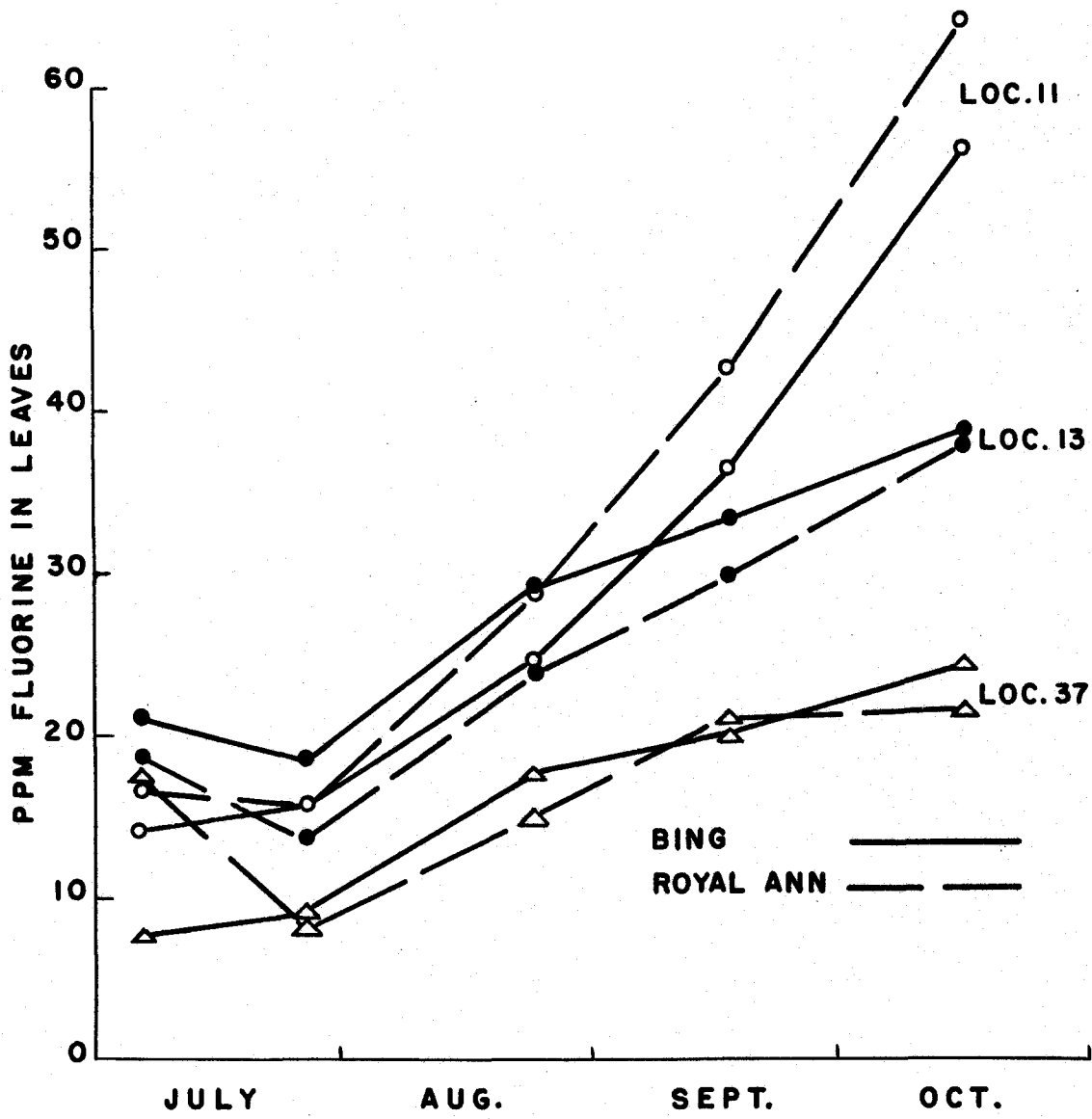


Figure 2. Seasonal changes in fluorine content of Bing and Royal Ann cherry leaves, 1964.

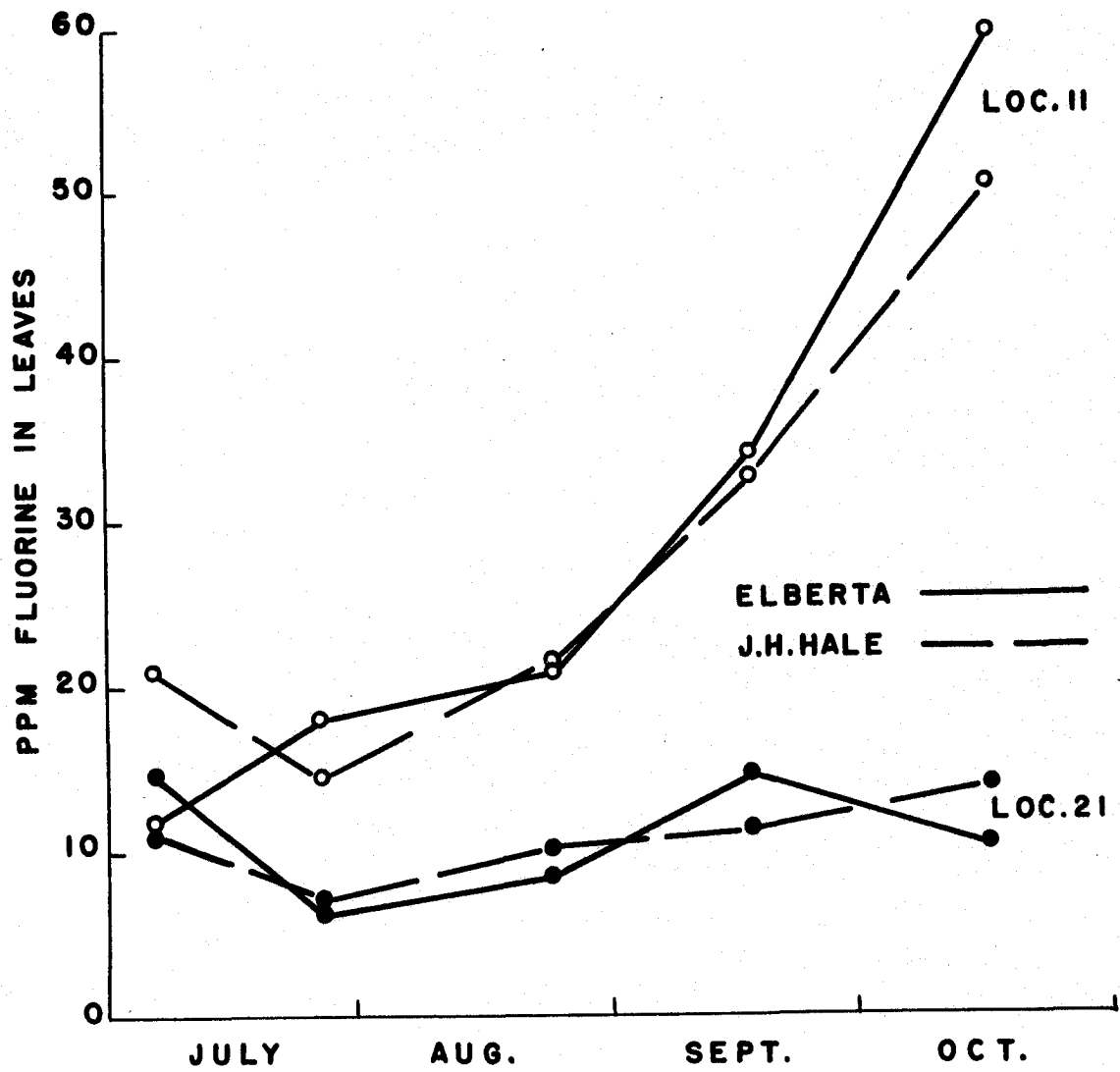


Figure 3. Seasonal changes in fluorine content of Elberta and J. H. Hale peach leaves, 1964

Table 1. Fluorine content of foliage samples,
The Dalles area, 1964

Station No.	Farm	Crop	Fluorine content, dry weight basis	
			July 1-3, 7-9 ppm	Sept. 17-18 ppm
1	Weeks	Cherry, Royal Ann	6.0	9.3
2	Klindt	Peach, Elberta	119.0*	291.0*
4	Fleck, K.	Peach, Hale	15.9	35.4
5	Kroon	Cherry, Royal Ann	30.6	52.3
8	Hertel	Cherry, Lambert	15.8	17.5
		Cherry, Royal Ann	16.9	18.8
9	Fleck, K.	Cherry, Bing	12.0	21.3
		Cherry, Lambert	13.2	27.5
		Peach, Elberta	17.3	15.8
10	Erickson (Nob Hill)	Cherry, Bing	11.8	38.1
11	Fleck, Joe	Cherry, Bing	14.1	36.3
		Cherry, Royal Ann	16.8	42.8
		Peach, Elberta	11.9	34.1
		Peach, Hale	21.1	32.9
	Fleck, Joe (Lower Orchard)	Cherry, Bing	8.9*	-
13	Hendricks	Cherry, mixed Bing & Lambert	21.0	-
		Cherry, Bing	-	33.2
		Cherry, Lambert	11.7	36.5
		Cherry, Royal Ann	18.6	29.8
15	Ellett	Cherry, Royal Ann	12.8	19.9
16	Malcom	Cherry, Royal Ann	18.0	29.5
17	Anderson	Cherry, Royal Ann	18.2	25.3
		Peach, Elberta	17.7	28.0
18	Meyer, W.	Cherry, Bing	14.0	18.8
19	Meyer-Erickson	Cherry, Royal Ann	15.8	16.1
		Peach, Elberta	7.5	13.9
20	Williams	Cherry, Bing	13.4	20.9
21	Francois	Peach, Elberta	9.2	14.9
		Peach, Hale	7.0	11.3
24	Curtiss Bros.	Cherry, Royal Ann	6.3	10.4
25	Davis	Cherry, Royal Ann	7.5	14.3
26	McCollum	Cherry, Royal Ann	4.6	7.5
		Peach, Elberta	10.8	7.6
27	Ranslam, Ed	Cherry, Royal Ann	5.8	6.9
		Peach, Hale	4.2	12.4
28	The Pines	Cherry, Royal Ann	4.4	7.3
30	Martin, John	Cherry, Royal Ann	4.0	8.7
31	Meyer, W.	Cherry, Royal Ann	7.2	13.3
32	Ranslam, Earl	Cherry, Royal Ann	8.1	13.2
33	High Rolls	Cherry, Royal Ann	6.3	10.7
		Peach, Elberta	6.8	14.0
34	Bailey	Cherry, Royal Ann	5.3	12.3

* Not included in averages.

Table 1 (Continued)

Station No.	Farm	Crop	Fluorine content, dry weight basis	
			July 1-3, 7-9 ppm	Sept. 17-18 ppm
35	Curtiss Bros.	Cherry, Bing	5.2	7.4
		Cherry, Royal Ann	6.3	15.2
		Peach, Elberta	11.1	11.1
36	Daniels	Cherry, Royal Ann	11.3	16.1
37	Roberts	Cherry, Bing	7.8	20.2
		Cherry, Lambert	9.5	21.1
38	Hollands Cooper, George	Cherry, Royal Ann	17.3	21.0
		Cherry, Royal Ann	3.9	11.2
39	Thienes	Cherry, Bing	5.3	13.8
		Peach, Elberta	8.7	9.6
		Cherry, Bing	5.2	9.0
40	Martin, Jack	Cherry, Royal Ann	-	7.5*
		Cherry, Royal Ann	12.8	6.4
41	Renkin	Peach, Elberta	7.0	7.9
		Cherry, Royal Ann	4.1	8.9
42	Sander Bros.	Cherry, Royal Ann	4.1	8.6
43	Elton	Cherry, Royal Ann	8.0	12.8
44	Cooper, Glen	Cherry, Royal Ann	6.9	9.1
46	Haner	Cherry, Royal Ann	6.5	9.4
47	Jones	Cherry, Bing	5.7	8.8
48	Kaufman	Cherry, Royal Ann	6.0	10.2
49	Thompson	Cherry, Royal Ann	25.7	38.1
		Cherry, Royal Ann	20.4	27.5
		Peach, Hale	15.3	34.5
50	Geiger	Cherry, Royal Ann	14.8	34.3
		Cherry, Lambert	11.2	26.7
51	Gilbert	Cherry, Royal Ann	12.9	23.2
52	McClaskey	Cherry, Royal Ann	8.7	20.5
53	Thompson (Todd)	Cherry, Bing	-	3.6*
56	Tenold	Cherry, Bing	-	3.7*
57	Lewis-Brown Farm Corvallis	Cherry, Lambert	-	2.4*
		Cherry, Royal Ann	-	2.2*
		Peach, Elberta	-	2.6*
		Cherry, Bing	-	
		Peach, Hale	-	

* Not included in averages.

Table 2. Fluorine content of foliage samples as the average per crop, 1964

Crop	Number of samples		Fluorine content, dry weight basis			
	July 1-3, 7-9	Sept. 17-18	The Dalles			
			July 1-3, 7-9		Sept. 17-18	
	Range	Average	Range	Average	ppm	ppm
Cherry	51	51	3.9-30.6	10.9	6.4-52.3	19.3
Bing	12	12	5.2-21.0	10.4	7.4-38.1	20.7
Lambert	5	5	9.5-15.8	13.1	17.5-36.5	27.4
Royal Ann	34	34	3.9-30.6	10.7	6.4-52.3	17.6
Peach	15	15	4.2-21.1	11.8	7.9-35.4	18.4
Elberta	10	10	6.8-17.3	10.8	7.6-34.1	15.7
Hale	5	5	4.2-21.1	13.7	11.3-35.4	23.9

Summary for The Dalles

	<u>July 1-3, 7-9</u>	<u>Sept. 17-18</u>
Total number of samples	66	66
Range, both crops, ppm	3.9-30.6	6.4-52.3
Average, both crops, ppm	11.1	19.1

Table 3. Fluorine content of Royal Ann sweet cherry leaf samples, The Dalles area, 1964

Station No.	Farm	Distance and direction from aluminum factory		Fluorine content, dry weight basis	
		miles	direction	July 1-3, 7-9 ppm	Sept. 17-18 ppm
1	Weeks	2 1/4	N	6.0	9.3
5	Kroon	1	S	30.6	52.3
8	Hertel	2 1/2	W	16.9	18.8
11	Fleck, Joe	1 3/4	S	16.8	42.8
13	Hendricks	2	S	18.6	29.8
15	Ellett	2	SW	12.8	19.9
16	Malcom	2	SW	18.0	29.5
17	Anderson	1 3/4	SW	18.2	25.3
19	Meyer-Erickson	2	S	15.8	16.1
24	Curtiss Bros.	3 1/2	S	6.3	10.4
25	Davis	3 1/2	S	7.5	14.3
26	McCollum	3 3/4	SW	4.6	7.5
27	Ranslam, Ed	4	SW	5.8	6.9
28	The Pines	4 1/2	SW	4.4	7.3
30	Martin, John	6	SW	4.0	8.7
31	Meyer, W.	2 3/4	S	7.2	13.3
32	Ranslam, Earl	3 1/4	S	8.1	13.2
33	High Rolls	3	S	6.3	10.7
34	Bailey	3 3/4	S	5.3	12.3
35	Curtiss Bros.	4	S	6.3	15.2
36	Daniels	3 1/4	SE	11.3	16.1
37	Hollands	3 1/4	SE	17.3	21.0
38	Cooper, George	3 1/2	S	3.9	11.2
40	Martin, Jack	4 1/2	SE	-	7.5
41	Renkin	4 1/2	SE	12.8	6.4
42	Sander Bros.	5 1/4	S	4.1	8.9
43	Elton	5 1/2	S	4.1	8.6
44	Cooper, Glen	4	SE	8.0	12.8
46	Haner	5	SE	6.9	9.1
48	Kaufman	4 1/2	SE	5.7	8.8
49	Thompson	5 1/4	SE	6.0	10.2
50	Geiger	4	SE	25.7	38.1
51	Gilbert	4 1/4	SE	14.8	34.3
52	McClaskey	4 3/4	SE	11.2	26.7
53	Thompson	5 1/2	SE	12.9	23.2

Table 4. Average fluorine content of foliage samples of sweet cherry trees grown at different distances and directions from the aluminum factory at The Dalles, 1964

Distance from factory miles	Average fluorine content, dry weight basis														
	N to W			W to SW			SW to S			S to SE			SE to E		
	July 1-3, 7-9	Sept. 17-18	ppm	July 1-3, 7-9	Sept. 17-18	ppm	July 1-3, 7-9	Sept. 17-18	ppm	July 1-3, 7-9	Sept. 17-18	ppm	July 1-3, 7-9	Sept. 17-18	ppm
0-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1-2	-	-	-	17.5	34.9	-	-	-	-	-	-	-	-	-	-
2-3	6.0	9.3	16.4	14.2	26.2	12.3	16.1	-	-	-	-	-	-	-	-
3-4	-	-	12.6	5.9	11.2	9.6	17.1	25.7	38.1	-	-	-	-	-	-
4-5	-	-	-	5.1	7.1	7.1	9.4	13.8	31.8	-	-	-	-	-	-
5-6	-	-	-	4.0	8.7	4.7	9.2	10.8	21.8	-	-	-	-	-	-

Table 5. Average fluorine content of foliage samples of sweet cherry trees grown at different distances from the aluminum factory at The Dalles, 1964

Distance from factory <u>miles</u>	Fluorine content, dry weight basis	
	July 1-3, 7-9 <u>ppm</u>	Sept. 17-18 <u>ppm</u>
0-1	-	-
1-2	17.5	34.9
2-3	13.3	20.4
3-4	9.6	17.1
4-5	8.5	15.1
5-6	6.6	13.4

Table 6. Average fluorine content of foliage samples of peach trees grown at different distances from the aluminum factory at The Dalles, 1964

Distance from factory <u>miles</u>	Fluorine content, dry weight basis	
	July 1-3, 7-9 <u>ppm</u>	Sept. 17-18 <u>ppm</u>
0-1	119.0	291.0
1-2	16.7	32.6
2-3	7.6	13.5
3-4	14.9	15.5
4-5	7.0	10.0
5-6	-	-

Table 7. Seasonal change in fluorine content of sweet cherry and peach leaf samples, The Dalles area, 1964.

Station No.	Farm	Crop	Fluorine content, dry weight basis				
			July 1-9 ppm	July 27-28 ppm	Aug. 24-25 ppm	Sept. 17-18 ppm	Oct. 16 ppm
<u>Cherries</u>							
9	Fleck, K.	Bing	12.0	11.6	15.4	21.3	34.9
		Lambert	13.2	9.8	17.1	27.5	33.1
11	Fleck, J.	Bing	14.1	15.8	24.5	36.3	56.4
		Royal Ann	16.8	15.7	28.6	42.8	64.2
13	Hendricks	Bing	21.0*	18.2	28.8	33.2	38.7
		Lambert	11.7	17.6	28.6	36.5	40.7
		Royal Ann	18.6	13.6	24.3	29.8	38.2
37	Hollands	Bing	7.8	9.2	17.7	20.2	24.2
	Roberts	Lambert	9.5	12.2	18.7	21.1	31.3
		Royal Ann	17.3	8.2	15.0	21.0	21.5
51	Gilbert	Lambert	15.3	19.3	26.4	34.5	44.3
		Royal Ann	14.8	18.5	24.9	34.3	38.4
<u>Peaches</u>							
11	Fleck, J.	Elberta	11.9	18.1	21.1	34.1	59.9
		J. H. Hale	21.1	14.8	21.4	32.9	50.7
21	Francois	Elberta	14.9	6.2	8.2	14.9	10.4
		J. H. Hale	11.3	6.9	10.2	11.3	14.1

* Mixed Bing and Lambert

Table 8. Weekly average atmospheric fluorine content, The Dalles area, 1964

Interval	Micrograms fluorine per cubic meter of air*									
	Curtiss No. 24	Daniels No. 36	Ellett No. 15	Elton No. 43	Gilbert No. 51	Hendricks No. 13	High Rolls No. 33	Kroon No. 5	Meyers No. 19	
April 24-30	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.1	0.0	
May 1-7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
May 8-14	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	
May 15-21	0.0	0.0	0.2	0.0	0.1	0.2	0.0	0.5	0.2	
May 22-28	0.1	0.1	0.2	0.0	0.1	0.4	0.1	0.6	0.5	
May 29-June 4	0.1	0.1	0.2	0.0	0.1	0.2	0.1	0.3	0.2	
June 5-11	0.0(1)	0.0(1)	0.2(1)	0.0	0.1	0.2	0.1(1)	0.3	0.2(1)	
June 12-18				0.0	0.1	0.0		0.0		
June 19-25				0.0	0.0	0.1		0.0		
June 26-July 2				0.0	0.0	0.0		0.1		
July 3-9				0.0(2)	0.1(2)	0.0(2)		0.0(2)		
Cumulative F, April 28-June 10	1.6	2.0	4.2	1.6	3.2	6.1	2.4	11.7	7.6	
F content, Royal Ann Cherry leaves July 1-9, 1964, ppm	6.3	11.3	12.8	4.1	14.8	18.6	6.3	30.6	15.8	

(1) Sampling ended June 10.

(2) Sampling ended July 8.

* Not corrected for air temperature and pressure.

Table 9. Range and average fluorine content of leaf samples of peach trees collected since 1953 in The Dalles area

Date sampled	No. samples	Fluorine content, dry weight basis	
		Range ppm	Average ppm
August 13, 1953	12	1-17	6
July 1, 1957	13	4-18	10
October 2, 1957	14	4-21	10
June 20, 1958	14	3-40	8
October 7, 1958	14	16-178*	76*
June 17, 1959	14	6-47	23
August 27, 1959	14	25-100	70
July 8, 1960	14	30-158	82
September 20, 1960	26	56-392	186
July 12, 1961	18	23-117	61
September 7, 1961	18	25-151	69
July 16, 1962	20	6-362	40
October 10, 1962	20	16-474	93
July 16, 1963	16	5-29	11
September 19, 1963	14	8-29	17
July 1, 1964	15	4-21	12
September 17, 1964	15	8-35	18

* Aluminum factory started operating July 26, 1958.

Table 10. Range and average fluorine content of leaf samples of sweet cherry trees collected since 1953 in The Dalles area

Date sampled	No. samples	Fluorine content, dry weight basis	
		Range ppm	Average ppm
August 13, 1953	18	3-17	8
July 1, 1957	20	5-18	13
October 2, 1957	23	5-20	11
June 20, 1958	23	3-14	6
October 7, 1958	23	16-197*	65*
June 17, 1959	24	9-65	29
August 27, 1959	24	20-207	88
July 8, 1960	26	30-248	96
September 20, 1960	26	56-431	196
July 12, 1961	44	20-202	68
September 7, 1961	44	23-144	79
July 16, 1962	44	7-111	32
October 10, 1962	43	28-232	95
July 16, 1963	41	4-34	13
September 19, 1963	41	9-72	22
July 1, 1964	51	4-31	11
September 17, 1964	51	6-52	19

* Aluminum factory started operating July 26, 1958.