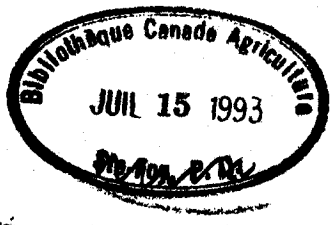
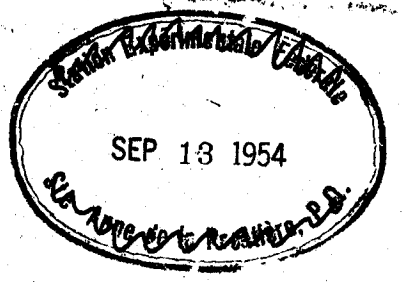

Bibliothèque Canada Agriculture
JUIL 15 1993


SEP 13 1954

CONTENTS

This volume includes Progress Reports of the following Experimental Stations of the Canada Department of Agriculture:

CANADA
DEPARTMENT OF AGRICULTURE
EXPERIMENTAL FARMS SERVICE

DOMINION EXPERIMENTAL STATION

SUMMERLAND

British Columbia

R. C. PALMER, B.S.A., M.S.A., D.Sc., SUPERINTENDENT

PROGRESS REPORT
1937-1948

HARVESTING APPLES IN THE
OKANAGAN VALLEY, B.C.
Photo by Nicholas Morant, 1948

Published by authority of the Rt. Hon. JAMES G. GARDINER, Minister of Agriculture,
Ottawa, Canada

RESEARCH STAFF

Dominion Experimental Station
Summerland, B.C.

and

Dominion Experimental Substation
East Kelowna, B.C.

Superintendent
R. C. Palmer, B.S.A., M.S.A., D.Sc.

Plant Nutrition, Soils and Irrigation
J. C. Wilcox, B.S.A., M.S.A., Ph.D.
J. L. Mason, B.S.A.

Fruit Breeding and Rootstocks
A. J. Mann, B. S. A.
F. W. L. Keane

Fruit Harvesting and Storage
D. V. Fisher, B.S.A., M.S.A., Ph.D.
S. W. Porritt, B.S.A.

Vegetables
C. A. Hornby, B.S.A., M.S.A., Ph.D.

Fruit and Vegetable Processing
F. E. Atkinson, B.S.A.
C. C. Strachan, B.S.A., M.S.A., Ph.D.
A. W. Moyls, B.S.A.

Dairy Cattle and Forage Crops
J. E. Miltimore, B.S.A.

CONTENTS

70884—1½

DOMINION EXPERIMENTAL STATION
Summerland B.C.

and

DOMINION EXPERIMENTAL SUBSTATION
East Kelowna B.C.

Progress Report 1937-1948

INTRODUCTION

The Summerland Station was established in 1914 and the Kelowna Substation in 1931. These Stations constitute links in the chain of Dominion Experimental Farms and Stations which extends across Canada. The headquarters of this chain is the Central Experimental Farm at Ottawa, where under the Department of Agriculture, the general policy of the Experimental Farms Service is formulated. All projects suggested by the personnel of the Branch Stations must be approved by the Divisional Officers concerned and authorized by the Director of Experimental Farms. This procedure ensures co-ordination of effort, while the establishment of Branch Stations throughout the country enables each Station to devote special attention to agricultural problems in the area in which it is located.

The Summerland and Kelowna Stations are situated in the Okanagan Valley in the centre of an irrigated area devoted largely to fruit growing, vegetable production and dairying. Accordingly, the projects conducted on these Stations are designed primarily to assist producers and processors of fruits, vegetables and dairy products.

During the past 12 years, the results secured from many of the projects under way have been published in the form of bulletins, technical papers and popular articles under the authorship of the research officers immediately responsible for the work. In this present progress report, the activities of the Station are reviewed in a broad way, the results from related projects being discussed together under general subject headings. No attempt is made to outline detailed methods of investigation or to present completely the wealth of data on which recommendations are based. All members of the staff have had a hand in gathering together the information which this report contains. In fact, the achievements of the Summerland and Kelowna Stations may be regarded as the result of team work in which every employee, from manual labourer to skilled research scientist, has played an important part.

It is with regret that we record the loss of three valued members of the staff in the death of W. M. Fleming, the retirement of J. E. Britton and the resignation of S. R. Noble. In their places we welcome C. A. Hornby, S. W. Porritt and J. E. Miltimore.

This summarized report is presented in the hope that it will give the reader a good idea of the scope of the investigational work in progress at Summerland and Kelowna and will encourage him to write for more detailed information regarding projects in which he is especially interested.

70884—2

WEATHER RECORDS

The influence of weather conditions on plant and animal behaviour constitutes a magnificent continuing phenomenon of nature. An important function of meteorological stations is to record as precisely as possible the character of the weather.

Records of temperature, rainfall and sunshine have been kept at the Summerland Station for a period of 32 years. These records provide useful information regarding climatic conditions which may be expected in this section of the Okanagan Valley.

During the 32-year period, the highest temperature recorded was 104°F. and the lowest —16°F. There was an average of 11 days each year when the temperature reached 90°F. and over. Periods of zero temperature were experienced in most winters but were of short duration, the average per year being 3·6 days. The latest spring frost occured on May 8, in 1922 and 1930, and the earliest fall frost on September 24, 1926. In most years, however, no frost occurred after April 30 or before October 15. The average frost-free period for the 32 years was 179 days.

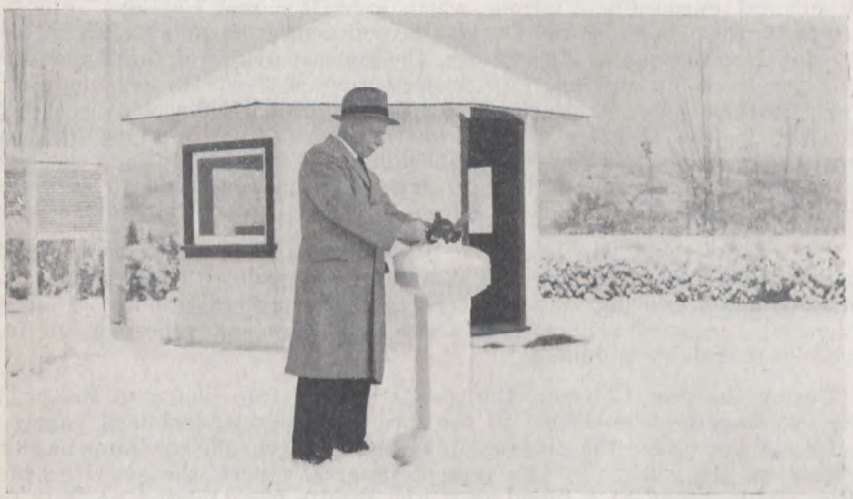


FIG. 1—METEOROLOGICAL STATION

G. W. Johnson, who recorded the weather data for twenty-eight years, is shown changing the paper in the sunshine recorder. 1940.

The average annual precipitation was 10·66 inches. In most years, June was the wettest summer month and December the wettest winter month. Evaporation was comparatively high. In fact, the average evaporation from an open water tank for the combined months of June, July and August exceeded the average annual precipitation. Sunshine averaged 1954·5 hours per year.

During the 12-year period covered by this report, weather conditions have not differed greatly from the foregoing averages except that the two hottest days of the 32-year period were recorded on July 16 and 17, 1941. During the year 1940, temperatures averaged somewhat warmer than usual. On the other hand, during the winter of 1942-43 the thermometer dropped to —13°F. causing serious injury to stone fruit trees.

A summary of meterological data recorded during the 32-year period, 1917-1948, is presented in Table 1.

More detailed information regarding maximum and minimum temperatures, frost records and monthly precipitation is to be found in Tables 2, 3, 4, and 5.

TABLE 1—SUMMARY OF METEOROLOGICAL RECORDS*

Dominion Experimental Station, Summerland, B.C.

1917-1948 (32 years)

Month	Highest and Lowest Temp. °F.				32 Yrs. Mean	Precipitation in inches	Evaporation in inches	Sunshine in hours
	Max.	Date	Min.	Date				
January	57	17 Jan. '20	−13	19 Jan. '35	25·88	·926	.....	48·31
February	62	27 Feb. '32	−16	7 Feb. '36	29·41	·675	.....	88·39
March	68	18 Mar. '30	8	9 Mar. '32	39·27	·660	.....	140·84
April	84	28 Apr. '26	16	2 Apr. '36	48·18	·741	.....	187·37
May	91	30 May '36	29	8 May '22	56·35	·966	5·89	236·34
June	101	26 June '25	35	1 June '43	63·63	1·260	4·33	237·52
July	104	16 and 17 July '41	41	5 July '32	70·16	·759	5·19	312·16
August	98	13 Aug. '20	43	17 Aug. '46	68·31	·713	4·31	270·99
September	92	6 Sept. '44	25	24 Sept. '26	59·71	·804	2·63	195·99
October	82	3 Oct. '47	15	31 Oct. '35	48·74	·928	.....	137·22
November	61	5 Nov. '41	2	19 Nov. '21	36·45	·976	.....	59·03
December	60	2 Dec. '32	− 9	17 Dec. '24	29·13	1·258	.....	40·36
Annual	.....	.....	.....	.....	47·93	10·666	.....	1,954·52

*Data recorded in co-operation with the Meteorological Division, Department of Transport.

TABLE 2—MAXIMUM TEMPERATURES*

Dominion Experimental Station, Summerland, B.C.

1917-1948 (32 years)

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1917	47·0	43·0	48·0	62·0	76·0	88·0	97·0	96·0	82·0	81·0	52·0	53·0
1918	44·0	48·0	64·0	81·0	79·0	94·0	100·0	88·0	83·0	67·0	50·0	48·0
1919	47·0	43·0	61·0	74·0	78·0	91·0	100·0	93·0	77·0	69·0	53·0	51·0
1920	57·0	46·0	57·0	72·0	77·0	90·0	96·0	98·0	82·0	61·0	52·0	45·0
1921	54·0	50·0	62·0	69·0	82·0	86·0	90·0	92·0	72·0	70·0	55·0	49·0
1922	37·0	43·0	50·0	68·0	85·0	94·0	98·0	91·0	82·0	62·0	46·0	49·0
1923	44·0	46·0	63·0	76·0	78·0	92·0	96·0	90·0	81·0	74·0	56·0	47·0
1924	51·0	55·0	59·0	74·0	90·0	96·0	100·0	94·0	89·0	67·0	54·0	58·0
1925	45·0	51·0	62·0	75·0	82·0	101·0	98·0	93·0	84·0	66·0	51·0	47·0
1926	42·0	54·0	64·0	84·0	81·0	96·0	102·5	88·0	80·0	68·0	58·0	51·0
1927	45·0	49·0	57·0	76·0	78·0	87·0	102·0	94·0	74·0	70·0	48·0	52·0
1928	44·0	46·0	65·0	71·0	87·0	90·0	100·0	94·0	91·0	65·0	58·0	45·0
1929	36·0	46·0	62·0	78·0	87·0	84·0	98·0	95·0	85·0	75·0	56·0	51·0
1930	38·0	56·0	68·0	71·0	80·0	87·0	100·0	93·0	83·0	79·0	57·0	44·0
1931	50·0	53·0	59·0	79·0	87·0	94·0	100·0	94·0	85·0	77·0	59·0	45·0
1932	46·0	62·0	64·0	71·0	76·0	90·0	94·0	94·0	86·0	76·0	57·0	60·0
1933	49·0	51·0	55·0	77·0	76·0	96·0	95·0	95·0	82·0	73·0	59·0	50·0
1934	49·0	50·0	63·0	83·0	90·0	92·0	103·0	94·0	85·0	78·0	55·0	48·0
1935	53·0	47·0	61·0	70·0	83·0	85·0	94·0	90·0	90·0	70·0	49·0	43·0
1936	48·0	49·0	56·0	75·0	91·0	97·0	98·0	92·0	84·0	75·0	54·0	56·0
1937	30·0	46·0	59·0	69·0	82·0	95·0	93·0	90·0	90·0	69·0	57·0	48·0
1938	47·0	47·0	58·0	75·0	88·0	96·0	98·0	89·0	91·0	72·0	54·0	49·0
1939	50·0	44·0	66·0	83·0	89·0	96·0	102·0	95·0	83·0	73·0	55·0	52·0
1940	49·0	50·0	64·0	71·0	89·0	92·0	97·0	93·0	90·0	75·0	52·0	48·0
1941	48·0	50·0	66·0	76·0	90·0	91·0	104·0	95·0	73·0	66·0	61·0	58·0
1942	49·0	53·0	63·0	79·0	81·0	93·0	99·0	95·0	86·0	73·0	51·0	44·0
1943	42·0	48·0	61·0	73·0	82·0	89·0	97·0	91·0	84·0	75·0	53·0	55·0
1944	52·0	53·0	62·0	73·0	87·0	90·0	97·0	88·0	92·0	72·0	56·0	52·0
1945	50·0	51·0	60·0	70·0	86·0	88·0	96·0	93·0	82·0	75·0	56·0	49·0
1946	47·0	48·0	64·0	79·0	83·0	90·0	93·0	91·0	86·0	67·0	48·0	52·0
1947	50·0	60·0	64·0	82·0	90·0	87·0	93·0	92·0	87·0	82·0	55·0	46·0
1948	45·0	51·0	60·0	74·0	85·0	92·0	89·0	85·0	87·0	67·0	53·0	42·0
Average	48·0	50·0	61·0	75·0	84·0	92·0	97·0	99·0	84·0	72·0	54·0	50·0

*Data recorded in co-operation with the Meteorological Division, Department of Transport.

70884—2½

TABLE 3—MINIMUM TEMPERATURES*

Dominion Experimental Station, Summerland, B.C.

1917-1948 (32 years)

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1917	−10·0	− 2·0	9·0	21·0	33·0	42·0	46·0	50·0	41·0	27·0	26·0	2·0
1918	− 2·0	4·0	11·0	25·0	31·0	37·0	48·0	44·0	43·0	34·0	19·0	16·0
1919	11·0	3·0	8·0	28·0	33·0	37·0	46·0	49·0	34·0	20·0	9·0	− 5·0
1920	5·0	18·0	18·0	19·0	33·0	40·0	52·0	44·0	40·0	25·0	19·0	20·0
1921	12·0	10·0	19·0	26·0	34·0	43·0	47·0	47·0	37·0	26·0	2·0	− 3·0
1922	2·0	− 1·0	12·0	26·0	29·0	47·0	48·0	50·0	42·0	31·0	25·0	− 5·0
1923	2·0	− 7·0	19·0	32·0	31·0	44·0	50·0	49·0	37·0	26·0	28·0	− 7·0
1924	− 6·0	23·0	23·0	27·0	38·0	47·0	48·0	45·0	39·0	34·0	12·0	− 9·0
1925	8·0	21·0	28·0	32·0	35·0	39·0	52·0	43·0	38·0	28·0	20·0	28·0
1926	23·0	27·0	25·0	28·0	35·0	43·0	50·0	47·0	25·0	30·0	22·0	1·0
1927	− 5·0	6·0	23·0	22·0	33·0	45·0	48·0	51·0	42·0	30·0	16·0	− 8·0
1928	− 1·0	9·0	19·0	27·0	33·0	44·0	53·0	45·0	39·0	30·0	24·0	10·0
1929	− 9·0	− 2·0	25·0	22·0	35·0	45·0	44·0	46·0	39·0	29·0	16·0	8·0
1930	− 6·0	13·0	13·0	32·0	32·0	44·0	47·0	48·0	35·0	24·0	22·0	13·0
1931	12·0	17·0	23·0	27·0	38·0	40·0	46·0	48·0	36·0	31·0	11·0	9·0
1932	0·0	− 6·0	8·0	29·0	33·0	44·0	41·0	44·0	36·0	27·0	26·0	2·0
1933	10·0	− 7·0	18·0	26·0	36·0	36·0	44·0	53·0	35·0	29·0	25·0	3·0
1934	18·0	18·0	21·0	30·0	36·0	43·0	45·0	45·0	35·0	31·0	26·0	6·0
1935	−13·0	18·0	19·0	17·0	31·0	40·0	45·0	43·0	35·0	15·0	13·0	16·0
1936	9·0	−16·0	13·0	16·0	38·0	43·0	48·0	48·0	35·0	30·0	16·0	13·0
1937	− 8·0	− 5·0	21·0	29·0	31·0	43·0	44·0	42·0	35·0	33·0	20·0	9·0
1938	11·0	5·0	21·0	24·0	34·0	43·0	48·0	46·0	47·0	31·0	17·0	10·0
1939	19·0	0·0	9·0	28·0	35·0	39·0	45·0	47·0	40·0	26·0	28·0	20·0
1940	10·0	20·0	25·0	32·0	38·0	45·0	50·0	47·0	44·0	32·0	10·0	18·0
1941	20·0	16·0	24·0	31·0	34·0	46·0	50·0	47·0	37·0	29·0	18·0	7·0
1942	7·0	13·0	21·0	31·0	36·0	41·0	52·0	45·0	35·0	30·0	24·0	14·0
1943	−13·5	13·0	10·0	28·0	33·0	35·0	43·0	50·0	40·0	25·0	25·0	13·0
1944	10·0	12·0	14·0	30·0	33·0	43·0	47·0	45·0	39·0	36·0	22·0	10·0
1945	12·0	12·0	9·0	25·0	37·0	39·0	47·0	45·0	35·0	27·0	7·0	12·0
1946	8·0	9·0	23·0	28·0	30·0	39·0	45·0	43·0	35·0	23·0	9·0	1·0
1947	− 2·0	− 1·0	16·0	27·0	38·0	46·0	45·0	46·0	34·0	30·0	23·0	18·0
1948	10·0	2·0	18·0	27·0	31·0	51·0	44·0	47·0	32·0	26·0	21·0	− 1·0
Average	5·0	8·0	18·0	27·0	34·0	42·0	47·0	47·0	37·0	28·0	19·0	8·0

*Data recorded in co-operation with the Meteorological Division, Department of Transport.

TABLE 4—FROST RECORDS*

Dominion Experimental Station, Summerland, B.C.

Year	Last Frost in Spring		First Frost in Fall		No. of Frost Free Days	Last Killing Frost in Spring		First Killing Frost in Fall		No. of Crop Days
	Date	Temp.	Date	Temp.		Date	Temp.	Date	Temp.	
1919.....	April 17	32	Oct. 9	29	174	April 16	28	Oct. 25	20	191
1920.....	April 15	32	Oct. 20	32	187	April 8	28	Oct. 31	25	205
1921.....	April 30	30	Oct. 22	32	174	April 8	27	Oct. 23	26	197
1922.....	May 8	29	Oct. 29	31	173	April 12	26	Nov. 2	27	203
1923.....	May 2	31	Oct. 25	30	175	Mar. 18	26	Oct. 28	27	222
1924.....	April 25	29	Nov. 5	30	193	April 24	27	Nov. 6	24	195
1925.....	April 28	32	Oct. 27	29	181	Mar. 29	28	Oct. 28	28	212
1926.....	April 6	29	Sept. 24	25	170	April 2	28	Sept. 24	25	174
1927.....	April 30	31	Oct. 31	30	183	April 20	22	Nov. 10	28	203
1928.....	April 20	30	Oct. 12	30	174	April 7	27	Nov. 1	28	207
1929.....	April 18	30	Oct. 29	29	193	April 12	28	Nov. 11	24	212
1930.....	May 8	32	Oct. 12	30	156	Mar. 17	28	Oct. 16	24	212
1931.....	April 20	29	Oct. 11	32	173	April 19	28	Nov. 11	25	205
1932.....	April 20	29	Oct. 9	27	171	Mar. 22	28	Oct. 9	27	200
1933.....	April 19	30	Oct. 15	31	178	April 10	26	Nov. 4	28	207
1934.....	April 15	30	Oct. 18	31	185	Mar. 26	28	Nov. 28	28	246
1935.....	May 2	31	Oct. 22	26	172	April 22	28	Oct. 22	26	182
1936.....	April 5	27	Oct. 21	30	198	April 5	27	Nov. 1	24	209
1937.....	May 6	31	Nov. 1	30	178	Mar. 26	26	Nov. 6	28	224
1938.....	April 21	31	Oct. 14	32	175	April 2	28	Nov. 6	26	217
1939.....	April 16	30	Oct. 24	30	190	April 6	28	Oct. 25	26	201
1940.....	April 30	32	Oct. 27	32	179	Mar. 12	26	Nov. 9	17	241
1941.....	April 18	31	Oct. 29	29	193	Mar. 14	26	Nov. 20	26	249
1942.....	April 4	32	Oct. 13	32	221	Mar. 28	28	Nov. 7	28	223
1943.....	April 22	32	Oct. 23	31	183	April 4	28	Oct. 31	25	209
1944.....	April 18	31	Nov. 11	31	206	Mar. 29	27	Nov. 13	28	228
1945.....	April 25	31	Oct. 18	27	175	April 13	28	Oct. 18	27	187
1946.....	May 1	30	Oct. 10	32	161	April 7	28	Oct. 16	27	191
1947.....	April 21	32	Oct. 6	30	167	April 4	27	Oct. 5	26	183
1948.....	May 2	31	Sept. 30	32	150	April 27	28	Oct. 17	26	172
Average.....					179					207

*Data recorded in co-operation with Meteorological Division, Department of Transport.

NOTE—Killing Frost 28°F. or lower.

TABLE 5—MONTHLY PRECIPITATION*

Dominion Experimental Station, Summerland, B.C.

1917-1948 (32 Years)

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1917	0·34	0·58	0·39	0·98	1·84	1·25	0·33	0·18	0·89	0·08	0·10	3·23	10·19
1918	1·10	0·46	0·30	0·08	0·28	0·19	1·16	1·62	0·22	0·94	1·01	0·50	7·86
1919	0·82	1·16	0·87	0·54	0·71	0·58	0·34	0·34	1·00	0·66	2·09	0·17	9·28
1920	1·64	0·03	0·46	1·63	0·06	0·98	0·84	0·18	1·51	1·66	0·70	0·54	10·23
1921	1·01	0·11	0·75	1·13	1·30	1·90	0·34	0·98	0·39	0·25	1·61	1·51	11·28
1922	0·40	0·56	1·62	0·75	0·26	0·20	0·15	1·56	1·03	1·50	0·42	0·99	9·44
1923	1·07	0·26	0·07	1·29	0·93	3·37	1·24	1·29	0·56	0·81	0·49	1·98	13·36
1924	0·66	0·24	0·11	0·03	0·08	0·40	0·35	0·67	0·37	0·97	0·99	1·75	6·62
1925	1·69	0·34	0·29	0·54	0·56	0·93	0·07	0·15	0·56	0·84	1·11	1·74	8·82
1926	0·68	0·72	0·62	0·83	0·98	0·69	0·16	0·83	0·55	0·73	0·72	0·97	8·48
1927	0·91	0·70	0·19	0·28	0·82	0·90	0·54	1·37	2·17	1·34	2·57	2·57	14·36
1928	1·12	0·14	0·90	1·57	1·16	1·48	1·65	0·23	0·01	0·39	0·35	0·76	9·76
1929	0·60	0·55	0·55	0·26	0·16	1·02	0·02	0·64	0·23	0·81	0·36	1·57	6·77
1930	0·65	0·21	1·36	0·97	1·28	0·85	0·17	0·42	0·53	0·92	0·69	0·10	8·15
1931	0·33	0·14	0·44	0·20	0·44	1·66	0·26	0·39	1·25	0·72	0·80	0·68	7·31
1932	0·65	0·39	2·73	0·95	0·29	0·21	0·79	0·66	0·60	0·66	2·27	1·10	11·30
1933	0·85	0·94	0·67	0·20	1·60	0·87	0·21	0·16	1·35	1·89	1·14	3·74	13·62
1934	0·69	0·05	1·17	0·17	1·19	0·17	0·18	0·71	1·13	0·59	1·08	1·44	8·57
1935	1·93	0·30	0·41	0·32	0·39	2·01	2·07	0·70	0·15	0·96	0·40	0·89	10·53
1936	1·68	2·05	0·45	0·81	1·19	2·18	1·40	0·49	0·59	0·15	0·07	0·96	12·02
1937	2·31	2·28	0·63	0·63	0·82	2·14	0·99	0·34	0·83	0·67	2·37	2·33	16·34
1938	0·64	1·85	0·37	0·25	0·07	0·65	0·45	0·89	1·34	0·83	0·60	1·38	9·32
1939	0·73	0·61	0·60	0·07	1·18	1·21	0·38	0·46	0·24	0·65	0·69	0·80	7·62
1940	0·73	1·23	1·20	0·60	2·18	0·16	0·55	0·19	0·79	1·90	0·95	0·67	11·15
1941	0·90	0·55	0·58	1·75	1·90	2·61	1·66	1·68	2·39	0·48	0·54	1·02	16·06
1942	1·04	0·67	0·22	1·46	2·43	1·31	2·18	0·21	0·02	0·60	1·54	2·07	13·75
1943	1·39	0·11	0·68	1·01	0·63	0·67	0·51	1·06	0·13	1·21	0·21	0·12	7·73
1944	0·63	0·99	0·42	1·47	1·88	0·84	0·50	0·65	1·59	0·32	1·63	1·69	12·61
1945	1·03	1·45	0·45	0·10	1·50	1·69	0·38	0·19	0·92	3·70	1·51	0·80	13·72
1946	0·70	0·38	0·51	0·33	0·89	1·95	0·73	0·19	0·88	1·05	1·01	0·63	9·25
1947	0·38	0·52	0·63	0·28	0·08	2·66	1·77	0·40	0·86	1·24	0·73	0·65	10·20
1948	0·33	1·02	0·48	2·23	1·82	2·59	1·93	2·98	0·66	0·18	0·48	0·91	15·61
Total	29·63	21·59	21·12	23·71	30·90	40·32	24·30	22·81	25·74	29·70	31·23	40·26	341·31
Average	·926	·675	·660	·741	·966	1·260	·759	·713	·804	·928	·976	1·258	10·67

* Data recorded in co-operation with the Meteorological Division, Department of Transport.

FRUIT BLOSSOM DATES

A. J. Mann and F. W. L. Keane

The dates when fruit trees come into blossom are influenced materially by weather conditions and vary from year to year. The date when varieties bloom affects their susceptibility to spring frost injury. It also influences their pollination status. Furthermore, blossom dates can be used to predict with some degree of accuracy the dates when varieties are likely to attain desirable harvest maturity.

In connection with fruit variety tests and fruit breeding projects conducted at this Station, blossom data have been recorded for a large number of varieties over a period of many years. These data include records of first bloom, full bloom and bloom fallen. The dates when a few representative varieties of fruit were in full bloom each year for the past 12 years are shown in Table 6.

TABLE 6—FULL-BLOOM DATES OF TREE FRUITS

Dominion Experimental Station, Summerland, B.C.

1937–1948 Inclusive

Fruit	Variety	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948
Apricot	Wenatchee Moorpark.	April 30	April 16	April 16	April 7	April 4	April 16	April 21	April 23	April 23	April 20	April 16	April 23
Cherry	Bing	May 4	April 25	April 25	April 16	April 12	April 21	April 28	May 8	May 2	April 29	April 26	May 9
Peach	Veteran	May 6	April 27	April 24	April 14	April 16	April 19	May 4	May 4	May 2	April 30	April 27	May 11
Prune	Italian	May 12	April 30	April 28	April 22	April 21	April 26	May 6	May 4	May 5	May 3	April 28	May 16
Pear	Bartlett	May 2	April 30	April 29	April 21	April 20	May 3	May 8	May 5	May 7	May 5	April 28	May 18
Apple	McIntosh	May 16	May 7	May 2	April 30	April 25	May 6	May 13	May 11	May 12	May 7	May 2	May 21

FRUIT BREEDING

A. J. Mann and F. W. L. Keane

Notwithstanding the high merit of the commercial varieties of tree fruits grown in the Okanagan Valley and adjacent districts, there is urgent need of improved varieties.

Delicious, Jonathan, McIntosh, Newtown, Rome Beauty, Stayman and Winesap, the main commercial apple varieties, are well and favourably known to the trade. Nevertheless, each of these standard varieties has its defects. Delicious is subject to mealiness if proper storage is delayed. Jonathan is susceptible to Jonathan spot, breakdown and soft scald. McIntosh is subject to pre-harvest drop and to core flush in storage. Newtown is none too hardy and consequently the areas where this variety may safely be planted are rather restricted. Rome Beauty is affected by mealiness, and climatic restrictions narrow its planting range. Stayman is sometimes affected by breakdown and is not sufficiently hardy for planting in all areas. Winesap requires a long growing season and is not very high in dessert quality.

Of pear varieties, Anjou is susceptible to loss by wind and it also has uncertain bearing habits. Flemish Beauty is not very high in quality. Bartlett has a comparatively short storage life. Other considerations for varietal improvement are hardiness and resistance to blight.

With peaches there is need of a variety maturing slightly later than Veteran, with the size and handling qualities of J. H. Hale, but more vigorous and hardy in tree characteristics than the latter variety. Improved varieties should be hardy of wood and bud, and produce fruit of high quality with sufficient firmness to withstand commercial methods of handling and long distance shipping.

With cherry, there is need for an earlier variety of the Bing and Lambert type, more resistant to cracking than those varieties, and of high pollinizing value.

Of apricot, there is need for a variety having the good bearing habits of Wenatchee Moorpark, but with greater hardiness, higher quality and more uniform ripening characteristics.

Progress in the breeding of superior new fruits depends in large measure upon the amount of land available for testing the seedlings, an area sufficient to take care of a large plant population being required. At the present time the land utilized for the project at this Station comprises only about ten acres.

With apple and pear, approximately ten years are required from seed to preliminary testing age. To propagate a promising seedling and test it on an extended basis requires an additional ten years. More years must elapse before commercial plantings come into bearing. With stone-fruits, the time required to test and establish a promising variety is somewhat shorter. Notwithstanding the time involved in the improvement of tree fruits, it is felt that the Summerland Station, situated in the centre of a large commercial fruit-producing area, should continually strive for the improvement of varieties of tree fruits through the medium of plant breeding.

In the following paragraphs a brief record is presented of work done on this project since 1924. It will be noted that, in this section of the report, discussion of the more promising seedlings is brought to a close at the point where they are transferred to the Variety List. This is in conformity with the policy whereby seedlings, as soon as they are considered sufficiently promising to propagate, are transferred to the Variety List and tested thenceforward in exactly the same manner as if they were varieties brought in, under name or number, from outside sources.

Apple Breeding

Work began in 1924, the chief parents used being Golden Delicious, Grimes Golden, Jonathan, McIntosh, Newtown, Rome Beauty and Winesap. From the 13 crosses made in 1924 to 1926, 1015 seedlings were raised to fruiting age. Of these, only seven seedlings survived the preliminary trials and were considered of sufficient merit to be placed on the Variety List.

After a lapse of ten years, apple breeding by means of controlled crosses was resumed in 1936 and continued in 1937 and 1938. During this period, 53 crosses were made, comprising a much wider range of parents but, in the main, keeping high quality and long storage life as the major objectives. The resulting progeny consisted of 1700 seedlings, of which 969 were planted out in 1939 to 1943, inclusive. However, owing to economies necessitated by the War, 821 of the planted seedlings were removed prior to fruiting, leaving 148 to grow for trial. Owing to undesirable characteristics of tree or of fruit, 100 of these had been deleted to the end of 1948. Two seedlings, a Jonathan × Newtown cross and a Winesap × Golden Delicious cross respectively, have shown sufficient merit to be transferred to the Variety List. The remaining 46 are still being tested as seedlings.

Commencing again in 1944 and continuing each year during the five-year period, 1944-48, hardier varieties, such as Haas, Haralson, Hibernal, Patten Greening and Secor, were included as parents for certain crosses in an attempt to develop improved varieties hardier than McIntosh. Beginning in 1946 and continuing in 1947 and 1948, early maturing varieties, such as Close, Crimson Beauty, Dunning, Empire Red, Henry Clay, Lodi, Melba and Red Van Buren, were included as parents for certain crosses in an effort to obtain improved varieties of summer apples.

The seedling population resulting from the crosses made in the 1944 to 1947 period is as follows at the end of 1948:—

Seedlings planted out	667
Seedlings in nursery	2,246

The seeds resulting from the crosses made in 1948 were sown in the nursery in the autumn of 1948.

Experience in breeding apples for high quality and long storage life indicates that Delicious is not a promising parent. On the other hand, Golden Delicious, Grimes Golden, McIntosh, Newtown and Winesap appear to have promise as parents.

Apricot Breeding

Work with this fruit was begun in 1936, when a survey was made of the apricot trees which survived and bore fruit after the severe winter of 1935-36. The fact that a few kinds, mostly seedlings, carried a crop in 1936 suggested that they were hardy of wood and bud. In the spring of 1937 pollen was collected from some of these hardy trees and crossed on Wenatchee Moorpark, a standard commercial variety. Again in 1938 the crossing was repeated. From these crosses, 292 seedlings were planted out in 1939 and 1940. Other seedlings were received from the Dominion Experimental Station, Morden, Man., and planted. In 1941, some of the seedlings commenced to bear and by 1942 and 1943 a majority of the seedlings were in heavy production. Evaluation of the seedlings commenced in 1942, and by 1944 only three seedlings remained. These were transferred to the Variety List, and the others removed as unpromising.

Apricot crossing was resumed in 1944 and continued each year up to 1948 inclusive. During this five-year period, 63 crosses were made and a wide range of varieties were used as parents. The crosses made during the years 1944 to 1947, inclusive, have given 3304 seedlings, of which 1719 are planted in the trial grounds and 1640 are being raised in the nursery. Of the seedlings planted out, a few commenced to fruit in 1948.

FIG. 2—THE RELIABLE APRICOT

This new apricot is a heavy yielder and has good handling characteristics. 1944.

Cherry Breeding

Work was begun in 1936, the chief parents used being Bing, Black Republican, Deacon, De Schrecken, Empress Eugenie, Giant, Hinton, Lambert, Royal Ann, Schmidt, Vernon, Victor, V-160140 and Windsor. In 1939 and 1940, 472 seedlings were planted out for trial and in 1941 an additional planting of 121 was made. To a large extent these seedlings were from open-pollinated crosses. By 1942, 103 seedlings had fruited and 9 had been selected and transferred to the Variety List. These first selections were seedlings of Empress Eugenie, Giant and Vernon. Further selections were made in 1943 and 1944, totalling 13 for the two years, and in 1946 an additional 19 were selected and placed on the Variety List. The work of testing and deletion continued, and by the end of 1948 the cherry seedling population had been reduced from 593 to 17. Of these 17 seedlings, 13, (12 black and 1 white), are being held for tests of virus disease resistance. The remaining 4, (3 black and 1 white), are still undergoing both horticultural and virus tests.

In 1945, cherry crossing was resumed and continued each year up to 1948 inclusive. During this four-year period, 212 crosses were made, using as parents a wide range of varieties and selected seedlings. The seed resulting from the 1945 and 1946 crosses was collected, stratified and sown in the nursery, but produced no seedlings. In the case of the 1947 crosses, notwithstanding special precautions to ensure a satisfactory stand of seedlings, only 10 seedlings were secured. The seed from the 1948 crosses was collected and forwarded to a nursery in the Fraser Valley, where more satisfactory conditions of soil temperature and moisture exist for the germination and development of cherry seedlings.

Peach Breeding

Breeding began in 1929 and continued for six years, after which no further crosses were made. The principal parents used were Elberta, J. H. Hale, Rochester, Vedette and Veteran. The resulting progeny consisted of 1025 seedlings which were planted out and raised to fruiting age. Testing of these seedlings commenced in 1939 and by 1943 those which appeared of no promise, to the number of 1004, had been deleted. The 21 remaining seedlings were transferred to the Variety List for extended trial in comparison with trees of commercial varieties planted at the same time.

It was noted that crosses of Rochester resulted in many seedlings having a solidly coloured dark red fruit, with heavy pubescence. J. H. Hale appeared promising as a parent, while Elberta was unsatisfactory, the majority of the seedlings of this variety being much too late in season for this area.

Pear Breeding

Work commenced in 1933, using as parents Anjou, Bartlett, Bosc and Clairgeau. The resulting progeny, consisting of 54 seedlings, were raised to fruiting age. None of these seedlings showed superiority over standard varieties and in due course they were deleted.

Further crossing of the pear was undertaken in 1944, 1947 and 1948, but only on a very small scale. Seedlings from the 1947 and 1948 crosses are now being grown in the nursery.

Plum Breeding

Reciprocal crosses of Italian Prune and Tragedy were made in 1937 and 1938. No seed, however, was obtained from these crosses.

Open-pollinated seed of various plums, particularly Italian Prune, was collected in 1937, 1938 and 1939, resulting in 573 seedlings being planted out. Of these seedlings, 9 were selected in 1947 and transferred to the Variety List.

Plum crossing was resumed in 1946, 1947 and 1948, but, largely because of poor germination of the seed in the nursery, no seedlings are available from these crosses.

Summary of Fruit Breeding

Emphasis in tree fruit breeding has been placed on apple, cherry and apricot. Of these fruits a large number of seedlings of known parentage are coming into bearing.

The outstanding named varieties produced by this project to date are:—

Jubilee and Spartan Apples,
Spotlight Peach,
Star and Van Cherries,
Reliable Apricot.

All of these give promise of becoming commercial varieties. They are discussed, and fully described, in the varietal section of this report.

FRUIT VARIETY TESTS

A. J. Mann and F. W. L. Keane

To a progressive fruit industry, an important phase of horticultural investigation is the search for promising new varieties and the testing of their potentialities in comparison with established sorts. In fact, variety enters into practically every phase of horticultural endeavour, whether experimental or commercial. New varieties are continually being introduced by Experiment Stations, nurserymen and growers. Those varieties which offer promise for this region are included in the variety trials at this Station.

New varieties received for trial may be the result of controlled crossing, bud sports or chance seedlings. When received for trial, new sorts may arrive in the form of buds or scions, which necessitate grafting or budding on established trees or propagating and raising in the nursery for one or two years, prior to planting out in the trial grounds. Some new varieties come to the Station as budded trees, ready for immediate planting.

The objective is to plant at least two trees of each variety and raise them to fruiting age, at which time preliminary fruit evaluations commence. Once in bearing, varieties are evaluated as quickly as possible and undesirable sorts are discarded promptly. Promising varieties are propagated to obtain additional trees for extended trial on the Station and in commercial orchards. In addition, buds and scions of promising new varieties are supplied to nurserymen.

Varietal data, which are systematically recorded, include origin, parentage, date planted, location, kind of rootstock, condition of tree at beginning and end of each season, blooming dates, amount of bloom, picking dates, amount of crop, detailed description of the tree and fruit, resistance to disease and winter injury, and evaluation of the fruit for size, colour, texture, firmness, quality and other factors.

A brief summary of the fruit variety testing work conducted at the Station during 1916 to 1948 inclusive is presented in the following paragraphs:—

Apple Variety Tests

A total of 358 varieties and strains of apple have been grown. Of these, 237 have been discarded or have died prior to evaluation, and 121 were under test during 1948. These 121 sorts include the eight popular commercial varieties Delicious, Jonathan, McIntosh, Newtown, Rome Beauty, Stayman, Wealthy and Winesap.

The following recent introductions under test in 1948 are considered to have commercial promise:—

Jubilee.—Originated by the Fruit Breeding Project of this Station. A full description will be found at the end of this section of this report.

Lodi.—An early yellow apple originated by the Fruit Breeding Station at Geneva, New York. Matures slightly later than Yellow Transparent but sizes considerably larger, which is a distinct advantage for the early cooker market. In other respects, Lodi is quite similar to Yellow Transparent.

Spartan.—Originated by the Fruit Breeding Project of this Station. A full description of this variety is given at the end of this section.

The following strains resulting from bud sports of established commercial varieties have proved sufficiently superior with respect to red colour development to justify planting in preference to the varieties from which they originated.

Delicious (Richared).—Introduced in U.S.A. Similar to Delicious except that the fruit is characterized by solid blush colour.

Delicious (Turner Red).—Originated in an orchard at Salmon Arm, B.C. Very similar to Delicious (Richared).

Delicious (Starking).—Originated in U.S.A. Somewhat darker in colour than Delicious (Richared).

Jonathan (Blackjon).—Introduced in U.S.A. While it is basically a striped apple, it is far more red in colour than the original variety, making it considerably more attractive. In other respects, this bud sport has the characteristics of Jonathan.

McIntosh (Rogers N.Y.).—A blushed strain of McIntosh which originated in New York State. It has all the characteristics of McIntosh and has not shown any tendency to develop bud sports which produce striped fruit.

McIntosh (Summerland).—A solidly blushed strain of McIntosh which originated at this Station. Very similar in all respects to McIntosh (Rogers N.Y.).

Stayman (Blaxtayman).—Introduced in U.S.A. Similar to Stayman in all respects except that the fruit is more highly coloured showing solid blush instead of the striped colour of the original variety.

Winesap (Seeando).—Introduced in U.S.A. It is basically a striped apple like winesap but much more highly coloured and consequently more attractive. In all other respects it is similar to Winesap.

Apricot Variety Tests

A total of 56 varieties have been grown. Of these, 26 have been discarded or have died prior to evaluation, and 30 were under test during 1948. These 30 sorts include the three standard varieties Blenheim, Tilton and Wenatchee Moorpark. The following recent introductions under test in 1948, are considered to have commercial promise.

Perfection.—A midseason variety, introduced in U.S.A. The tree is vigorous and productive. The fruit is very large and uniform, firm if picked at correct maturity, fair in quality. Has promise as a variety for the fresh fruit trade.

Reliable.—This variety was originated by the Fruit Breeding Project of this Station. A full description is given at the end of this section.

Cherry Variety Tests

A total of 104 varieties have been grown. Of these, 42 have been discarded or have died prior to evaluation, and 62 were under test in 1948. These 62 sorts include the three standard varieties Bing, Lambert and Royal Ann. The following recent introductions, under test in 1948, are considered to have commercial promise:—

Star.—Originated by the Fruit Breeding Project of this Station. A full description will be found at the end of this section.

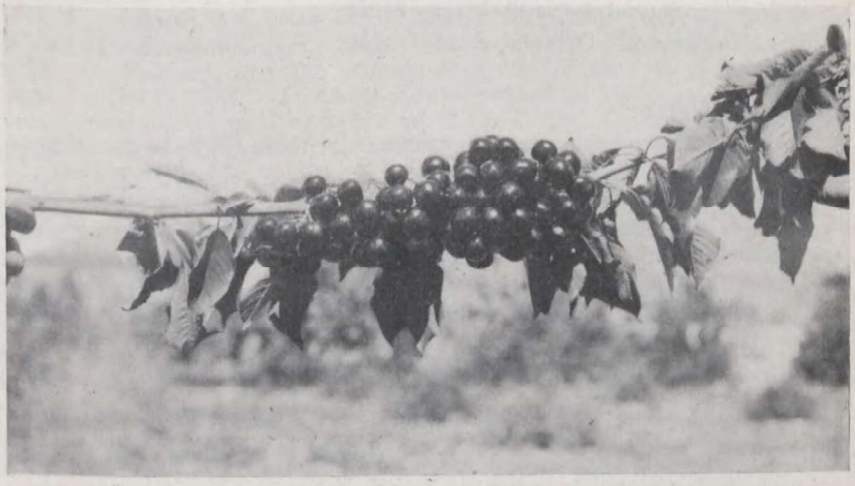


FIG. 3—THE VAN CHERRY

This variety produces heavy clusters of fruit on young wood. The fruit has high quality and good shipping characteristics. 1946.

Van.—Originated by the Fruit Breeding Project of this Station. A full description is given at the end of this section.

Peach Variety Tests

A total of 149 varieties have been grown. Of these, 70 have been discarded or have died prior to evaluation, and 79 were under test during 1948. These 79 sorts include the three standard varieties Elberta, J. H. Hale and Rochester. The varieties Valiant, Vedette and Veteran, which were originated by the Horticultural Experiment Station, Vineland, Ont., were brought here for test about twenty years ago. They were subsequently recommended by this Station and are now being grown very extensively in the commercial peach orchards of British Columbia. The following recent introductions, under test in 1948, are considered to have commercial promise:—

Redhaven.—An early variety, introduced by the Michigan Experiment Station. It is ahead of Rochester in season and is much more highly coloured and attractive. Outstandingly firm and with excellent handling characteristics. Yellow fleshed, semi-clingstone, above fair in quality.

Spotlight.—Developed by the Fruit Breeding Project of this Station. A full description will be found at the end of this section.

Pear Variety Tests

A total of 116 varieties have been grown. Of these, 83 have been discarded or have died prior to evaluation and 33 were under test during 1948. These 33 sorts include the commercial varieties Anjou, Bartlett and Flemish Beauty. At present none of the newer sorts holds promise of becoming important commercially.

Plum Variety Tests

A total of 123 varieties have been grown. Of these, 83 have been discarded or have died prior to evaluation, and 40 were under test during 1948. These 40 sorts include the commercial varieties Bradshaw, Italian and Peach. Three early strains of Italian, under test in 1948, are promising:—

Italian (De Maris).—This strain originated in U.S.A., probably as a bud sport. It is similar to Italian except that it matures two to three weeks earlier.

Italian (Greata).—Discovered in British Columbia, possibly from a bud sport. It is very similar to Italian (De Maris).

Italian (Richards).—Originated in U.S.A. Very similar to Italian (De Maris).

Grape Variety Tests

A total of 116 varieties have been grown. Of these, 46 have been discarded or have died prior to evaluation and 70 were under test during 1948. The following recent introductions are considered to have commercial value:—

Patricia.—Originated in Ontario. A hardy midseason blue variety of fair quality. Suitable for culinary purposes and fresh shipment.

Sheridan.—Originated by the Fruit Breeding Station at Geneva, New York. A hardy late blue grape of good quality which should be grown only in the most favoured areas.

Other Fruits, Variety Tests

The foregoing kinds of fruit are the basis of the commercial fruit industry in the area served by this Station. In addition, variety tests have been conducted of the following fruits which are of lesser commercial importance. The number of varieties grown is indicated by the figures in brackets:—

Nectarine (5), Quince (3), Blackberry (2), Dewberry (4), Gooseberry (10), Raspberry (32), Red Currant (17), White Currant (6), Black Currant (10), Strawberry (68).

Of the above, only 4 varieties of Black Currant remained in the plantings in 1948.

The following recent introductions have commercial value in the area served by this Station:—

Washington Raspberry.—Originated by the Western Washington Experiment Station, Puyallup, Washington. Vigorous, productive and comparatively resistant to virus diseases. Fruit is of good size and excellent quality. Suitable for fresh shipment. This variety requires good soil drainage.

British Sovereign Strawberry.—Originated in the Fraser Valley, B.C. The plant is vigorous and productive. The fruit is of good quality, suitable for fresh shipment and canning.

Nut Variety Tests

There are no large-scale commercial plantings of nuts in the area served by this Station. However, many people are interested in growing a few walnuts and filberts for home use. With this fact in mind, 68 varieties of nuts have been included in the variety trials. Of these, 45 have been discarded or have died prior to evaluation and 23 were still under test in 1948. The following varieties have given exceptionally good results in the trials:—

Broadview Walnut.—Originated in B.C. from a nut imported from Odessa. The tree is vigorous, productive and moderately hardy. The nuts are medium in size, well filled and crack very easily. The kernel is of good quality and easy to extract from the shell.

Comet Filbert.—Originated by J. U. Gellatly of Westbank, B.C. The tree is comparatively hardy and productive. The nuts are large and very uniform in size and shape. They are well filled and the kernels have only a small amount of pellicle.

Holder Filbert.—Originated by J. U. Gellatly of Westbank, B.C. The trees are comparatively hardy and productive. The nuts are of only medium size but husk and crack easily. The kernels are of good quality and attractive appearance, having very little pellicle.

The Jubilee Apple

Origin.—Jubilee is a cross of McIntosh × Grimes Golden, originated at the Dominion Experimental Station, Summerland. The cross was made in 1926, (R. C. Palmer), and the original tree was planted in November, 1928, and first fruited in 1934. The selection was made in 1936, (A. J. Mann), and the variety was named in 1939 in honour of the British Columbia Fruit Growers' Association's Golden Jubilee Convention. It was introduced in 1939.

Tree.—The original tree has been a fairly consistent, though not a heavy bearer. The tree is large for its age, vigorous and moderately spreading, with reasonably strong limbs and crotches and with a fairly desirable habit of growth. Tests in grower orchards in the colder commercial fruit growing areas suggest that Jubilee is about as hardy as McIntosh. However, the trees under trial are only about eight years old and during this period there has only been one moderately severe winter, and no winter cold enough to adequately test the hardiness of Jubilee. The fruit requires moderate thinning. It picks fairly easily and is quite resistant to pre-harvest drop. Young trees are rather slower in coming into bearing than McIntosh or Spartan.

Fruit.—The fruit is of medium size, fairly attractively coloured with a bright and rather light scarlet blush. The flesh is firm, crisp, cream-coloured and juicy. The core is smaller than that of McIntosh. The quality is very good to good. The stem is of medium length and not likely to cause stem-punctures. The skin is fairly thick and tough and the variety has good handling qualities.

Picking Season.—Jubilee matures at least three weeks later than McIntosh and at least a week later than Delicious.

Storage Characteristics.—Given prompt storage at 31°F., indications are that Jubilee can be held in good marketable condition until late February, nearly a month later than McIntosh. In common storage also, it ripens about a month after McIntosh. It is less susceptible than McIntosh and Jonathan to shrivelling in common storage, and less susceptible than McIntosh to core flush in common and cold storage.

Pollination.—Jubilee is inter-fertile with Delicious (Turner Red), McIntosh (Summerland), Newtown and Spartan. It also appears to be a good pollinizer for Jonathan and to be satisfactorily pollinized by Golden Delicious and by Stayman (Blaxtayman). Further pollination studies are in progress.

Commercial Status.—Jubilee appears promising and is being commercially planted. Earlier plantings are now bearing and commercial handling, storage and marketing trials are in progress. Reports on these trials continue to be favourable.

(The above results are based on the performance of the original tree and of young bearing trees at the Station and in commercial orchards.)

The Spartan Apple

Origin.—Spartan is a cross of McIntosh × Newtown, originated at the Dominion Experimental Station, Summerland. The cross was made in 1926, (R. C. Palmer), and the original tree was planted in November, 1928, and first fruited in 1932. The selection was made in 1934, (A. J. Mann), and the variety was named in 1936, the name "Spartan" being chosen because of the robust nature of the tree and the good characteristics of the fruit. Spartan was introduced in 1936.

Tree.—The original tree has been a fairly consistently heavy bearer. It is of McIntosh type, with strong limbs and crotches and desirable habit. Tests in grower orchards in the colder commercial fruit growing areas suggest that Spartan is about as hardy as McIntosh. However, the trees under trial in those areas are only about eight years old and during this period there has only been one moderately severe winter, and no winter cold enough to adequately test the hardiness of Spartan. The fruit requires moderate thinning. It picks easily, but is more resistant than McIntosh to pre-harvest drop.

FIG. 4—THE SPARTAN APPLE

This promising variety has good tree and fruit characteristics. 1944.

Fruit.—The fruit is above medium size, somewhat of McIntosh shape but more symmetrical and uniform in outline, highly coloured with a solid dark red blush. The flesh is firm, crisp, white and juicy. The core is smaller than that of McIntosh. The quality is very good. The stem is short and has the same tendency as McIntosh to stem-puncturing, but the skin is thicker and tougher than McIntosh, and Spartan has good all-round handling qualities.

Picking Season.—Spartan matures two to three weeks later than McIntosh, and in districts where McIntosh is heavily planted Spartan can be used to extend the picking season.

Storage Characteristics.—Given prompt storage at 31°F., indications are that Spartan can be held in good marketable condition until early February. In common storage, Spartan also ripens slightly later than McIntosh. It is less susceptible than McIntosh to shrivel and core flush in common storage and to core flush in cold storage.

Pollination.—Spartan is inter-fertile with Delicious (Turner Red), Golden Delicious, Jubilee, McIntosh (Summerland), Newtown and Stayman (Blaxtayman). It also appears to be a good pollinizer for Jonathan and at least a fair pollinizer for Winesap (Seeando). Further pollination studies are in progress.

Commercial Status.—Spartan appears promising and is being planted commercially. Earlier plantings are now bearing and commercial handling, storage and marketing trials are in progress. Reports on these trials continue to be favourable.

(The above results are based on the performance of the original tree and of young bearing trees at the Station and in commercial orchards.)

The Reliable Apricot

Origin.—Reliable is a cross of Wenatchee Moorpark × L-129 (Hewetson), a hardy seedling from Kelowna, B.C. It originated at the Dominion Experimental Station, Summerland, the cross being made in 1937 (A. J. Mann), and the original tree planted in 1939. The selection was made in 1942 (A. J. Mann). The variety was introduced commercially in 1945 and was named in June, 1946.

Tree.—The original tree has been a heavy annual bearer. It has attained good size for its age, is upright and spreading in shape with a fairly strong limb structure, and is vigorous and healthy. It has proved hardy at the Summerland Experimental Station during one moderately severe winter. The fruit is well distributed and sets rather thickly, and the crop requires moderate thinning.

Fruit.—The fruit is of medium size, somewhat of Tilton shape, of outstandingly attractive orange colour with a blush. It is outstandingly firm, dry in texture, of fair dessert quality and very uniform in all respects. Tests indicate that, as a canning variety, Reliable is satisfactory, although it does not hold its shape as well as Blenheim or Tilton.

Picking Season.—Reliable is slightly later in season than Wenatchee Moorpark and should not be picked until it attains full orange colour. It is then quite firm and an excellent shipper. At the Summerland Station, over a period of five seasons, the fruit of this variety has yearly remained firm on the tree for about ten days after attaining full colour, giving an exceptionally long picking range. The entire crop can be harvested in two pickings.

Pollination.—Indications are that Reliable is self-sterile, and suitable provision should be made for cross-pollination by a standard variety. Further pollination studies are in progress.

Commercial Status.—Reliable appears promising and is being planted for extended commercial trial in the apricot districts of British Columbia.

(The above results are based on the performance of the original tree only.)

The Star Cherry

Origin.—Star is an open-pollinated seedling of Deacon, originated at the Dominion Experimental Station, Summerland. The seed was collected and sown in 1936, (A. J. Mann), and the original tree was planted in the spring of 1939. The selection was made in 1944 (A. J. Mann), under the number S-10-21 (SF). The variety was named in January, 1949, and was introduced at that time.

Tree.—The original tree has been a moderately heavy and a consistant annual bearer. It is of only moderate size, but is located on light sandy soil and its water supply has sometimes been inadequate. It is healthy and reasonably vigorous. It has proved hardy at the Summerland Experimental Station during one moderately severe winter. The fruit sets thickly enough to give a full crop, but not so thickly as to reduce fruit size.

Fruit.—Star is a black cherry intermediate in shape between Bing and Lambert. Indications are that it is of similar size, firmness and quality to Bing, and also that it is somewhat similar in its susceptibility to cracking. It attains a very attractive, deep, rich, dark red colour, merging into black, and the juice is also a very dark red.

Picking Season.—Star appears to be more than a week earlier than Bing, and can be used to advantage to obtain an earlier start in the season for cherries of Bing quality.

Pollination.—Two years' tests indicate that Star is inter-fertile with Van. It appears to be unsatisfactory as a pollinizer for Bing, Lambert, S-6-10 (7) and S-8-4 (SF). It is, however, satisfactorily pollinized by S-6-10 (7) and S-8-4 (SF), although not by Bing and Lambert. One year's tests suggest that Star may be inter-fertile with Deacon. Further pollination studies are in progress.

Commercial Status.—Star is promising and is being introduced for limited commercial trial in the cherry districts of British Columbia.

(The above results are based on the performance of the original tree only.)

The Van Cherry

Origin.—Van is an open-pollinated seedling of Empress Eugenie, an old French variety classified as a Duke or semi-sour cherry. It was originated at the Dominion Experimental Station, Summerland. The seed was collected and sown in 1936, (A. J. Mann), and the original tree was planted in the spring of 1939. The selection was made in 1942, (A. J. Mann), and the variety was named in 1943, the name "Van" being chosen in honour of J. R. Van Haarlem, Pomologist at the Horticultural Experiment Station, Vineland, Ont. It was introduced in 1944.

Tree.—The original tree has been a heavy annual bearer. It is of good size for its age, vigorous and of upright growth. It has proved hardy at the Summerland Experimental Station during one moderately severe winter. The fruit sets thickly and is well distributed on the limbs, with heavy clusters on the younger wood. The stem is short and this factor combined with the heavy set of fruit makes picking slightly less easy than with longer stemmed varieties.

Fruit.—Van is a black cherry of Bing type. The fruit is about as large as Bing, slightly firmer, quite as good in quality and more sprightly. It is outstandingly attractive, with a very bright lustre. It has good storage life and retains its lustre and firmness well after picking. Van is somewhat resistant to cracking of the fruit, and is superior to Bing in this respect.

Picking Season.—Van reaches picking maturity slightly earlier than Bing and remains in good harvesting condition several days later than that variety.

Pollination.—Van has shown itself to be a successful pollinizer for Bing and Lambert and to be successfully pollinized by Bing, Deacon, Lambert and Royal Ann.

Commercial Status.—Van appears promising and is being planted for extended commercial trial in the cherry districts of British Columbia. It is recommended as a pollinizing variety for Bing and Lambert, and has marketing potentialities much superior to Deacon, Black Tartarian and Black Republican. (The above results are based on the performance of the original tree only.)

The Spotlight Peach

Origin.—Spotlight is a cross of Veteran × Rochester, originated at the Dominion Experimental Station, Summerland. The cross was made in 1934 (J. E. Britton), and the original tree was planted in April, 1937. The selection was made in 1940 (A. J. Mann). The variety was introduced in 1946 and was named in November of that year. During canning trials, comprising 12 varieties, held during that month, this seedling, under number S-9-10, took the spotlight for quality. Accordingly there and then it was named Spotlight.

Tree.—The tree has proved hardy at the Summerland Experimental Station. The variety bears heavily and requires heavy thinning.

Fruit.—The fruit is medium in size. When mature, it has a rich orange ground colour splashed with attractive red. It is yellow-fleshed, firm, good to above fair in quality. It has a somewhat smoother skin than peaches of Rochester type. It is semi-clingstone, being somewhat similar to Rochester in this respect. Spotlight attains high colour on the tree while still firm and should not be picked until good colour has developed. As a canning variety, Spotlight is rated very good.

Picking Season.—Spotlight matures about a week earlier than Rochester and the entire crop can be harvested in two or three pickings.

Commercial Status.—Spotlight appears promising and is being planted for extended commercial trial in the peach districts of British Columbia.
(The above results are based on the performance of twelve young bearing trees at the Summerland Experimental Station.)

ROOT AND FRAMEWORK STOCKS FOR FRUIT TREES

A. J. Mann and F. W. L. Keane

The root system is a very important part of a fruit tree. It not only anchors the tree to the soil, provides water and plant nutrients but also influences the size, productivity, disease resistance and length of life of the resulting tree. Modern commercial varieties of fruit do not come true from seed nor can they be propagated readily by cuttings or layers. It is for this reason that most fruit trees are budded or grafted on seedling rootstocks. Having regard to the fact that seedling rootstocks are variable in hardiness, vigour and growth habit, it is remarkable that their use has given such good results in North American orchards. Nevertheless, the serious losses which have occurred from winter injury to root systems and from the ravages of the crown-rot organism, *Phytophthora cactorum*, indicate that there is urgent need for rootstocks which are uniformly hardy and resistant to disease.

One possible method of securing hardy, disease-resistant rootstocks is the use of seedlings of known parentage. Another method of ensuring uniformity in root systems is the use of so-called clonal rootstocks which are raised by vegetative means. All the rootstocks of a particular clone are vegetative propagations originating from one plant, thus they are all alike in root characteristics, in contrast to seedlings which may be variable.

The trunk and framework also play very important roles in the performance of a fruit tree. It is desirable that the trunk and main framework be hardy, disease-resistant and structurally strong. Some commercial varieties which produce excellent fruit develop unsatisfactory trunks and frameworks. For this reason, they are often topworked on some strong, hardy, disease-resistant framework stock.

The development and testing of root and framework stocks require many years of experiment and systematic recording of data before definite conclusions can be reached. In fact, projects dealing with these phases of fruit production which were begun at this Station over 20 years ago are only now beginning to yield their most valuable information. Some of the more important findings are summarized briefly in the following paragraphs:—

Malling Rootstocks for Apples

The size of apple trees can be controlled to some extent by use of the proper rootstocks. European horticulturists have long recognized this fact and have developed the so-called "Paradise" stocks. There are several Paradise stocks which are alike in that they can all be propagated vegetatively by mound layering, but which are very different in the effects which they produce on scion varieties worked on them. These Paradise stocks became seriously mixed in European nurseries, but Sir Ronald Hatton, Director of the Research Station at East Malling, Kent, England, after careful study of their leaf and stem characteristics, segregated 16 clones, each of which comprised propagations from one individual plant. These clones were given Malling numbers from I to XVI and under these numbers have been distributed to research stations and nurserymen in many lands.

FIG. 5—FIVE-YEAR-OLD DWARF DELICIOUS APPLE TREE

This dwarf tree has been produced by budding on Malling IX rootstock. 1948.

In the hope that the Malling stocks might prove of value to British Columbia orchardists, small quantities of Malling I, II, IX, XII and XVI were secured from the East Malling Research Station in 1925. Some difficulty was experienced in propagating these stocks under Okanagan conditions. The slightly alkaline soils, dry summers and cold winters, characteristic of the B.C. dry belt, are much less favourable for vegetative propagation than the neutral soils, moist summers and mild winters experienced in Kent, England. However, by liberal use of peat mull and adoption of a nurse-root technique, a supply of Malling stocks was built up. These stocks were budded to commercial varieties with the result that by 1933 it was possible to set out a small block of McIntosh worked on Malling I, II and XII roots in comparison with trees of

the same age worked on open-pollinated seedlings of Beautiful Arcade. In the following year, additional trees of McIntosh and also trees of Delicious, Jonathan, Newtown and Winesap worked on Malling I, II and XVI were planted. A few years later a large number of varieties including Delicious, Early McIntosh, Golden Delicious, Jonathan, Jubilee, McIntosh, Melba, Newtown, Rome Beauty, Spartan, Stayman and Winesap worked on Malling IX were set out. Care was taken to plant the trees with the union of scion and stock above ground level. This is necessary to ensure that the scion variety does not develop roots of its own.

Commercial varieties such as Delicious, McIntosh, Newtown and Winesap worked on Malling I, II, IX, XII and XVI made good nursery stock and grew well when planted in the orchard. The Malling IX stock produced dwarf trees which came into production very early. At 12 years of age some of these trees had a height of 7 feet and a spread of 11 feet and were producing at the rate of about 50 pounds per tree per year. Owing to the brittle nature of the Malling IX rootstock, it was found necessary to support each tree worked on this stock in order to prevent breakage from wind or weight of crop.

Information with regard to the growth and yield of Delicious and McIntosh worked on Malling I, II, XII and XVI in comparison with trees of similar age worked on seedling roots is presented in Table 7.

TABLE 7—INFLUENCE OF ROOTSTOCK ON SIZE AND YIELD OF APPLE TREES

Rootstock	Number of Trees	Average Height Oct., 1948	Average Spread Oct., 1948	Average Trunk Circumference Oct., 1948	Three-Year Average 1946-1948
		feet	feet	inches	pounds
Delicious (Turner Red)—Planted 1933. Orchard No. 4					
Malling II	5	17·0	21·6	23	193
Malling XVI	5	19·5	24·7	27	256
Melba	4	18·3	22·3	25	206
Yellow Transparent	3	18·4	22·0	26	181
McIntosh (Summerland)—Planted 1933. Orchard No. 4					
Malling II	4	17·8	22·5	26	266
Malling XVI	4	20·4	26·3	28	428
Melba	5	17·1	23·8	25	384
Yellow Transparent	4	18·2	24·0	27	353
McIntosh—Planted 1934. Booster Orchard					
Malling I	6	20·2	22·3	26	279
Malling II	6	18·6	21·9	25	285
Malling XII	6	22·8	27·6	36	340
Beautiful Arcade	6	20·4	22·0	27	278

The data presented in Table 7 suggest that when Delicious and McIntosh are worked on Malling II roots, the resulting trees are likely to be slightly smaller than is the case when these varieties are propagated on seedling roots. Nevertheless by 1948 Delicious and McIntosh worked on Malling II had developed into good sized trees.

It will be noted also that the McIntosh trees worked on Malling I roots developed into trees of similar size to those budded on open-pollinated seedlings of the variety Beautiful Arcade. On the other hand, the use of Malling XVI roots gave trees which averaged slightly larger in size than those secured by the use of Melba and Yellow Transparent seedlings. Furthermore, McIntosh worked on Malling XII roots produced very large trees for their age.

With respect to yield, trees worked on Malling I and II roots came into bearing a year or two earlier than those worked on seedling roots. However, the yield in these early years was not great, and by the time the trees reached 10 years of age those on seedling roots were yielding as much or more per tree as those on Malling I and II roots. Delicious and McIntosh trees worked on Malling XVI have given slightly higher yields than those worked on open-pollinated seedlings of Melba and Yellow Transparent. The McIntosh worked on Malling XII, on the other hand, have been slow in coming into bearing and even at age 15 were still producing lighter crops for their size than McIntosh on other rootstocks.

The numbers of trees included in these experiments are too small to give reliable information regarding the influence of rootstock on uniformity of tree performance. Suffice it to say that the seedling stocks as well as the Malling have produced trees which are reasonably uniform with respect to size and productivity.

There has been no material difference in the colour, size, quality and storage behaviour of fruit from trees grown on the various Malling and seedling stocks, except that the McIntosh trees on Malling XII have produced a high proportion of undesirably large, poorly coloured fruit.

With respect to hardiness, none of the rootstocks tested have suffered winter injury during the 15 years that the experiment has been in progress. In this connection, it should be pointed out, however, that no severe test winter temperatures have been experienced during this period. Experience elsewhere indicates that Malling stocks are not so hardy as some seedling stocks.

Inoculation tests conducted in co-operation with the Summerland Laboratory of Plant Pathology have revealed that Malling II and IX are only slightly susceptible to attacks of the crown-rot organism, *Phytophthora cactorum*. Malling XII and XVI show somewhat more susceptibility to this organism and Malling I is quite susceptible.

Although the trees in the Summerland experiments are still young—the oldest being 15 years of age—and although the number of trees involved is small, their performance does give some indication of the growth and yield which can be expected from Delicious and McIntosh apple trees grown on certain Malling rootstocks in the irrigated areas of B.C.

Accordingly, the following recommendations are presented:—

(1) Nurserymen propagating trees on Malling roots should take the utmost care to keep separate their supplies of the various numbered Malling stocks. It is obvious that confusion will result if stocks such as Malling II, IX and XII become mixed.

(2) In propagating trees on Malling stocks, it is important that the bud be inserted at least 6 inches above ground level. This precaution is necessary to ensure that the union is kept well above soil level when the tree is planted in the orchard. If the union is buried the scion variety may send out roots which interfere with the influence of the Malling stock.

(3) Purchasers desiring a very dwarf tree should specify nursery stock worked on Malling IX roots. This stock has the disadvantage that each individual tree must be supported. On the other hand it has shown resistance to crown rot.

(4) The Malling II rootstock is worthy of consideration by growers interested in securing crown-rot-resistant trees slightly smaller than those commonly obtained by the use of seedling rootstocks.

(5) Malling XVI should develop a satisfactory tree of about the same size as on a seedling rootstock.

(6) Malling XII may be expected to develop a tree larger than one on a seedling rootstock. In view of the commercial trend towards smaller, rather than larger, trees, this stock is not recommended.

Crown-Rot-Resistant Rootstocks for Apples

Crown rot has caused serious losses in many apple orchards in the irrigated areas of B.C. The disease is caused by a fungus, *Phytophthora cactorum*, which attacks the bark at or near ground level and in severe cases may completely girdle the tree. As fruit trees are usually planted with the bud or graft union near ground level, the crown-rot organism may attack the rootstock, the scion or both the rootstock and scion variety.

Through the co-operation of officers of the Summerland Laboratory of Plant Pathology, 60 apple varieties, framework stocks and clonal rootstocks, were tested for resistance to crown rot by inoculating them with the organism. These tests revealed remarkable differences in the susceptibility of varieties and clonal stocks to attack by the crown-rot organism. For example, the varieties Antonovka, Delicious, Dolgo Crab, McIntosh, Newtown, Robin Crab and Spartan proved resistant to *Phytophthora cactorum* whereas the varieties Beauty Crab, Canada Baldwin, Grimes Golden, Hyslop Crab and Winter St. Lawrence were very susceptible to the disease. Similarly, the Malling II rootstock showed only slight susceptibility to crown rot whereas Malling I was very susceptible.

Having regard to the fact that such varieties as Delicious and McIntosh showed marked resistance to crown rot, efforts were made to propagate these varieties on their own roots. By use of a nurse-root graft technique, it was found possible to secure some trees of both these varieties on their own roots, but the percentage of rooting was disappointing and on this account the cost of raising these varieties on their own roots would be high. Neither Delicious nor McIntosh responded well to attempts to propagate them by the stooling method used in the propagation of Malling stocks.

In an endeavour to ascertain whether seedling stocks uniformly resistant to crown rot could be secured by raising seedlings of known mother parents, several thousand seedling stocks were inoculated with the crown-rot organism. These tests revealed that a high percentage of the seedlings of Antonovka, Columbia Crab, Dolgo Crab and *Pyrus robusta* were resistant to the crown-rot organism, whereas a high percentage of the seedlings of Anis, Canada Baldwin, Duchess, Estelline, Grimes Golden, Rome Beauty, Winesap and Yellow Transparent were susceptible to crown rot.

Attempts were made to propagate vegetatively, by use of the nurse-root graft technique, over 700 seedling rootstocks which showed resistance to crown rot. Most of these stocks showed very poor rooting characteristics but 72 showed sufficient promise to justify further attempts at propagating them vegetatively.

Hardy Framework Stocks for Apples

Hardy framework stocks provide a promising means of growing comparatively tender varieties such as Delicious in areas where winter weather conditions are conducive to trunk and framework injury. In brief, the procedure is to raise nursery stock of the framework variety and plant these trees in the orchard where they are permitted to grow for several years before being topworked to the desired commercial varieties.

To be ideal as a framework stock, a variety must meet the following requirements:—

It is of outstanding importance that the stock should be extremely hardy. It should also be resistant to diseases, including anthracnose, perennial canker and crown rot. It should develop a strong, well-balanced framework capable

of supporting heavy crops without breakage. It should make strong unions with the scion variety worked on it. It should result in productive and long-lived trees.

Trunk and framework injury have caused serious losses in orchard areas of British Columbia during severe winters. In an endeavour to ascertain the extent to which these losses can be prevented by the use of hardy framework stocks and in order to determine the most satisfactory stocks for the purpose, a hardy framework project was begun at the Summerland Experimental Station in 1925. However, it was 1936 before work was undertaken on this project on an extensive scale. In that year propagating material was secured of the following varieties of hardy apples and crabapples which it was considered might have value as framework stocks:—

Anis, Antonovka, Atlas, Beauty, Bedford, Canada Baldwin, Charlamoff, Columbia, Dolgo, Florence, Haas, Haralson, Hibernal, Hyslop, Lobo, Martha, McIntosh, Melba, Olga, Osman, Pioneer, *Pyrus baccata*, Robin, Sherriff, Tony, Transcendent, Virginia, Winter St. Lawrence, Wolf River.

Nursery stock of the above varieties was raised at the Summerland Station on quite a large scale with the result that by 1941 over 8,000 trees had been distributed to over 100 co-operating growers located in 13 districts. By 1943, another 2,000 trees had been sent out. Most of these trees were placed with growers in the Kamloops, Vernon and Creston districts where serious trunk and framework injury had been experienced in previous years. Officers of the Provincial Department of Agriculture Extension Service co-operated in the placement of these stocks and in the pruning and the topworking of the resulting trees.

Although the Summerland Station is located in an area where comparatively moderate winter conditions prevail and where there has been very little loss from trunk and framework injury, a two-acre block of hardy framework stocks was planted on the Station in 1939. This block contains ten trees each of nine framework stocks budded on Malling XVI roots. The stocks are Antonovka, Canada Baldwin, Charlamoff, Hibernal, McIntosh, Melba, Osman, Virginia Crab and Winter St. Lawrence. For comparison, two trees each of Delicious, Jonathan, Newtown, Stayman and Winesap budded on Malling XVI roots were planted at the same time.

These trees grew well and two of each of the stocks were budded to each of the varieties Delicious, Jonathan, Newtown, Stayman and Winesap during the second and third years after planting.

It was found that excellent results were secured by inserting the buds in the main scaffold branches about 18 inches from the trunk. The buds were inserted on the side rather than on the upper or under surfaces of the branches.

Records have been kept of the growth and yield performance of these trees on the Summerland Station. The following data regarding the behaviour of the various framework stocks are based on these records and on the results of other experiments:

Antonovka.—With this stock, the framework branches have left the trunk at a rather narrow angle in a manner somewhat similar to the variety Rome Beauty. Like Rome Beauty, the resulting frameworks appear to be strong in spite of their narrow structure. Antonovka has made excellent unions with Delicious, Jonathan, Newtown, Stayman and Winesap. The resulting trees are of good size, and are cropping well. Inoculation tests conducted in co-operation with officials of the Summerland Laboratory of Plant Pathology have revealed that Antonovka is resistant to attacks of the crown-rot organism, *Phytophthora cactorum.*

Canada Baldwin.—This stock has produced fairly good frameworks which have united well with Delicious, Newtown and Winesap, but with Jonathan and

Stayman the framework has tended to grow slightly larger than the scion variety. The resulting trees are of good size for their age and are bearing well. Unfortunately this stock has proved to be susceptible to crown rot.

Charlamoff.—Good frameworks have been produced by this stock. It has made satisfactory unions with Delicious, Jonathan, Newtown and Winesap, but with Stayman the scion variety has tended to grow slightly larger than the stock. The resulting trees have made good growth and are yielding well. Charlamoff has shown moderate susceptibility to crown rot.

Hibernal.—This stock has made good frameworks which have united well with Delicious, Jonathan, Newtown and Winesap, but not so satisfactorily with Stayman. The resulting trees have grown well and produced good crops. Inoculation tests indicate that this stock is moderately susceptible to crown rot.

McIntosh.—Fairly good frameworks have been produced and they have united well with Delicious, Jonathan, Newtown and Stayman but with Winesap the scion has shown a slight tendency to grow larger than the stock. The trees resulting from the use of this stock have grown well and carried good crops. McIntosh is slightly susceptible to crown rot. Previous experience indicates that McIntosh is not so hardy as varieties such as Antonovka, Charlamoff and Hibernal.

Melba.—The scaffold branches of this stock tend to leave the trunk at a narrow angle. Nevertheless the frameworks appear to be strong and trees with a large bearing area have been developed. Melba has made good unions with Delicious, Jonathan and Newtown, but with Stayman and Winesap the scion variety has tended to outgrow the stock. There is some evidence that Melba is resistant to the crown-rot organism.

Osman.—Good frameworks have been produced but the scion varieties have tended to outgrow the stock. In spite of this fact, the resulting trees are large and bearing well. To date there has been no breakage. Osman is moderately susceptible to crown rot.

Virginia Crab.—Extra care in pruning is necessary to develop a well balanced framework. The scaffold branches tend to leave the trunk at a very flat angle. This stock shows great vigour in the early years but seems to have a somewhat dwarfing influence on the scion varieties worked on it. Furthermore, there is a tendency to make poor unions with the scion variety. This is especially true with Delicious, Stayman and Winesap. The resulting trees have borne well in their early years. Virginia Crab is slightly susceptible to crown rot.

Winter St. Lawrence.—Fairly good frameworks have been developed with this stock. They have united very well with Delicious, Newtown, Stayman and Winesap but with Jonathan there has been a slight tendency for the framework to outgrow the scion variety. The resulting trees have made good growth and are bearing well. This stock is susceptible to crown rot.

Summary.—The two-acre block of representative framework stocks planted on the Summerland Station in 1939 has provided some interesting data on the growth and yield which can be expected from double-worked trees. The information secured from these trees may be summarized briefly as follows:

(1) Development of satisfactory double-worked trees with hardy frameworks requires some skill and special attention to the technique of pruning and budding.

(2) Satisfactory double-worked trees of Delicious, Jonathan, Newtown, Stayman and Winesap have been developed with the use of suitable framework stocks. Of these, Antonovka, Charlamoff and Hibernal combine reasonably satisfactory structural characteristics with hardiness and may be considered

promising. In fact, some of the resulting trees have wider angled crotches than are usually secured when these varieties are grown with their own trunks and scaffold branches.

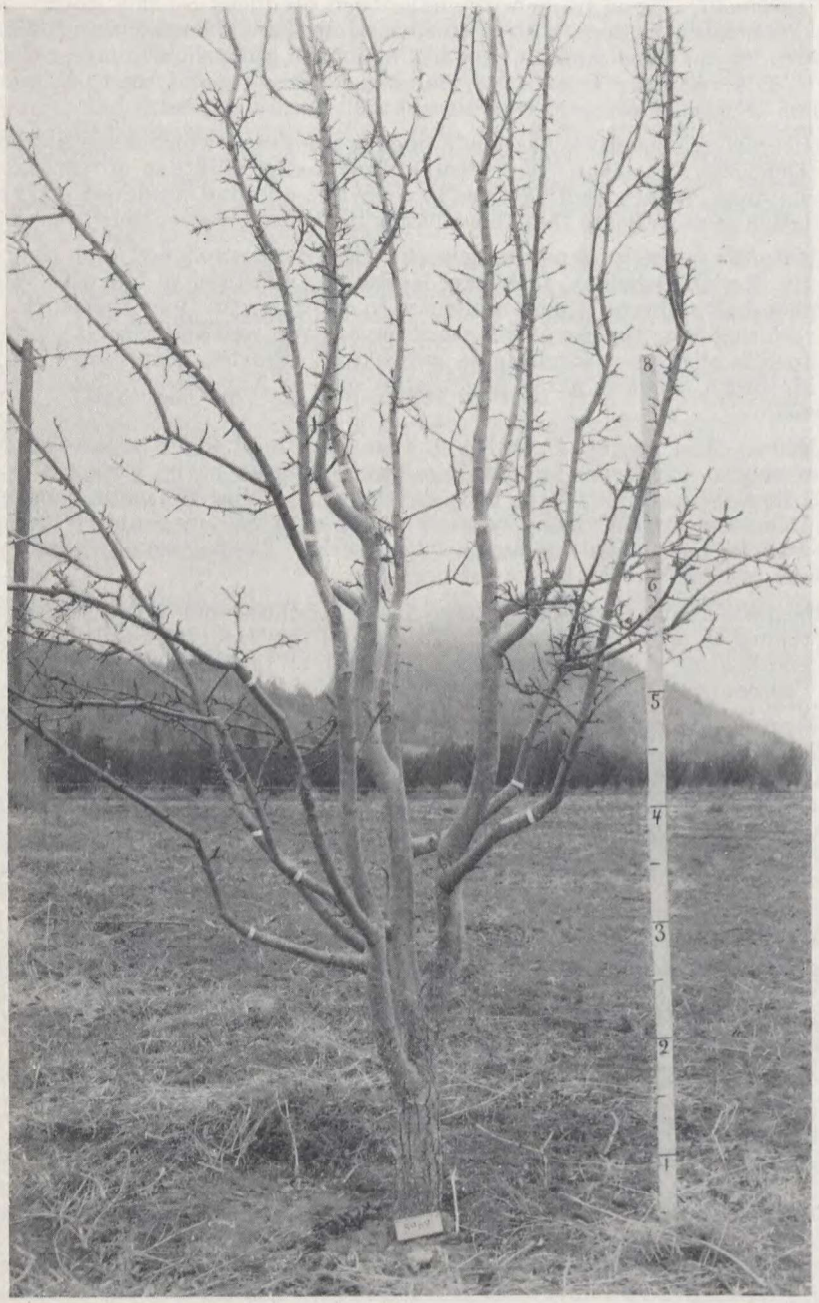


FIG. 6—A TWELVE-YEAR OLD BARTLETT TREE TOPWORKED ON OLD HOME

Topworking develops a wider spreading tree which is desirable. The white bands on the branches indicate the union of Bartlett and Old Home. 1938.

(3) At 10 years of age, well grown double-worked trees of Delicious, Jonathan, Newtown, Stayman and Winesap are almost as satisfactory in size and productivity as trees of these varieties grown on their own frameworks.

(4) Virginia Crab has given unsatisfactory results as a framework stock, especially when top-worked to Delicious and Stayman.

Fire Blight Resistant Framework Stocks for Pears

In severe outbreaks of fire blight which occur periodically, the organism often spreads to the main framework and trunk of susceptible varieties such as Bartlett. This may result in serious mutilation or even death of the tree.

The use of blight-resistant framework stocks offers a promising method of checking the spread of blight and reducing the losses caused thereby.

With the co-operation of officers of the Summerland Laboratory of Plant Pathology, 20 pear varieties and framework stocks were tested for resistance to the fire-blight organism. These tests revealed that the Farmingdale, Old Home and Variolosa framework stocks are resistant to blight. Of these, the Old Home makes the strongest framework. Furthermore, this stock is compatible with commercial varieties.

In order to test the efficiency of the Old Home stock under conditions of natural infection, blight was allowed to run rampant in a block of Old Home stocks top-worked to varieties such as Bartlett and Flemish Beauty. On these trees, the blight spread down the branches of the commercial variety until it reached the Old Home stock and then stopped. This made it possible to saw off the affected limbs and re-graft the Old Home frameworks to the desired commercial varieties. The grafts made rapid growth and the trees were back in bearing again in a few years.

The above results are supported by experience in commercial orchards. Accordingly, in areas where blight is a serious factor, the use of Old Home is suggested as a framework for standard varieties.

Rootstocks for Sweet Cherries

In order to secure information regarding the suitability of Mahaleb and Mazzard rootstocks for sweet cherries, 23 trees of Bing, Deacon, Lambert and

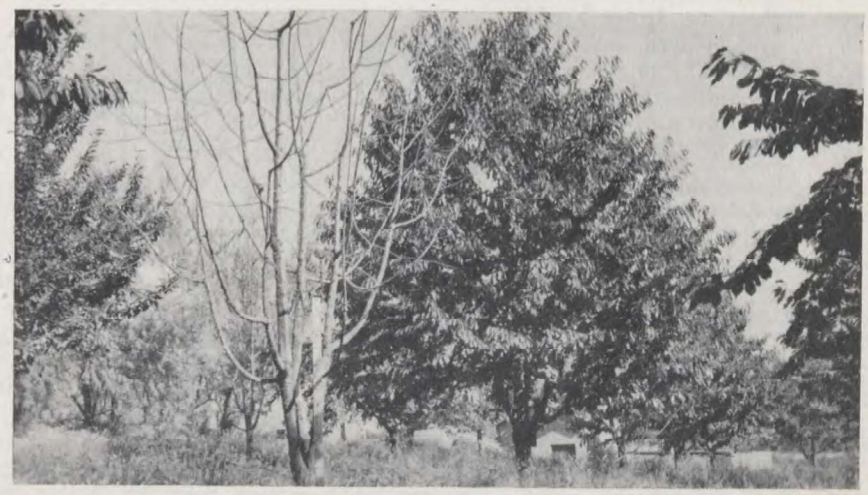


FIG. 7—BING CHERRY TREES

The dead tree on the left is budded on Mahaleb rootstock; the healthy tree on the right is on Mazzard roots. 1945.

Royal Ann were planted in 1936. Approximately one-half these trees were on Mahaleb and one-half on Mazzard roots. Although the number of trees involved in this experiment was small, the results left no doubt as to which of the rootstocks gave the most satisfactory results. For the first few years, all the trees grew well but by 1944 the trees worked on Mahaleb roots showed marked variability in size and performance. Several trees on this stock had died and others showed signs of ill-health. Furthermore, the fruit produced by trees on Mahaleb roots tended to be softer and poorer in quality than that produced by trees worked on Mazzard roots. It is quite probable that Mahaleb roots do not always give as poor results as those recorded in this experiment. However, in view of the fact that very unsatisfactory performance may result from the use of Mahaleb roots, it is recommended that Mazzard rootstocks be used for sweet cherries in this region.

PLANT NUTRITION AND IRRIGATION

J. C. Wilcox

The experimental work conducted at the Plant Nutrition Laboratory at Summerland and that conducted at the Dominion Experimental Substation at Kelowna are complementary to one another. They have been so closely associated that it would be difficult to separate them. Accordingly, this one report covers the experimental work at both places. It also covers a large amount of experimental work conducted in grower-owned orchards.

Under the general heading of "plant nutrition", the major investigations that have been conducted during the past twelve years are as follows:—

1. A study of factors affecting apple yields.
2. Orchard fertilizer tests.
3. Soil erosion studies.
4. Cover crop tests in orchards.
5. Sprinkler irrigation studies.
6. Irrigation water analyses.

Each of these will be summarized in turn.

Factors Affecting Apple Yields

Yield and growth were taken for six years (1937-42) on 290 mature McIntosh trees (in 73 groups or plots) located in various districts in the Okanagan Valley. Soil and shoot samples were taken in 1939 and 1940 for analysis. Root studies were also made in 1940. The relationships between the records obtained and the tree performance have been studied in some detail.

The vigour of the trees was found to affect both yield and quality of fruit. Non-vigorous trees bore small fruit high in colour and quality, but the yields were low. Vigorous trees bore high yields of large fruit that was poor in colour and quality. The happy medium was found to be somewhere between these two extremes. Where pruning was adequate, such that the trees were well opened up, the highest yields of high quality fruit were obtained at a degree of vigour represented by an average annual terminal growth of 10 to 12 inches. In measuring the vigour, only leading terminal shoots growing around the outside perimeter of the tree at an angle of about 45° were used. Based largely on these findings, sufficient nitrogenous fertilizer is being recommended to maintain an annual terminal growth of 10 to 12 inches with apple trees.

Most of the 290 trees showed some tendency toward biennial bearing,—that is, they bore a heavier crop every second year than they did in the intervening years. Some were almost completely biennial in habit, bearing little or no fruit during the off years. This condition was aggravated to some extent by poor vigour of the trees. In the main, however, it appeared to be caused by

adverse weather conditions. For example, a late spring frost might kill the blossoms, producing an off-year, and this in turn would be followed by a very heavy crop the next year. In many cases the off-and-on cycle was continued throughout at least the six years of recording.

FIG. 8—BRANCH OF McINTOSH APPLE TREE SHOWING TERMINAL GROWTH

Fruit tree vigour is measured in terms of average annual growth of the terminal shoots. The terminals used for this purpose are those growing upward at an angle around the outside perimeter of the tree, as indicated by the arrow in this photograph. 1942.

Biennial bearing was found to exert a marked effect on average tree yields. Over the six-year period, complete biennial bearers produced about 400 loose boxes less per acre annually than did complete annual bearers. The average annual loss per acre among the 290 trees, attributable to biennial bearing tendencies, was 200 loose boxes. Since biennial bearing of the apple is so prevalent in the southern interior of B.C., this constitutes a serious financial loss to the growers.

The effects of soil type on root growth were studied carefully. In deep sand, silt or clay loam soils, the roots grew down to depths of eight feet or more and also grew right across the panels. No evidence of hardpan was found. In many cases, the top soil was underlaid at depths of one to three feet by a mixture of coarse sand and gravel. In such cases, only a few scattered roots would descend below a depth of four or five feet. Little relationship was found between the depth, spread or concentration of the roots on the one hand and tree growth or yield on the other hand.

A wide variation in soil texture and depth was encountered. Most of the soil profiles, however, consisted either of deep silt loams, or of shallow sandy loams underlaid by gravel. The deep silt soil was usually neutral or nearly so

in reaction in the top soil, but alkaline (up to pH 8·4) in the subsoil as a result of the presence there of free lime. The shallow sands were usually somewhat acid, with no free lime present. The amounts of phosphorus and potassium available for plant use were higher in the surface soil than in the subsoil. Heavier soils contained much more available potassium and calcium than did lighter soils. There was little relationship, however, between soil texture and the phosphorus content.

Tree performance was found to be quite definitely affected by the texture and depth of the soil. Growth and yield were less on light shallow soils than on deep heavy soils. The exact causes of this relationship, however, have not been determined. No consistent relationship was found between the available phosphorus, potassium or calcium content of the soil and tree growth or yield.

Shoot analyses for two consecutive years (1939 and 1940) showed that the nutrient content of the tissues was affected by the amount of crop. In the heavy-crop year, the nitrogen content was higher and the phosphorus and potassium contents lower than in the light-crop year. More nitrogen was present in the shoots of vigorous trees than in those of non-vigorous trees. No consistant relationship was found between the average phosphorus or potassium content of the shoots over a two-year period and tree growth or yield.

Some of the correlations determined in the above studies are summarized in Table 8. In this table, those correlations involving soil pH, or the available contents of P, K or Ca in the soil, have all been adjusted for the variable effects of the moisture-holding capacity of the soil. The biennial bearing index is a measure of the tendency to bear heavily in alternate years and lightly in the intervening years. An index of 100 indicates complete biennial bearing, and an index of zero indicates complete annual bearing. Other biennial indices likewise are measures of the regularity of higher and lower values in successive years.

TABLE 8—SOME CORRELATIONS OBTAINED FROM THE INVESTIGATIONS ON APPLE YIELDS

Two sets of data correlated		Coefficient of correlation
Biennial bearing index	Biennial terminal index	+ 0·634**
Biennial bearing index	Biennial N index in shoots	+ 0·330**
Biennial bearing index	Biennial P index in shoots	− 0·231**
Biennial bearing index	Biennial K index in shoots	− 0·316**
Biennial bearing index	Tree yield	− 0·526**
Biennial bearing index	Terminal growth	− 0·064
Terminal growth	Tree yield	+ 0·260**
N content of shoots	Tree yield	+ 0·262*
N content of shoots	Terminal growth	+ 0·280**
P content of shoots	Tree yield	+ 0·049
P content of shoots	Terminal growth	+ 0·126
K content of shoots	Tree yield	− 0·129
K content of shoots	Terminal growth	+ 0·165
Fibrous roots in soil	Tree yield	+ 0·127
Fibrous roots in soil	Terminal growth	+ 0·076
Moisture-holding capacity of soil	Tree yield	− 0·410**
Moisture-holding capacity of soil	Terminal growth	+ 0·262*
Soil pH	Tree yield	+ 0·036
Soil pH	Terminal growth	+ 0·060
Available P content of soil	Tree yield	+ 0·095
Available P content of soil	Terminal growth	+ 0·103
Available K content of soil	Tree yield	+ 0·032
Available K content of soil	Terminal growth	+ 0·321**
Available Ca content of soil	Tree yield	+ 0·045
Available Ca content of soil	Terminal growth	+ 0·092

* Significant, with odds between 19×1 and 99×1.
** Highly significant, with odds greater than 99×1.

Fertilizer Tests on Apple Trees

Several series of fertilizer tests that had been started in the 1920's were continued into the past twelve years. In each series of plots, nitrogen, phosphate and potash fertilizers were tested. Nitrogen increased both tree vigour and yield, and in some cases reduced fruit colour somewhat. There was no consistent effect of phosphate or potash on tree performance. Results similar to these have been obtained in fertilizer tests conducted by the B.C. Department of Agriculture in the Okanagan Valley. In no case has there been any consistant effect of fertilizers on the biennial bearing habits of the trees. Typical results from these fertilizer tests are presented in Table 9.

Storage tests have been made for several years on fruit from the fertilizer plots. Heavy applications of nitrogen have delayed maturity at picking time, and induced larger sized fruit with poorer storage quality and more core browning. There has been no measurable effect of phosphate or potash on maturity or storage quality.

TABLE 9—DATA FROM FERTILIZER PLOTS IN BARNARD ORCHARD

—	Treatment			
	O*	N	NP	NPK
Yield 1932-33**	16·2	21·5	19·5	19·4
Yield 1934-35	10·6	22·6	17·7	18·7
Yield 1936-37	13·9	19·4	19·8	20·1
Yield 1938-39	17·3	22·1	18·4	19·4
Yield 1940-41	10·6	17·8	14·0	15·3
Yield 1942	10·7	16·4	15·3	16·0
Average yield per tree	13·4	20·3	17·6	18·3
Biennial bearing index	53·4	34·0	36·9	39·8
Terminal growth (cm.)	20·9	28·1	29·1	28·0

* Treatments: O—no fertilizer; N—nitrogen; P—phosphate; K—potash.
** The yields are expressed in terms of loose bushel boxes.

Since no definite effects had been obtained by 1943 from phosphate or potash fertilizers, soil samples were obtained that year from orchard areas in the United States and Canada where definite deficiencies of phosphorus and potassium had been established. These samples were analysed for available potassium and phosphorus, and comparisons were made with the soils in the fertilizer plots and those in the 73 plots of mature McIntosh trees. All of the surface soils in the fertilizer plots were higher in phosphorus and potassium than were those from areas of known deficiency, but some of the surface soils from the 73 McIntosh plots were as low as the established deficiency levels. Indications were, then, that some of the shallow sandy soils in the Okanagan Valley might already be deficient in phosphorus and potassium. Fertilizer plots have now been set out in orchards where these low levels were found. In the meantime, phosphate and potash fertilizers are being recommended on light shallow soils.

The fertilizer plots conducted by this Station and also those conducted by the B.C. Department of Agriculture were used as a basis for studying the value of soil and tissue analyses. Phosphate added to the soil over a period of ten years or more enriched the phosphorus content to a depth of eight inches, but had little if any effect below that depth. Similar results were obtained with potash. Neither phosphate nor potash caused consistent increases in their respective contents in the shoots of the trees. They did, however, cause such increases in the leaves. It was concluded that both soil analysis and leaf analysis show good promise as a basis for making fertilizer recommendations for tree fruits.

Following the discovery of boron deficiency in orchard soils in 1935, borax and boric acid were applied annually to apple plots in varying amount. After several years, annual applications of one pound or more caused injury to the roots and tops of the trees. Before such injury was observed in the tops, however, both McIntosh and Jonathan apples were found to break down badly in storage (Table 10). This indicated a distinct danger from excess boron applied to the soil.

TABLE 10—EFFECTS OF EXCESS BORON ON KEEPING QUALITY OF APPLES, 1941

Tree No.	Borax or boric acid applied in six years	Flesh browning (Nov. 22)	Water core (Sept. 30)	Flesh breakdown (Nov. 22)	Yield
	ounces	%	%	%	bushels
McIntosh—					
Q 16	48	7	.....	.....	30
R 17	96	50	.....	.....	4
Q 17	96	22	.....	.....	12
R 19	192	45	.....	.....	11
S 19	320	77	.....	.....	7
Jonathan—					
O 19	6	.....	20	17	17
P 20	12	.....	0	0	25
P 18	24	.....	70	2	30
P 19	24	.....	20	2	27
P 17	48	.....	65	5	20
R 20	192	.....	80	47	16
S 18	320	.....	100	87	24

Soil Erosion

Studies on soil erosion were started in 1937. Serious erosion was found to have occurred in orchards, vegetable fields, small fruit plantations, and grazing lands. The most serious erosion has been induced by application of irrigation water by the furrow method. Orchards have been found with their original top soil almost entirely eroded away after only 30 to 40 years of land use. Serious losses of soil have also occurred in non-irrigated orchards, where lack of water has prevented the growing of cover crops.

Much of the orchard area in the Okanagan Valley is on benches that lie above silt cliffs. With application of water by the furrow method, excess gravitational water flows down through the subsoil and comes out on the faces of the cliffs. This eventually causes the cliffs to crumple and collapse. Sometimes the collapse is spectacular and much orchard land is lost.

Experimental work with furrow irrigation at the Substation has revealed the following facts: (1) Most of the erosion occurs in the bottoms of the furrows. (2) The steeper and longer the slope, the greater the erosion. (3) Sand or silt soil erodes in the furrow more readily than does clay or gravelly soil. (4) Cover crops greatly reduce erosion losses. The most efficient are the sod grasses. (5) Cultivation increases erosion markedly, especially when done during the irrigation season. (6) In addition, comparisons made in grower-owned orchards have revealed much less erosion under the sprinkler method of irrigation than under the furrow method.

These findings have led to the following recommendations for control of erosion in irrigated orchards: (1) Make the furrows shallow, short, and on the contour. (2) Or better still, irrigate by the sprinkler method. (3) Grow permanent cover crops. If erosion is serious grow a grass sod. (4) Do not cultivate during the irrigation season. If the cover crop grows too high for convenience, mow it or float it. By following these procedures, many growers have practically eliminated soil erosion.

In vegetable fields and in non-irrigated orchards, erosion control is not so easy. Lack of a proper cover allows both serious furrow erosion and sheet erosion from heavy rains. Maintenance of organic matter with manure, straw, over-winter crops such as fall rye, and use of rotations is strongly recommended.

FIG. 9—GULLY EROSION IN A SANDY LOAM SOIL AT SUMMERLAND

Gully erosion is a serious problem in both irrigated and non-irrigated orchards in British Columbia. When the surface soil is thus removed, the best part of the soil is lost. 1947.

Cover Crop Tests in Orchards

Since 1937, about 20 acres of orchard on the Summerland Station and at the Kelowna Substation have been allocated to cover crop tests. Because of the erosion problem, stress has been laid on perennial crops, handled with as little cultivation as possible. A large number of grasses and legumes have been under test, for the most part in $\frac{1}{4}$-acre plots.

The most promising cover crops for use in irrigated orchards are as follows: For apples and pears, grasses such as Kentucky blue, red top, creeping red fescue, and brome. These help to give better colour to the fruit and to mature the trees properly in the fall. For apricots and peaches, legumes or legume-plus-grass mixtures are recommended. Where the orchard is sprinkled, white Dutch clover and Ladino clover have proved very satisfactory for stone fruits. Where the soil is heavy and tight, alfalfa is recommended, as it opens up the soil better than any other known method. Under sprinkler irrigation, the cover crop is usually mown or floated in midsummer.

In some non-irrigated areas in the southern interior of B.C., there is not enough soil moisture to allow growing permanent cover crops. Tests with blue grass made at Salmon Arm show that during most years a permanent cover crop causes some wilting of the trees. Other measures are needed to prevent the serious erosion that occurs. Straw, sawdust, hay and manure are too expensive for wide-spread use. The most promising approach appears to be to grow over-wintering crops and to cultivate in midsummer.

FIG. 10—MOWING AN ORCHARD COVER CROP

Sod grass cover crops are excellent for controlling soil erosion in orchards. When tall grasses are grown, such as brome grass, it is customary to mow them once or twice a year. 1944.

Cover crop tests have also been made in vineyards during the past 10 years. Most vineyards have been planted up and down the slope, and have been irrigated by the furrow method, with consequent serious erosion. Low-growing crops such as Kentucky blue grass, creeping red fescue, white Dutch clover and Ladino clover have grown very well and have reduced erosion markedly. No adverse effect has been found on yield or sugar content of the grapes. Growers are now making good use of such cover crops in vineyards, and to some extent also in raspberry plantations. It is common practice to mow the cover crops in midsummer.

Sprinkler Irrigation

In the southern interior of B.C., irrigation water has in the past been applied mostly by the furrow or rill method. In two districts, however,—i.e. Creston and Penticton—many orchards have been irrigated by the sprinkler method for at least 15 years. Interest in this method has become keen during the past five years, chiefly as a result of improvements in sprinkler equipment. A considerable proportion of the orchards and vegetable fields in the southern interior of British Columbia are now being irrigated by sprinkling.

Experimental work on sprinkler irrigation was started at this Station in 1945. Three lines of attack have been followed: tests of sprinkler heads, comparison of sprinkler irrigation and furrow irrigation, and study of soil moisture conditions under sprinkler irrigation.

Tests have been made of low-pressure sprinkler heads that are sold in B.C. for use in orchards, to determine the uniformity with which they distribute water. Cans are laid out in a 5 × 5 foot pattern, the sprinkler is placed in the middle of the pattern and is run for one hour, and the water in each can is measured. This procedure is repeated for each nozzle size and for pressures ranging from 10 to 60 pounds per square inch. From the data obtained, recommendations have been drawn up covering the best sprinkler spacing for each nozzle size and pressure. These studies have been supplemented by actual use of each sprinkler under orchard conditions. It has thus been possible to learn the advantages and disadvantages of each type of sprinkler. Field experience has also been gained with each type of coupler and pipe on the market.

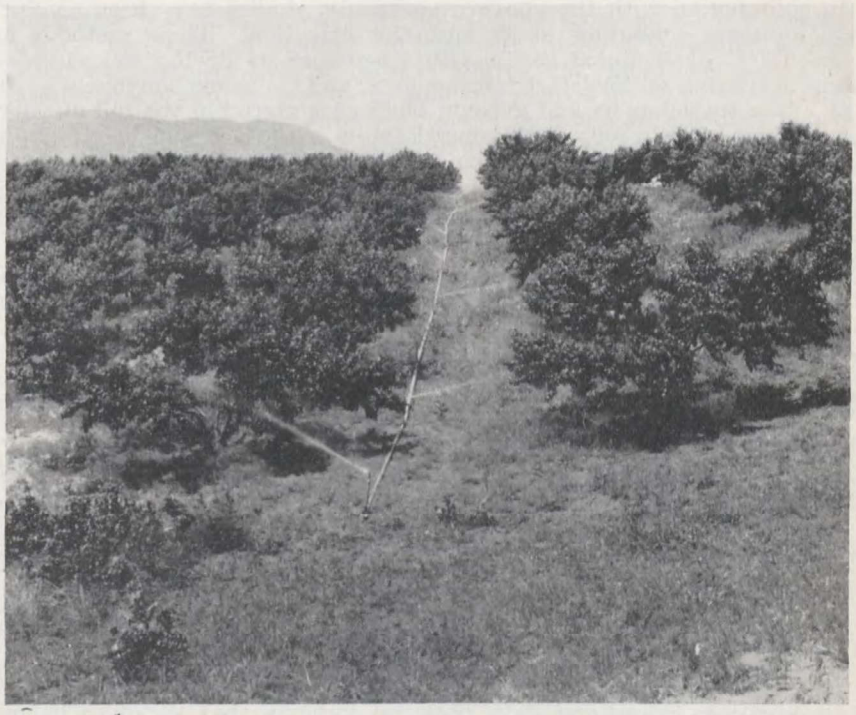


FIG. 11—SPRINKLER IRRIGATION IN AN ORCHARD

The most popular type of sprinkler irrigation system in British Columbia is one consisting of a main line pipe underground, and one or more portable lateral pipes feeding from it. Above is shown a lateral pipe consisting of 30-foot lengths of aluminum tubing held together with quick couplers. A sprinkler is located at every coupler. 1946.

During 1946, 1947 and 1948, comparisons of sprinkler irrigation and furrow irrigation have been made at both the Station and the Substation. Savings of water by the sprinkler method have ranged around 30 per cent. Results for 1947, obtained in apple orchards, are summarized in Table 11. These experiments have been supplemented by records taken in grower-owned orchards. For the most part, growers have been saving from 10 per cent on heavy soil to as high as 50 per cent of the water used on sandy soil. In some cases they have

actually been using as much or more water by the sprinkler method, because of poorly engineered sprinkler systems that allow excessive wastage of water. Such mistakes are rapidly being remedied.

TABLE 11—WATER REQUIREMENTS UNDER FURROW IRRIGATION AND SPRINKLER IRRIGATION IN 1947

—	Summerland plots	Kelowna plots
Soil texture	Sandy loam	Loamy sand
Soil depth to gravel, in inches	36	15
Length of furrows, in feet	300	130
Inches per month required:		
Sprinkler irrigation	5·40	5·43
Furrow irrigation	7·80	7·60
Savings of water by using sprinklers	32%	28%

In conjunction with the above experiments, studies have been conducted on soil moisture conditions under sprinkler irrigation. Three methods have been used: (1) determining soil moisture contents by drying soil samples in the oven; (2) using soil moisture tensiometers; and (3) using Bouyoucos gypsum blocks. The tensiometers and gypsum blocks are placed in the soil at varying depth, and are used to record the general status of the soil moisture throughout the season. It has thus been possible to obtain information for use in drawing up recommendations covering the best amount of water to apply at each irrigation and the best interval between irrigations in each type of soil. Tentative recommendations for mature orchards in the southern Okanagan Valley are outlined in Table 12.

TABLE 12—SPRINKLER IRRIGATION RECOMMENDATIONS FOR MATURE ORCHARDS IN SOUTHERN OKANAGAN VALLEY

Safe interval	Amount per application	Amount per month	Rate of flow per acre	Suitable length of irrigation	Rate of application per hour
days	inches	inches	g.p.m.*	hours	inches
5	2	12	6·3	8	0·25
7	2½	10	5·2	8	0·31
10	3	9	4·7	12	0·25
15	4	8	4·2	12	0·33
21**	5	7	3·7	12	0·42
	5	7	3·7	24	0·21
30	6	6	3·1	24	0·25

* Imperial gallons per minute.

** Two alternative rates of application are suggested, depending on the soil permeability.

Observations made and data obtained indicate that sprinkler irrigation has the following advantages over furrow irrigation: *(a)* It saves water. *(b)* It saves labour. *(c)* It reduces soil erosion. *(d)* It keeps the soil more uniformly wetted. *(e)* It promotes better growth of the cover crop. *(f)* It eliminates furrows from the orchard. On the other hand, it costs more to install a sprinkler system than a flume system. Sprinkler irrigation is recommended wherever there is evidence of soil erosion, wherever the soil is sandy, and wherever the contour or other conditions make furrow irrigation difficult.

Irrigation Water Analyses

Most of the water used for irrigation purposes in the southern interior of B.C. comes either from mountain streams or from large lakes. Starting in 1943, samples of water have been obtained from all of the major irrigation

systems. In some districts, samples have been taken at different times during the season and at different points upstream from the irrigation intakes. Analyses have been made for pH, total salt content, phosphorus, potassium, calcium and magnesium.

Most of the water has proved to be quite suitable for irrigation purposes. Occasionally, however, it has been found to contain too high a concentration of mineral salts or to be too alkaline in reaction. Such a condition is usually caused by pollution with seepage water or drainage water.

Both season and elevation have been found to affect the quality of the water, especially where it is obtained from mountain streams. Early in the season, when the streams are in flood, the silt content is high but the nutrient content is low compared with later on in the season. At any one time during the season, the water increases in nutrient content and in alkalinity as it flows down the mountain. Okanagan Lake is higher in salt content and alkalinity than any of the larger streams flowing into it, apparently because of heavy evaporation from the surface of the lake.

Irrigation water has proved to be an excellent source of some of the mineral nutrients. The calcium content is relatively high. The major sources of irrigation water supply lime at rates of 200 to 800 pounds per acre annually Potassium is supplied, as a rule, in amounts equivalent to 10 to 50 pounds of muriate of potash per acre annually, and magnesium in amounts equivalent to 50 to 300 pounds of epsom salts annually. The amounts of phosphate supplied are relatively small. Typical data are summarized in Table 13. The actual fertility value per acre is obtained by multiplying the pounds per acre foot by the number of acre feet applied annually.

TABLE 13—FERTILITY VALUES OF SOME SOURCES OF IRRIGATION WATER IN SOUTHERN BRITISH COLUMBIA

Source of water	Month collected	pH	Conductivity*	Phosphate content**	Potash content	Lime content	Magnesia content
				pounds	pounds	pounds	pounds
42. Osoyoos lake	Sept.	8·11	22	0·7	16	224	234
44. Similkameen river	Sept.	7·96	19	0·9	8	219	132
45. Keremeos creek	Sept.	8·29	25	0·9	10	286	256
41. Shingle creek	Sept.	8·38	29	1·8	12	259	276
54. Ellis creek	Aug.	7·70	11	0·2	9	69	33
26. Penticton creek	Aug.	7·60	5	0·2	5	37	19
19. Aeneas creek	Aug.	8·01	26	.....	10	294	226
21. Trout creek	Aug.	7·56	13	.....	10	112	69
43. Okanagan lake	Sept.	8·21	22	0·7	12	230	234
72. Peachland creek	Aug.	7·98	18	0·1	11	222	102
30. Trepanier creek	Sept.	8·28	16	.....	12	173	61
70. Powers creek	July	7·80	9	2·0	9	106	55
37. Mill creek	Sept.	8·40	36	2·0	18	286	414
32. Sawmill creek	Sept.	8·42	33	.....	22	320	317
7. Canyon creek	July	7·44	15	.....	11	71	61
36. Mission creek	Sept.	7·80	11	0·7	8	73	63
35. Scotty creek	Sept.	7·49	17	.....	3	100	55
15. Oyama creek	Aug.	8·28	7	.....	7	39	52
40. Wood lake	Sept.	8·45	30	0·5	26	227	441
5. Kalamalka lake	July	8·44	32	0·5	22	246	295
2. Swan lake	July	7·56	65	.....	9	322	1,075
3. Coldstream creek	July	7·48	9	.....	6	63	55
4. B.X. creek	July	8·11	20	.....	10	228	129
6. Shuswap lake	July	8·26	12	.....	8	107	83
49. North Thompson river	Oct.	8·00	8	0·3	7	103	28
50. South Thompson river	Oct.	8·18	9	0·4	7	99	36
51. Heffley creek	Oct.	8·28	53	0·2	23	468	731

* The electrical conductivity is expressed in terms of mhos x 10^5 at 25°C.

** The P, K, Ca and Mg contents are expressed as pounds of superphosphate (18%), muriate of potash (50%), lime (carbonate) and epsom salts per acre foot of water.

FRUIT HARVESTING AND STORAGE

J. E. Britton and D. V. Fisher

The activities of this section are concerned with how to produce fruit of high quality, how to harvest it at optimum maturity, and how to handle and store the crop so as to maintain it in prime condition until bought by the consumer. These objectives involve a wide range of experimental activities from pruning, thinning and harvesting methods in the orchard to a study of packing procedures, storage temperatures, regulation of storage atmosphere and examination of fruit for condition and disorders following periods of refrigeration. Furthermore, a comprehensive study has been made of the physical problems involved in warehousing the crop such as building construction, capacity of refrigerating machinery and construction and operation of air duct systems.

Pruning the Prune

A number of comparatively simple experiments have been carried out both on and off the Station to encourage greater interest in the proper pruning

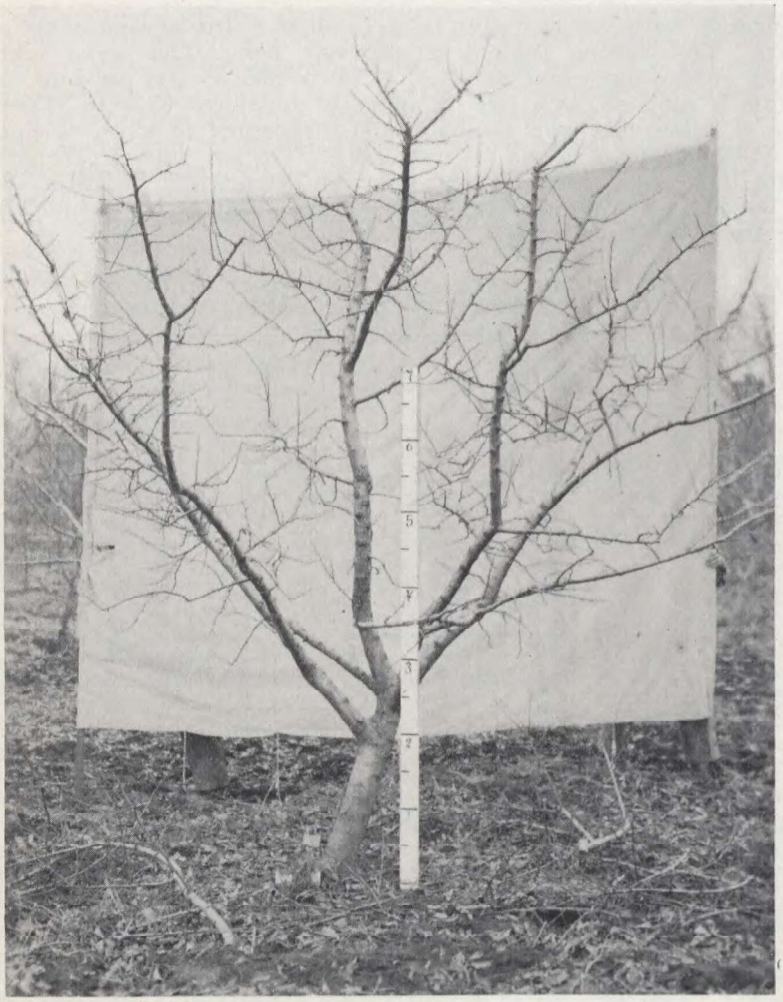


FIG. 12—A WELL-PRUNED ITALIAN PRUNE TREE
Note that all surplus spur wood has been removed. 1948.

of prune trees. The spurs on prune trees are long-lived and as the trees get older, the limbs become crowded with a dense mass of spur wood. This results in overblooming and overcropping with a corresponding decline in size and quality of fruit. Moreover, fruit on such trees ripens irregularly and later, compared with properly pruned trees. A simple rule to aid in the production of large crops of good quality prunes is to remove each winter approximately one-third of the spurs as well as any interfering branches or main limbs.

Fruit Thinning

Fruit thinning is an important and costly item in orchard management. It is, however, essential in the irrigated orchard areas of B.C. with all fruits except prunes and cherries. Hand thinning of apricots has in the past been an exceedingly laborious and expensive procedure. A large tree would often take five hours to thin. The "stick" thinning method has made it possible to do an effective thinning job in a matter of half an hour for the average tree. The thinning stick is made from a 30-inch length of an old hoe handle, and fitted over the tip of the stick is an 8-inch sleeve cut from a piece of $\frac{3}{4}$ inch rubber hose. The rubber sleeve is slightly bevelled at the tip. When the fruit is about $\frac{3}{4}$ inch in diameter, the thinner simply jars branches and spurs with the stick which readily removes surplus fruits. The time saved through thinning by this method enables the whole crop to be thinned in a relatively short period of time. It is very important to get the thinning completed early, since experiments indicate that in biennial-bearing varieties of apricots fruit buds are not likely to be formed when thinning is performed later than 6 weeks from full bloom.

Experiments in thinning Bartlett pears have indicated that with mature, full-bearing trees, thinning to 7 inches between fruits results in only slight reduction in crop which is more than offset by almost complete elimination of C-grade fruit and culls.

The loss of the United Kingdom market and its replacement by the United States market has resulted in a demand for apples in the larger size ranges. B.C. apples are no longer wanted in sizes smaller than 163 per box (2-11/16 inches diameter). Comparatively heavy thinning is required to produce apples in the preferred sizes of $2\frac{3}{4}$ to 3 inches diameter. Depending on age of tree, heaviness of crop and variety, this means thinning to 6 to 10 inches between fruits.

Some data indicating the differential effects of various degrees of thinning carried over a 9-year period, 1930-1939, are given in Table 14.

TABLE 14—INFLUENCE OF DEGREE OF THINNING ON SIZE OF APPLES
(1930-1939)

Variety	Thinning Distance (Inches)	Average Yield Per Tree Per Year				
		Over 3 Inches	2½ to 3 Inches	2¼ to 2½ Inches	Culls	Total
		Pounds	Pounds	Pounds	Pounds	Pounds
McIntosh	9	373	379	14	86	852±36·5
	6	350	269	95	84	825±33·1
	3	260	317	98	85	760±33·2
Delicious	9	343	272	93	79	787±38·3
	6	279	417	43	79	818±32·8
	3	128	450	111	64	753±43·7
Rome	9	200	304	31	63	598±31·5
	6	108	333	55	55	551±38·9
	3	106	315	53	52	526±41·0
Newtown	9	68	255	44	37	404±27·1
	6	47	286	56	36	425±36·6
	3	55	267	90	48	460±36·8

Increased thinning requirements and mounting labour costs have resulted in a marked interest in the use of chemical thinning sprays at bloom time. Varying results with such sprays have been reported from fruit districts all over Canada and the United States. Experiments conducted by this Station have shown that results are somewhat unpredictable. However, once standardized concentrations, rates of application, times of application and varietal response are worked out, this method may materially reduce thinning costs, and prevent enough fruits from setting to increase the formation of fruit buds for the following year's crop. For those wishing to experiment with blossom thinning sprays for apples and peaches, sodium dinitrocresylate (20 per cent) is suggested at the rate of 1½ pints per 100 gallons. The spray should be applied just as the first petals start to fall and the tree should receive a drenching spray.

Bitter Pit of Apple

This disorder is found in all apple growing sections of the world. It is characterized by small brownish pits in the flesh of the fruit which usually occur in a shallow area just beneath the skin, and, in advanced stages, are evident from the exterior. Occasionally the pits extend deeply into the flesh. In the Okanagan Valley, bitter pit affects a number of varieties such as Cox Orange, Northern Spy and Newtown, but Newtown is the only one of these varieties which is extensively grown. The disorder seems to run in cycles. It was particularly prevalent in the years 1937 to 1940 and since that time has not caused serious losses. It may be just a coincidence that the disorder was most serious in the years immediately following the two severe winters of 1935-36 and 1936-37, which caused considerable tree injury in some orchards. On the other hand, slight freezing injury to the trees may have caused some physiological disturbance which resulted in appearance of bitter pit in the fruit.

No "cure" for bitter pit has been found. On the other hand, a number of facts have been learned about its occurrence which have been of assistance in minimizing losses. In the first place, trees in their heavy crop year seldom have bitter pit apples, whereas trees in their off-year, or young trees, seem particularly liable to produce pitted fruits. Moreover, not all pitted apples show up at time of picking, but rather develop symptoms of the disorder after as much as 8 weeks at 32°F. Accordingly, it is recommended that light and heavy-crop trees be harvested separately, and that the crop from light-crop trees be held in cold storage for 8 weeks so that all pit may make its appearance before the fruit is packed.

The relationship between size of crop and incidence of bitter pit is illustrated in Table 15.

TABLE 15—AMOUNT OF CROP AND BITTER PIT IN NORTHERN SPY APPLES OBTAINED FROM RICHARDS ORCHARD

Tree No.	Performance 1938		Performance 1939	
	Crop	Bitter Pit	Crop	Bitter Pit
		%		%
1	Light	33	Heavy	15
3	Light	31	Light	20
5	Light	41	Very heavy	1
6	Light	32	Very heavy	0
8	Light	35	Light	38
2	Heavy	8	Heavy	2
4	Heavy	8	Light	5
7	Heavy	10	Light	33
9	Heavy	6	Very heavy	0
10	Heavy	12	Light	2

It has also been found that early picking, expecially in Cox Orange, increases the incidence of bitter pit. Certain maturity standards have been developed, particularly for the Newtown variety which indicate the optimum picking maturity based on the disappearance of starch in the flesh of the apple. This test involves placing a cut half of several apples in a weak iodine solution. The iodine turns the starch blue, and by the intensity and extent of the blue area the stage of maturity of the apple may be gauged. A useful means of avoiding too early picking in Newtowns is to be certain never to pick this variety in less than 155 days from full bloom.

Black-end of Pears

This disorder which has been known for over twenty years is found in Bartlett, Anjou and to a lesser degree, in other varieties. In some areas of the Pacific Northwest, there are losses as high as 20 per cent from this disorder. In the Okanagan, losses are largely confined to the Bartlett variety, which, depending on the orchard and the season may run from 0 to 50 per cent.

The terms "black-end" and "hard-end" are used to describe two different forms of the same disease. *Black-end* fruits are characterized by a hard, brownish-black area at the calyx end of the fruit. The area of skin involved may vary from a visible spot of black to a patch of two square inches or more. Sometimes instead of a solid black area, a black speckling of the skin occurs. Furthermore, affected fruits frequently show a premature yellowing of the skin. *Hard-end* fruits show the same symptoms as black-end except that there is no blackening of the skin around the calyx.

FIG. 13—TESTING PEARS FOR MATURITY

Mechanical pressure testers are used to determine the stage of maturity at which pears are ready to pick. 1946.

Certain abnormalities in shape of fruit are characteristic of the disease. The fruits may have a flat shiny area surrounding a calyx with small constricted lobes. In other cases, the calyx has been described as a "sheep's-nose" effect. In the various degrees of the disorder the flesh in the calyx end of the fruit is hard and gritty. When ripened, some fruits are barely edible while in others the gritty portion is confined to the extreme calyx end.

Black-end in pears is generally believed to be associated with trees propagated on oriental rootstocks. In fact, United States investigators go so far as to say that this is almost the sole cause of the disorder. Be that as it may,

the severity of the injury varies greatly from year to year, from orchard to orchard and from tree to tree. A long range project is being conducted by this Station to study the extent of occurrence of the disorder from year to year in approximately 100 trees of Bartlett and Anjou situated in several growers' orchards.

Thus far it is apparent that no tree having black-end can be expected to make a complete recovery, although the seriousness of this disorder may vary markedly in individual trees from year to year. This is illustrated by data presented in Table 16. These data are from the Smuin orchard in Penticton where records have been kept over the past three years.

TABLE 16—SEASONAL FLUCTUATIONS IN SEVERITY OF BLACK-END IN BARTLETT PEARS, 1946-1948, AS RECORDED AT HARVEST

Tree No.	Black-end or Hard-end Fruits		
	1946	1947	1948
1	10	20	15
2	20	80	20
3	10	50	5
4	5	25	35
5	5	20	15
6	10	40	15
7	10	25	20
8	2	0	3
9	3	75	50
10	10	70	70

There is at least some evidence to indicate that black-end becomes less serious as orchard conditions and tree vigour improve. It is often possible to determine rapidly whether or not a tree has black-end by looking up the trunk and observing the pears in the inside of the tree. If no black-end pears are found in this area, the tree is usually free of the disease. On the other hand, on trees showing the disorder, the most seriously affected fruits are commonly found on the inside of the tree, and it is good policy, accordingly, to remove all such inside fruit at thinning time.

It has been found that with a little training, pickers can detect accurately most of the black-end fruits at harvest time. The grower should take pains to train his pickers to discard as many as possible of such fruits at harvest so as to avoid sending the fruit to the packing house and thereby running the risk of having black-end pears get into the pack. There is ample evidence from consumer reports that black-end fruits in a box of pears create definite buyer resistance. Similarly black-end fruits are unsuitable for canning.

Controlled Atmosphere Storage (Gas Storage)

Considerable interest has been shown from time to time in the Okanagan in reports dealing with gas storage of apples and other fruits. This work was first started in England and the problem has since received extensive investigation in many countries. In Britain, commercial gas storage of Bramley Seedling, the leading culinary variety, produced outstanding results, for the variety could be stored under 7 per cent carbon dioxide at 40°F., whereas at 32°F. severe core browning developed. Other varieties such as Cox Orange and McIntosh apparently respond favourably to this method of storage in some areas. However, the popular notion that most British apples are held under gas storage is erroneous, since recent authoritative information indicates that not more than two million bushels of apples out of a seventeen million crop are given this treatment.

The possibilities of controlled atmosphere storage for Okanagan apples and pears have received considerable thought and experimentation. McIntosh and Delicious were stored under various concentrations of carbon dioxide at 32° and 40°F. It was found, however, that the life of McIntosh was not greatly increased by the treatment, and a peculiar type of skin injury often occurred. With Delicious, storage under different concentrations of carbon dioxide accelerated softening and development of mealiness. A further extension of the experiment, involving storage of Delicious in atmospheres of very low oxygen content and no carbon dioxide resulted in somewhat superior keeping over ordinary air storage. Data indicating condition of Delicious apples seventeen days after removal from controlled atmosphere storage to air at 65°F. on March 6, 1941, are given in Table 17.

TABLE 17—CONDITION OF DELICIOUS APPLES 17 DAYS AFTER REMOVAL FROM CONTROLLED ATMOSPHERE STORAGE TO AIR AT 65°F. MARCH 6, 1941

Treatment No.	Treatment	Storage Temperature	Flavour	Mealiness	Firmness
		°F.			
1a	2·5% O_2	40	5	Excessive	9·9
1b	5·0% CO_2	40	5	Excessive	8·5
1c	92·5% N_2	32	5	Excessive	9·6
1d	.....	32	5	Excessive	9·2
2a	2·5% O_2	40	5	Excessive	9·1
2b	0·0% CO_2	40	6	Moderate	9·6
2c	97·5% N_2	32	7	Moderate	10·5
2d	.....	32	7	Moderate	9·9
3a	25·0% O_2	40	5 stale	Excessive	7·7
3b	5·0% CO_2	40	5 stale	Excessive	7·9
3c	70·0% N_2	32	5	Excessive	9·2
3d	.....	32	5	Excessive	8·6
4a	.....	40	3 stale	Excessive	8·7
4b	Air	40	3 stale	Excessive	8·7
4c	.....	32	4 stale	Excessive	8·8
4d	.....	32	4 stale	Excessive	8·8

Unfortunately the provision of low oxygen storage necessitates such expensive alteration of existing storages, and extra expense in management, as to make the change impractical. A semi-commercial gas storage trial with McIntosh and Delicious demonstrated so amply the difficulties involved in sealing storages for gas tightness as to discourage any commercial large-scale adoption of this procedure for apples.

With the increasing tonnages of Bartlett pears being used by the canning industry, and the limited period of 6 to 8 weeks during which this variety can safely be held in 30°-32°F. before canning, any means of prolonging the storage period is of some considerable importance. Experiments have been conducted for three seasons storing Bartletts in atmospheres of 7 per cent carbon dioxide at 32°F. During two of these years, canning tests have been conducted with fruit removed after different periods of carbon dioxide storage.

Whereas the normal safe storage period for Bartletts is only 8 weeks at 32°, pears of this variety have been removed from gas storage after as much as 22 weeks when they ripened with normal texture and flavour and made a satisfactory canned product.

Refrigerated carbon dioxide storage for Bartlett pears is the only application of controlled atmosphere storage which appears to offer any commercial possibilities in this area. Even then, it would mean that specially sealed pear storages would have to be built for the purpose. Carbon dioxide storage tests with apricots and peaches have given discouraging results.

McIntosh Harvesting and Storage Studies

McIntosh is the most important apple grown in the Okanagan Valley, with a production in some years of more than three million boxes. Being a fall apple which matures during the warm weather of late September, and ripens rapidly after picking, this variety presents unique problems in commercial handling.

In past years, owing to inadequate packing and storage facilities, and insufficient attention to rapid transportation of fruit from orchard to the packing house, McIntosh have sometimes remained out of storage for periods of 1 to 3 weeks in the orchard or packing house, at temperatures of 60°F. These periods of delay before entering cold storage, particularly in warm seasons, have resulted in fruit being packed in a ripe condition, and being unfit for long storage or shipment to distant markets. Fortunately, great strides have been made in the last two years under the guidance of the Better Fruit Committee of the British Columbia Fruit Growers' Association in speeding up the handling of this variety after picking. Moreover, handling facilities, grader and cold storage capacities have been significantly increased. As a result, the industry is in a better position today to handle the McIntosh crop than ever before.

However, there is still need for a great deal more information on best methods for handling and storing McIntosh. Packing houses have, for example, complained of the seriousness of bruising when McIntosh are packed after being held loose in cold storage. In order to provide information on this and other problems, commercial-scale packing and storage experiments have been conducted in regular packing houses during the past two seasons. Apples were packed immediately, after a delay of one week in the orchard, and after being held for 1 or 2 months in cold storage. The fruit was examined by officials representative of the industry. In both seasons the fruit packed immediately, or after a period of one month in cold storage, showed some superiority in condition over fruit delayed at orchard temperatures or held 2 and 3 months in cold storage before packing. There seemed, however, to be a marked improvement in the general keeping quality of all lots in 1948 as compared with 1947. This improvement may have been due to differences in orchards supplying the fruit or to differences in fruit quality inherent with the growing season. On the other hand, the poor keeping quality of the 1947 fruit may have been due to high autumn temperatures and overloading of storages which resulted in slow reduction of holding temperatures to 32°F., whereas in 1948 the fruit was reduced quickly to 32° and held steadily at that temperature.

Whatever the causes of differences in keeping quality of McIntosh apples may be, these experiments serve to demonstrate that laying down rules for handling of McIntosh is no simple matter. The influence of maturity, growing conditions and storage temperatures upon handling and keeping of McIntosh all require additional investigation, particularly into the physiological aspects involved. Until more is known, it appears advisable to harvest McIntosh when the seeds are brown and flesh is white, and to pack and place the fruit under refrigeration as rapidly as possible after picking, preferably within three days.

Fruit Storage Facilities

In 1941, a survey study of cold storage facilities in the irrigated fruit areas of British Columbia was made in co-operation with B.C. Tree Fruits Limited. At that time there were 33 cold storage plants with a packed box capacity of 2,669,000 boxes. Many of these plants were found to be deficient in refrigerating capacity. Following the survey, a letter was sent to each storage, suggesting needed improvements. These, in most cases, were carried out. However, the great expansion in refrigerating plants during the War and postwar years has resulted in a present total of 60 plants capable of warehousing over 6,500,000 boxes of apples.

The Summerland Experimental Station carried out another survey of storages in 1946 in order to keep abreast of developments and problems, and discovered that while most storages had installed adequate and well-balanced refrigerating machinery, the air duct systems used to circulate cold air throughout these plants had, in many cases, been faultily constructed and were the source of considerable worry and financial loss to operators. These losses have been caused by leakage of refrigerated air to the outdoors, excessive friction and turbulence from poorly built ducts, and both slow rates of cooling and freezing of fruit owing to improper location of ducts and air outlets from them. The need for research into duct design and air movement was explained to the Executive of the B.C. Fruit Growers' Association and this organization provided funds to pursue special work on this problem.

FIG. 14—INTERIOR VIEW OF A PALLETIZED STORAGE

These modern cold storage houses have 22-foot ceilings. The fruit is moved on pallets by lift trucks which stack the boxes eighteen high. 1948.

The air distribution systems of 44 storages have been studied, and a great wealth of data has been gathered from a wide variety of installations. Some plants had good systems. As a result of recommendations from this study, several plants have completely rebuilt their duct systems and in nearly all cases minor, but important changes have been made. The benefits achieved have usually been out of all proportion to the smallness of the cost entailed. The most important fundamental recommendations made to date are as follows:

1. The volume of air delivered should be approximately 1,100 cubic feet per minute per ton of refrigeration with air delivered at 28° and returned at 34°F.

2. Air ducts should be built with a minimum of turns, and where right-angled turns are necessary, these should be streamlined with vanes to reduce turbulence; in any event, the inside of the turn should be bevelled.

3. Ducts and duct orifices should be sized for delivery velocities not exceeding 1,500 feet per minute, preferably not more than 1,000 feet per minute.

4. A "well" type ductless return leading directly to the fan room involves cheap construction and gives good results.

5. Return openings should be approximately 10 to 20 per cent greater than supply openings to provide leeway when balancing up air movement.

6. Twin delivery duct systems with ducts located on the outer line of beams and discharging toward walls are preferred, together with a central "well" type return.

7. The total area of vent openings from ducts should be several times that of the supply opening into the duct. By fitting the vents with adjustable shutters, it is possible to produce a near uniform air delivery throughout the room, thus eliminating warm spots and freezing corners.

During the past two seasons, actual rates of cooling for packed apples have been recorded in a number of commercial storages. These storages are plants with capacities of between 75,000 and 300,000 boxes. Four of these houses are constructed for pallet truck operation and consist of a single room with a trussed ceiling 22 feet high instead of the conventional design of three 9-foot-high floors one above the other. In all cases, air duct design was fairly efficient, although storages G and I were lacking in refrigerating capacity.

Records were taken of supply air, return air and central aisle air temperatures. By the placing of thermocouple pyrometers in various locations in the storage rooms it was possible, after the apples had cooled to equilibrium, to establish the range in temperature between warmest and coolest fruit. These data are presented in Table 18.

TABLE 18.—RATE OF COOLING OF PACKED APPLES IN COMMERCIAL COLD STORAGES

Storage	Air Temperatures			Fruit Temperatures		
	Supply °F.	Return °F.	Center Aisle °F.	Highest °F.	Lowest °F.	Range °F.
A	29·5	33·5	34·0	36·0	33·0	3·0
B	25·5	32·0	31·5	33·5	30·5	2·0
C	28·0	34·0	34·5	35·0	33·0	2·0
D	29·0	34·5	35·0	36·0	34·0	2·0
E	30·0	35·0	34·5	36·0	33·0	3·0
F*	28·0	31·0	32·0	33·0	32·5	0·5
G	30·5	35·5	35·5	36·5	32·5	4·0
H	30·0	34·0	33·5	35·5	32·6	2·9
I*	28·5	34·3	34·3	37·0	33·5	3·5
J*	28·7	31·8	31·6	33·0	31·2	1·8
K*	27·0	31·5	32·0	32·9	31·5	1·4

* Palletized Storages.

From this table it may be noted that the range in temperature between supply and return varied between 3°F. and 6·5°F., but averaged well under 6°F. which is considered to be satisfactory where supply air temperature is 28° or slightly lower. Since the central aisle is usually in the return air path, central aisle temperature closely paralleled return air temperature.

Very considerable differences were encountered in fruit temperatures within individual storage rooms. They ranged between extremes of 2° and 4°F., usually about 2° to 3°F. The most uniform fruit temperatures within individual rooms were found in palletized storages. This result is not surprising since elimination of ceilings and greater ease of air movement between stacks of pallets produces more uniform circulation. Fruit temperatures at ceiling and floor levels in palletized plants did not show variations in excess of 1°F.

FRUIT AND VEGETABLE PROCESSING

F. E. Atkinson and C. C. Strachan

The Summerland Fruit and Vegetable Products Laboratory is organized to develop new processes for fruit and vegetable products; to devise improved processes for established products; and to assist commercial processors with their manufacturing problems. Through a co-operative arrangement with the Science and Marketing Services of the Department, chemical and bacteriological examination of commercial products before final grading is performed in the Laboratory. This makes it possible for the Laboratory to follow a product from its original development through its adaptation to commercial industry and keep in touch with the quality being produced.

Some of the more important problems investigated during the past twelve-year period are summarized in the following paragraphs:—

Improved Candying Process

Candied cherries, citron and zucca melon are used extensively in the bakery and soda fountain trades. Stated briefly, the candying process is a method of impregnating the tissue of the fruit with sugar syrup of sufficient concentration so that preservation of the fruit is effected. This requires a sugar concentration in the cell of the fruit of 70 to 75 per cent. In older methods of candying, the fruit after its pre-treatment was placed in dilute syrup, and each succeeding day syrups approximately 8 per cent stronger were placed on the fruit until a syrup of 75 per cent concentration did not weaken. The syrup was left to cool each day which permitted fermentation to take place. Furthermore the sudden increase of 8 per cent in the syrup had a tendency to plasmolyse the tissue, resulting in shrivelling of products with skins, such as cherries. Also, with this older process, either the syrup was concentrated by boiling in kettles which resulted in caramelization, or an expensive vacuum pan had to be installed. To overcome these difficulties, this Laboratory developed a process by which the fruit and syrup are kept hot at approximately 140°F. This effects two purposes; first, fermentation is prevented, and secondly, the temperature greatly increases the permeability of the membranes so that the sugar is absorbed quickly. In addition, a syrup evaporator was designed which is inexpensive to build and which continually concentrates the syrup in a tank. Besides improving the technique of candying fruit, these processes have materially reduced the cost of operation. They have been installed in several large-scale commercial plants.

The rate of inversion of sucrose syrup, and the rate of evaporation in a fruit candying dehydrator are given in Tables 19 and 20.

TABLE 19—INVERSION OF SUCROSE IN A FRUIT CANDYING DEHYDRATOR

pH Range of Syrup, 3·0 to 4·0*

Syrup Temperature, 115°F. to 155°F.**

Elapsed time	Syrup per cent sugar	Reducing sugar per cent of total sugar	Sucrose per cent of total sugar
days	%	%	%
1	23·36	4·23	95·77
2	30·38	15·24	84·76
3	36·08	25·86	74·14
4	43·91	31·93	68·07
5	50·11	38·89	61·13
6	57·09	40·70	59·30
7	64·97	46·88	53·12
8	69·96	49·96	50·04
9	75·90	52·41	47·49

* The syrups for the first 24 hours consisted of sucrose and water. After this time, 10 ounces of citric acid was added to each 250 pounds of fruit. As this process is continuous, the syrups would be of lower pH in later batches. The average pH should range between 3·0 and 3·3.

** The temperature of the syrup varies according to its concentration with a constant dry bulb temperature. With a dry bulb temperature of 170° to 180°F. and optimum drying conditions, syrups of 30° Balling will approximate 115°F. In 70 to 75° Balling Syrups, the temperature will rise to 155°F. The latter temperature if maintained for an extended period causes caramelization.

TABLE 20—RATE OF EVAPORATION IN A CANDYING DEHYDRATOR

Test number	Strength of syrup at time of testing	Evaporation per hour	Evaporation per square inch of surface per hour
	°B.	cc.	cc.
1	30·0	48·60	1·000
2	30·5	17·60	0·357
3	40·0	13·40	0·310
4	53·0	12·31	0·280
5	60·5	8·38	0·180
6	70·0	6·00	0·125
7	76·0	4·00	0·083

Introduction of Zucca Melon

The so-called zucca "melon" is actually a large gourd sometimes attaining a length of four feet and weighing as much as 130 pounds. The flesh of this gourd is very suitable for candying. Consequently, Vancouver manufacturers were importing the diced product preserved in salt brine from the Oroville district of California. In 1938, this Station obtained a few seeds and was successful in growing some melons to maturity. In 1939, a few were successfully grown in Osoyoos and throughout the War this industry expanded rapidly as the zucca flesh replaced imports of citrus peels, chiefly from Italy. The melons were grown mainly in Osoyoos, Summerland and Keremeos. This Laboratory worked out practical methods of preparation and preservation. The solution finally adopted for preserving this product contained 1 per cent sulphur dioxide and 6 pounds of calcium carbonate (whiting) per 100 Imperial gallons. The popularity of zucca melon has decreased since the War but there are indications that it will continue as a permanently established crop.

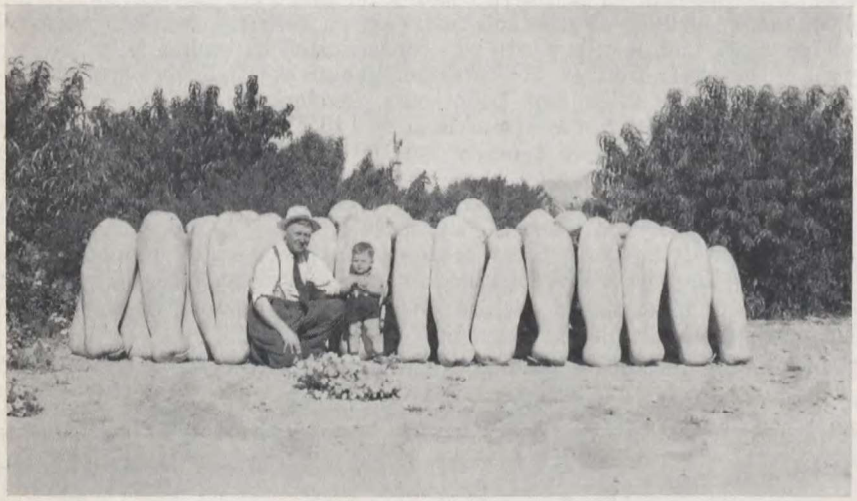


FIG. 15—ZUCCA MELONS HARVESTED FOR PROCESSING
The so-called "Zucca Melon" is actually a gourd and is grown to make candied products for use in the bakery trade. 1942.

Small Cannery Design

The last ten years have been characterized by a large increase in the number of small canneries. This Laboratory has provided details of equipment for these plants and the recommendation has been made that even if a manufacturer is operating only a single line, the plant should be sufficiently mechanized so that his costs are as low as his competitors'. It now appears that single-line plants are an economic unit to operate. With these small plants, overhead and costs of manufacture can be kept low. A bulletin dealing with the layout and equipment for smaller canneries has been published. Line drawings of the floor plan of a No. 1 size small cannery and of a No. 3 size, together with an elevation of the latter, are shown in Figures 16, 17, and 18.

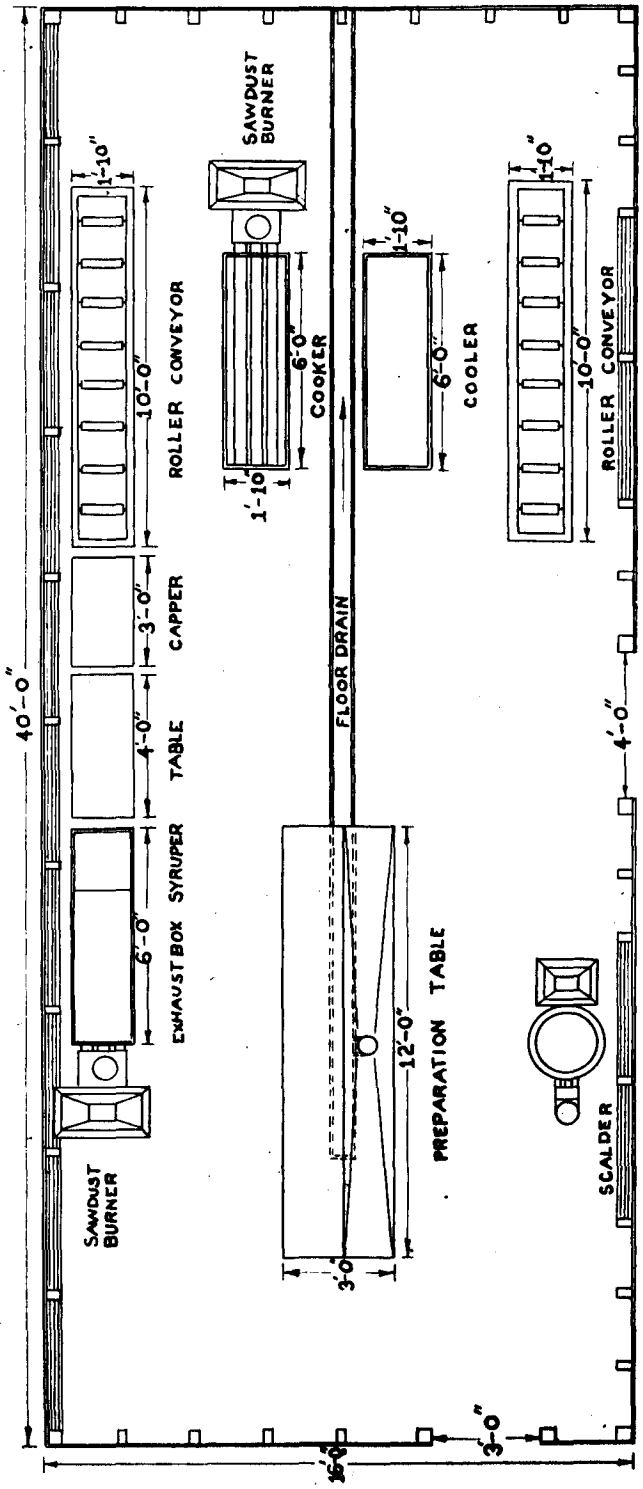


FIG. 16—FLOOR PLAN OF No. 1 CANNERY

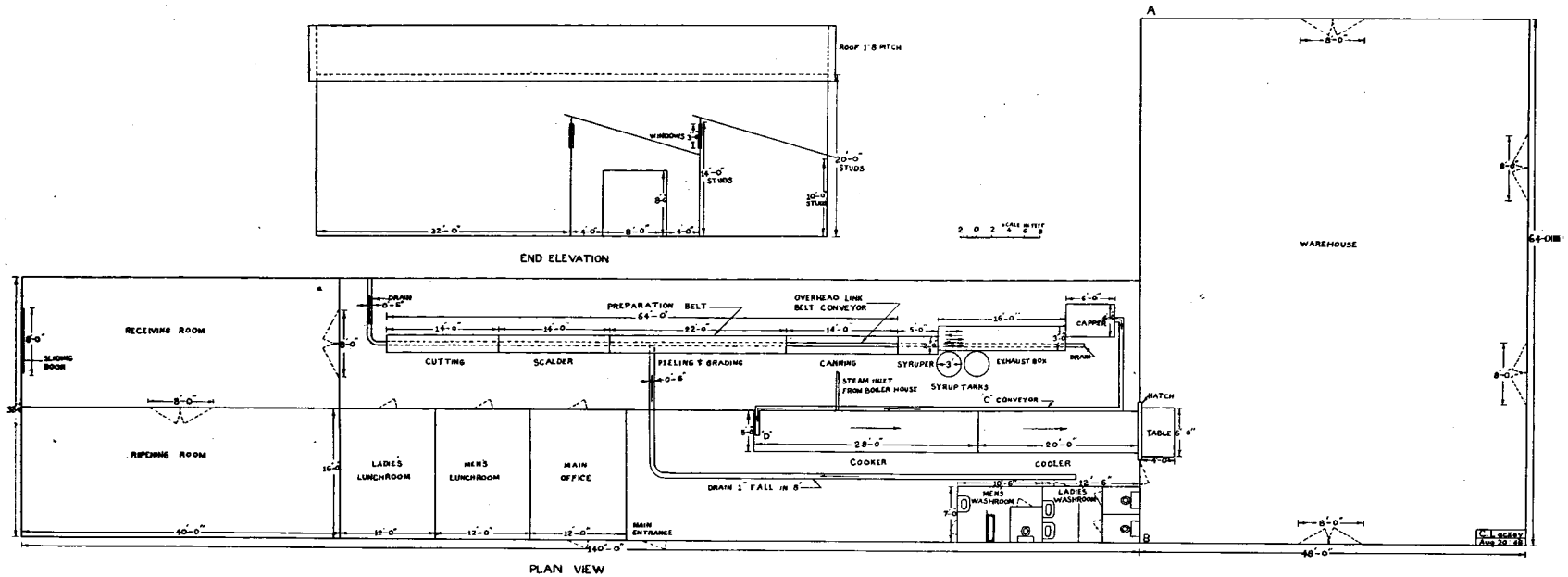


Fig. 17—FLOOR PLAN AND ELEVATION OF No. 3 CANNERY.

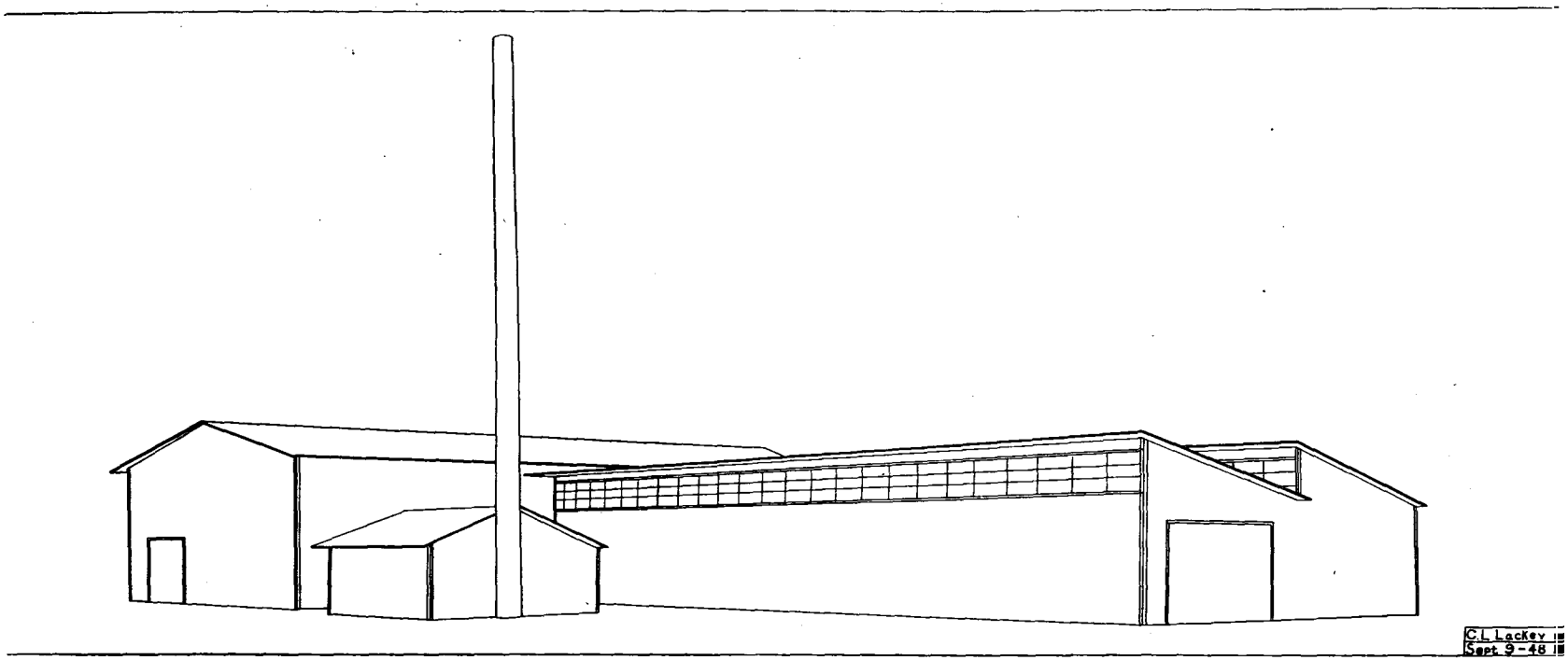


FIG. 18—PERSPECTIVE OF No. 3 CANNERY

Shows warehouse, boiler house, and sawtooth roof over cannery lines.

Storage of Fruits for Canning

Cold storage of fruits is very important to canneries as it enables them to purchase fruit while it is in the peak of supply and deliver it to the processing lines in an even flow. Experiments have been conducted to determine the temperature and length of storage which are most desirable for the various tree fruits. Apricots, peaches and prunes held at 31 to 32°F. for three weeks have made a satisfactory canned product. Bartlett pears picked at the proper maturity and stored within 24 hours at a temperature of 30 to 31°F. have been held in good condition for 60 days but commercial storage should not be relied upon after 45 days. Peaches should be ripened at 70 to 75°F. until almost ready for canning before being placed in storage at 31 to 32°F. This overcomes difficulty in removing the skin and pit, and gives a better flavour.

Syrup Equalization Rates

A comprehensive study has been made of the rate at which the sugar of syrup in canned fruits equalizes with the cell contents of the fruit. This work has practical application both to the cannery inspector and to the factory operator. From the standpoint of the cannery inspector, he is provided with tables from this work showing what the cutout or syrup strength should be in the can at various periods after canning and when he can expect it to be stabilized. After it is stabilized then he can determine the net drained weight of the contents. For the factory operator, he can refer to the tables and determine what strength a syrup on a fruit should be 24 hours after canning if the correct strength of syrup has been applied. Thus he can check on the efficiency of his factory operation. Pertinent data dealing with this project are given in Tables 21 and 22.

TABLE 21—STANDARDIZATION DATA

Fruit	Canned Foods Act requirements, Can size 307 x 409			Final equalization of fruit and syrup			Wt. of ingoing fruit required to meet minimum regulations
				Syrup cutout		Av. loss in wt. of fruit	
	Min. net weight	Min. drained weight	Syrup	Usual range	Extreme range		
	oz.	oz.	%	%	%	%	oz.
Apricots	21	11	45	25–27	23–28	.....	.....
Blenheim and Royal	.....	.....	.....	25·5–27·2	.....	9	12·1
Tilton	.....	.....	.....	26·5–27·0	.....	3–4	11·5
W. Moorpark	.....	.....	.....	25·1–27·4	.....	8·7	12·0
*Cherries**	21	11	30	22–24	21–26	.....	.....
Bing	.....	.....	.....	.....	.....	5–6	11·7
Lambert	.....	.....	.....	.....	.....	7	11·8
Royal Ann	.....	.....	.....	.....	.....	6	11·7
Peaches	20	12	45	24–26	22–28	.....	.....
Elberta	.....	.....	.....	24·5–25·7	.....	7–8	13·0
Hale	.....	.....	.....	24·0–25·5	.....	10	13·4
Rochester	.....	.....	.....	21·0–22·5	.....	.....	.....
"V" varieties	.....	.....	.....	24–26	.....	4–5	12·6
Pears							
Bartlett	20	12	35	20–22	18–24	1–2	12·25
Prunes (Italian)	20	11	30	.....	20–26	.....	.....
Blue (17% T.S.S. or more)**	.....	.....	.....	24–25	23–26	11	12·4
Red (Less than 17%)	.....	.....	.....	21–23	20–24	11	12·4

* Limited number of samples on cherries, hence data not complete.

** T.S.S.—Total soluble solids by refractometer.

TABLE 22—RATE OF EQUALIZATION AND ESTIMATION OF FINAL SYRUP CUTOUT

Fruit	Days to equalize at 68°F.	Approximate correction to be subtracted from cutout readings according to when examined after canning.		
		Immediate	24 hours	48 hours
	days			
Apricots	10 to 14	9·0	2·5	1·0
Cherries	10 to 14*	3·5	0·8	Usually nil
Peaches	14	8·6	3·0	1·5
Pears	14*	4·0	0·7	Practically Nil
Prunes (Italian)—				
Blue maturity	7*	3·0	1·7	0·8
Red maturity	7	4·0	2·5	1·0

* Cherries, pears and prunes may equalize almost completely in 3 or 4 days with only very slight change in drained weight thereafter.

Canned Apple Juice

During the past twelve years, canned apple juice has made its debut as a Canadian product. This is by no means a new product as apple juice was canned in Michigan at the beginning of the century. Later, packs were put up at Hood River and Ashland, Oregon. However, in these earlier packs there were several difficulties. The juice was not properly clarified and deposited a very undesirable sludge, the cans were not resistant to malic acid, and spoilage through can failure was frequent. Then again, the method of sterilzation involved a long heat treatment with the result that the canned product had a cooked, caramel flavour. The solutions to those problems came from several sources. A can company developed a cold rolled steel for the basic material in its containers which proved to be resistant to the attacks of fruit acid and so provided a satisfactory container for apple juice. Enzymes for clarification were developed in Great Britain and in the United States, and the clarifying process using tannin and gelatin which has been standard in the cider and wine industries of Europe for years, was also adapted for use with apple juice. Finally, flash heating and pasteurizing of juice which had been developed in Germany and experimented with in the United States on citrus juices, was tried here.

With the above factors as a foundation, this Laboratory developed a satisfactory process for canning clarified apple juice. The groups which now constitute the B.C. Fruit Processors Ltd. were sufficiently progressive to give the process a trial. It is interesting to note that these individual companies were small and inexperienced in the canning field but they had the initiative and the optimism which are so important in establishing new industries.

Within a year, Louis Deighton, a grower-canner of Oliver; Clifford Fallow, manager of the Woodsdale branch of the Vernon Fruit Union; and Paul Walrod, then production manager of Modern Foods Ltd.; all put up small trial packs. These concerns had very little equipment or capital. Consequently this Laboratory was called on to do a great deal of improvisation in order to ensure manufacture of a high quality product as inexpensively as possible.

Statistics make dry reading, but the progress that has been made since the inception of this industry makes interesting reading. The three original producers have been merged by the formation of B.C. Fruit Processors Ltd., a grower-owned company controlled by the B.C. Fruit Growers Association. This Company's assets approximate $500,000 and the pack of juice in 1948 was valued between $800,000 and $1,000,000. Apple juice has become the main by-product manufactured from the lower grades of the apple crop. Approximately 20,000 tons went into processing in 1948.

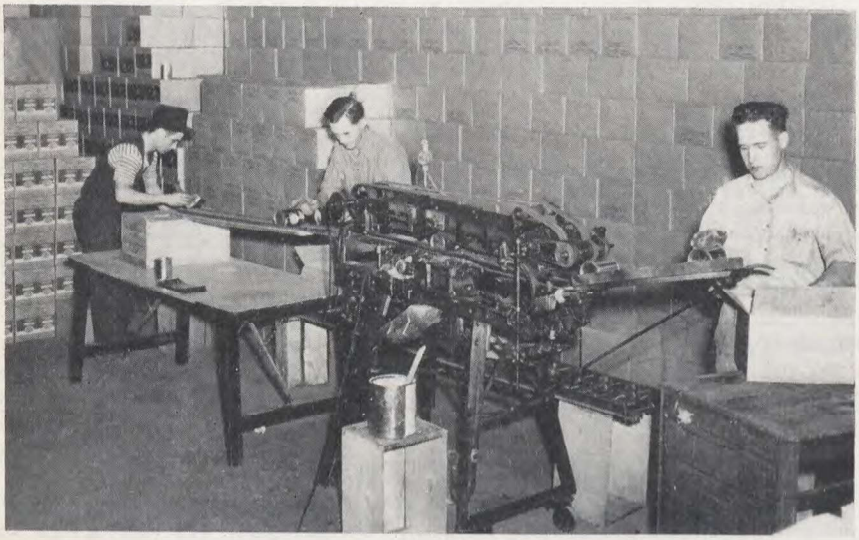


FIG. 19—LABELLING IN A SMALL CANNERY

Several very efficient and well equipped small canneries are now operating in the Okanagan Valley. 1946.

The most recent development is the production of natural or "opalescent" apple juice. Dr. Carl Pederson of the New York Agricultural Experiment Station and Paul Walrod, general manager of B.C. Fruit Processors Ltd., both had the idea that the addition of ascorbic acid to apples being ground for manufacture into juice, would prevent the oxidation that destroys the natural apple flavour. From experiments conducted in the Summerland Laboratory, a suitable commercial process for making natural apple juice was devised. To design equipment of sufficient size to handle about 6 tons of apples per hour, a conference was held between F. E. Atkinson representing the Laboratory, Paul Walrod representing B.C. Fruit Processors Ltd., and Alec Ellett of the Ellett Copper and Brass Co. Ltd., Vancouver, fabricators of stainless steel equipment for juice manufacture. The final outcome of this combined effort was the installation in the former Okanagan Fruit Juices Ltd. plant in Kelowna, of equipment for the manufacture of natural apple juice, and the production of 130,000 cases in 1948. In 1949, this company increased its capacity to 8 tons of apples per hour.

Data concerning the loss of ascorbic acid in proportion to oxygen present in the juice, are given in Table 23.

TABLE 23—THE ASCORBIC ACID CONTENT OF APPLE JUICE BLENDED IN VARYING ATMOSPHERES OF AIR AND NITROGEN AT 99°F. (37°C.)

Lot	Ascorbic acid content of juice (mg./100 g.)		Loss of ascorbic acid		Atmosphere	Oxygen in blending atmosphere	Ratio of ascorbic acid loss (mg.) to oxygen (ml.) in blending atmosphere
	Original	After 30 min.	mg./100 g.	%			
	mg.	mg.				ml.	
1	48·6	38·9	9·7	20	Air	94·5	1 : 9·7
2	50·0	49·3	0·7	1	N_2	Natural O_2 content	
3	50·0	47·9	2·1	4	25% air 75% N_2	23·6	1 : 11·3
4	49·3	44·5	4·8	10	50% air 50% N_2	47·2	1 : 9·8
5	51·0	44·7	6·3	12	75% air 25% N_2	70·8	1 : 11·2

Fruit Juice Concentrator

Concentration of apple juice is a desirable process in an apple products manufacturing plant, as it provides for the utilization of juice from peelings and cores that usually cannot be used in any other way except in vinegar. This concentrate can be used in the manufacture of apple jelly or for fortifying tanks of cider which are to be fermented for vinegar manufacture. In this way a much higher acetic acid content can be made than when the manufacturer is dependent on the natural sugar content of the apple juice. In the past, evaporators of many designs have been used. Those working at atmospheric pressure have resulted in a caramelized juice while those utilizing a high vacuum are very expensive. In an endeavour to devise an efficient and comparatively cheap evaporator, a stainless steel tube 1 inch in diameter and 20 feet long was placed in a vertical position and surrounded with a 6-inch pipe which provided a steam jacket. Apple juice was introduced at the bottom and steam pressures in the jacket of 75 to 115 pounds were used to boil this juice. Because of the high steam pressure and the relatively small amount of juice being added, a violent boil took place in which the juice continually rose up the tube and eventually passed from the top of the tube through a header to a separator. By this time the juice was concentrated to over 70 per cent total soluble solids and was in the form of fine droplets which were gathered in the separator while the water phase passed off as vapour from the top of the separator. This operation was completed in 45 seconds and the resulting product was not caramelized. This process has been modified and adapted by the B.C. Fruit Processors Limited where a plant handling about 5,000 gallons of apple juice per 24-hour day has been installed.

Ascorbic Acid in Tomato Juice

Tomatoes are a rich source of ascorbic acid (vitamin C). However, this nutritional factor can be quickly destroyed through oxidation. Actual analysis of some commercial juices revealed that they did not contain any ascorbic acid. Because of this situation, it was thought wise to conduct a survey to ascertain the ascorbic acid content of commercial juices. In addition, juice was made under controlled conditions to determine the percentage of vitamin C that could be retained with proper manufacturing. It was found that under both Laboratory and commercial conditions the loss of ascorbic acid can be limited to 3 mg. or less per 100 grams if the proper precautions are taken. These include milling the tomatoes and immediately heating to 190°F. which will inactivate oxidative enzymes, extracting the juice, preheating again to 190°, filling the cans, capping, cooking 10 minutes for 20-ounce cans, and cooling.

A high percentage of the ascorbic acid can be retained if the juice is extracted cold and immediately pasteurized to temperatures in the neighbourhood of 190°F. However, if an appreciable headspace is left in the can, the oxygen in the headspace causes a significant loss of ascorbic acid especially if lacquered cans are employed.

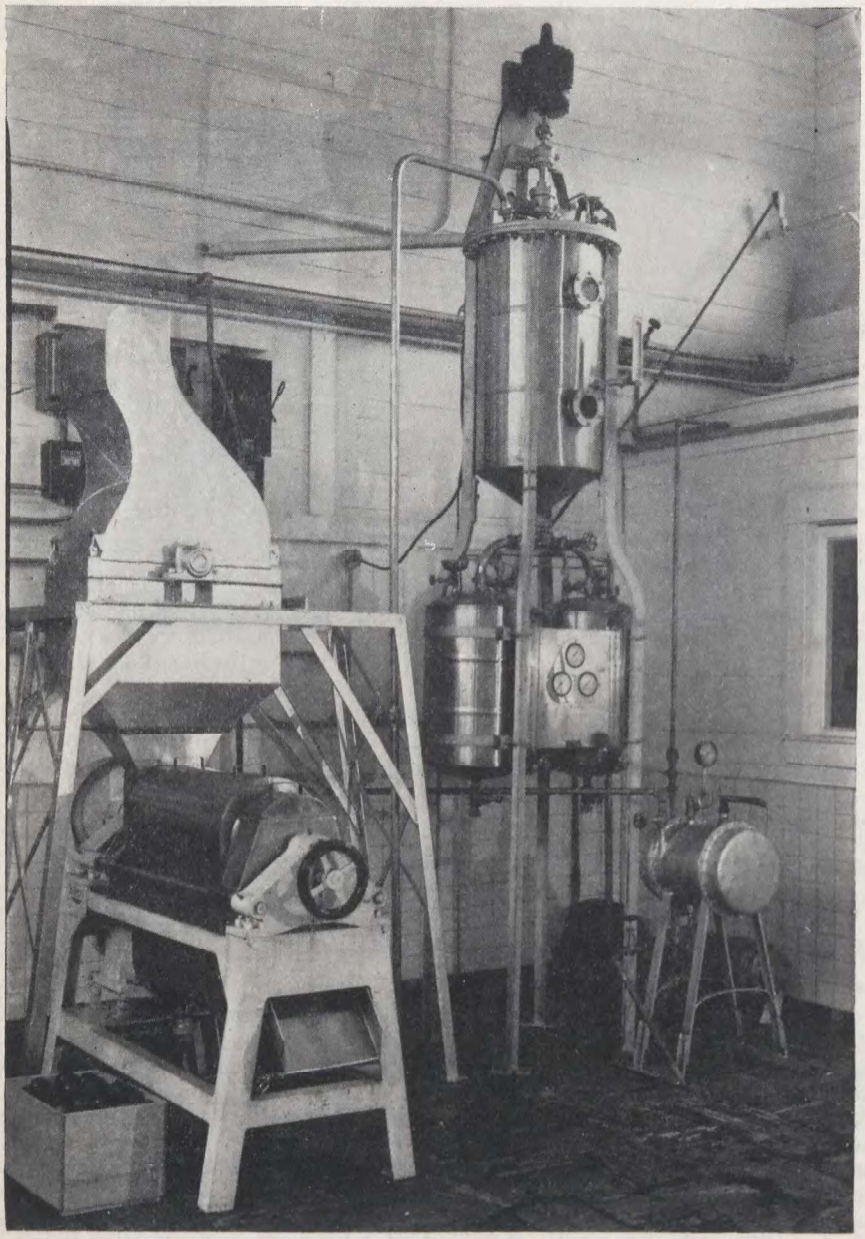


FIG. 20—EQUIPMENT USED IN THE DEVELOPMENT OF NATURAL APPLE JUICE

Apple juice of high quality is now produced in large volume by processors in British Columbia.

Surveys of all British Columbia factories manufacturing tomato juice have been conducted over several years, and the recommendations of this Laboratory have been followed, with the result that it is now possible for British Columbia manufacturers of tomato juice to meet a very high requirement for ascorbic acid content.

Data concerning the survey of tomatoes and tomato juice canned in Quebec, Ontario and British Columbia are given in Table 24.

Loss of ascorbic acid in commercial manufacture of tomato juice is shown in Table 25.

TABLE 24—ASCORBIC ACID CONTENT OF COMMERCIALLY CANNED TOMATO JUICE AND TOMATOES IN CANADA

Year packed	Area	Number of samples analysed	Ascorbic acid values per 100 ml. of juice		
			Average	Maximum	Minimum
			mg.	mg.	mg.
Juice					
1941	British Columbia	18	22·3	33·3	12·6
1942	Eastern Canada	12	14·4	19·5	8·7
1944	Quebec	44	14·2	26·0	6·1
	Ontario	220	15·1	25·0	4·3
	British Columbia	54	19·8	26·9	15·6
1947	Quebec*	80	13·0	15·6	9·8
	Ontario*	556	15·9	21·5	8·6
	British Columbia	170	18·2	28·8	13·8
			Per 100 grams of tomatoes		
Tomatoes					
1940–41	British Columbia	39	21·6	32·4	14·4
1944	Quebec	5	15·9	18·9	14·1
	Ontario	30	17·2	20·3	15·1
	British Columbia	53	22·5	27·7	16·3

* Figures of Chemistry Division, Science Service, Ottawa.

TABLE 25—RETENTION OF ASCORBIC ACID AT PROGRESSIVE STEPS IN COMMERCIAL PROCESSING OF TOMATO JUICE

Test No.	Steps in Processing	Ascorbic acid per 100 g.
	Factory C (1944)	mg.
A-1	Raw tomatoes	25·0
2	Emerging from hot break at 200°F	22·2
3	In finisher receiving tank at 188–190°F	20·7
4	Holding-salting tank (100 gals.) at 183°F	19·4
5	After filler prior to sealing can at 182°F	19·3
6	After canned juice stored three weeks	19·2
B-1	Raw tomatoes	20·8
2	Emerging from hot break at 200°F	19·6
3	In finisher receiving tank at 188–190°F	19·2
4	Holding-salting tank (100 gal.) at 183°F	17·2
5	After canned juice stored three weeks	17·3

Stone Fruit and Berry Juices

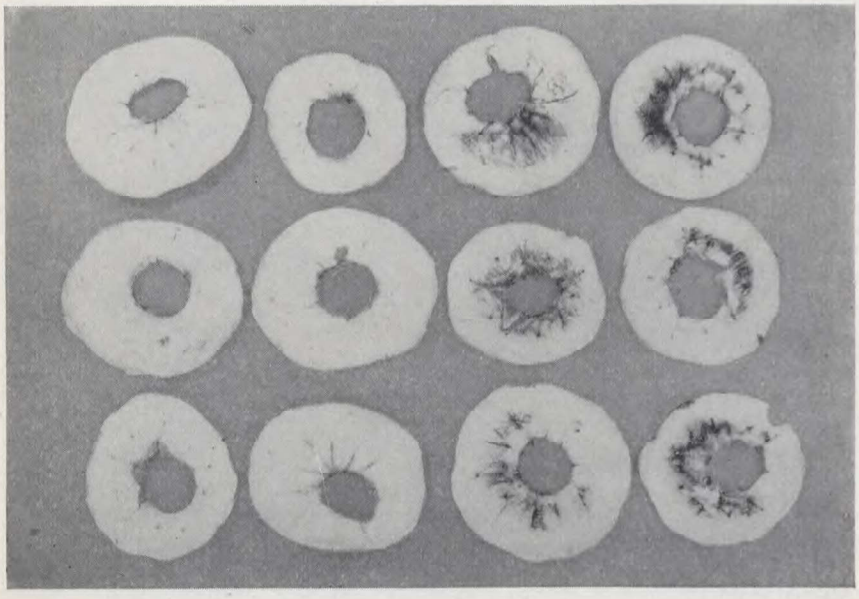
Fruit juices are very desirable products from the standpoint of consumer acceptance. In British Columbia, the two juices manufactured in largest quantity are apple and tomato. These are both made from relatively low-priced raw materials. While stone fruits and berries usually command higher prices, economic conditions may change so that it would become advisable to

manufacture juices from them. With this possibility in view, methods have been devised for making acceptable products from peach, apricot, Italian prune, black currant, raspberry and loganberry, and blends of raspberry and black currant with apple.

The results secured from this work indicate that the pulpy juices obtained in the manufacture of apricot, peach and prune may be diluted to produce juices with suspended solids. They may be used also as purees. These purees can be thickened, sweetened and used for making several other products such as frozen desserts, toppings for desserts, flavouring for ice cream and so forth. They must be made from mature fruit free from rot or other disqualifications that would detract from the flavour and colour of the product.

Preservation of Colour in Dehydrated Apples

Dehydrated or evaporated apples of a few years ago often turned to various shades of brown before they were consumed. In order to obtain a wider acceptance of this product by the consumer, it was necessary to preserve the creamy white colour characteristic of this product when first dehydrated. Sulphur dioxide was used as an agent to prevent browning during the preparation of the fruit for dehydration. Experiments proved, however, that 90 per cent of this sulphur dioxide was lost during the dehydration process and consequently if the fruit was to be kept a creamy white colour during the period between dehydration and consumption, it was necessary to add the sulphur dioxide after the dehydration process and before packing. Experiments were conducted to determine the minimum amount that would keep the apples of a desirable colour for several months. This amount was finally determined to be in the neighbourhood of 770 p.p.m. As a result of this work, the Meat and Canned Foods Act was amended, requiring a minimum concentration upon packing of 700 p.p.m. in dehydrated apples, and considerable improvement has taken place in the colour of this product now on the market. Effects of sulphuring in the slice and sulphuring whole are shown in Figure 21.



A B

FIG. 21—THOROUGH SULPHURING OF APPLES PRESERVES THE WHITE COLOUR

A. Apples sulphured in the slice.

B. Apples sulphured whole. The dark ring is due to lack of sulphur.

Preservation of Fruits with Sulphur Dioxide for Jam

This process originated in Spain or Holland and was introduced to British Columbia from the United Kingdom. Sulphur dioxide is one of the more desirable preserving compounds as it is a gas and if a food is to be heated to boiling in its manufacture then most of the sulphur dioxide will pass into the air as a gas. Before the War, large tonnages of British Columbia berries were preserved in sulphur dioxide and sold to the United Kingdom market. However, there was a lack of standardization and this Laboratory was called upon to help with the standardizing of this process. The delicate flavour of raspberries, loganberries and strawberries is somewhat destroyed by sulphur dioxide. Consequently, the jams made from these fruits are inferior to those made from fresh or frozen fruit. However, the flavour of jam made from peaches, apricots or prunes preserved with sulphur dioxide is quite satisfactory. If British Columbia is to cultivate a market in the United States for berry products due to the loss of a market in the United Kingdom, then it will be necessary to turn to another preservative method, namely, freezing, in order to enter this market where sulphur dioxide preserved fruits are not used for jam.

Quantities of various sources of calcium required per barrel of berries are given in Table 26.

TABLE 26—COMPARATIVE QUANTITIES OF CALCIUM SULPHITE, WHITING, HYDRATED LIME, AND CALCIUM OXIDE REQUIRED FOR STRAWBERRIES OF VARIOUS MATURITIES PER BARREL OF 350 POUNDS OF FRUIT

Calcium sulphite 25·5% Ca	Whiting* (calcium carbonate) 40% Ca	Hydrated* lime (calcium hydroxide) 54% Ca	Calcium* oxide 71·4% Ca	Maturity
oz.	oz.	oz.	oz.	
4	2·5**	2·0**	1·5**	All green.
5	3·25	2·25	1·75	Green with only red spots.
6	3·75	2·75	2·0	Red with green tips or shoulders.
7	4·5	3·25	2·5	Ripe, red, but not soft.
8	5·0	3·75	2·75	Fully ripe.
.....	6·0	4·5	.....	Ripe fruit in bruised condition.

* For all quantities of whiting, hydrated lime, and calcium oxide listed here, 26 pounds of 3% sulphurous acid would be used. Water would be added to make a total weight of water and acid of from 26 to 33 pounds, in any of the formulae used. This variation is dependent on the season and quality of the berries.

** For practical use, the fractions have been changed to the nearest quarter.

Freezing of Fruits and Vegetables

Freezing experiments with fruits and vegetables have been conducted to determine the varieties best suited to freezing and the best method of preserving the natural flavour of the fresh product. With peaches it has been found necessary to use anti-oxidants to prevent browning. Ascorbic acid at the rate of 150 to 200 mg. per 1 pound of fruit and syrup was found most suitable for this purpose.

With vegetables, frozen pack studies have dealt mainly with the relation of size of pieces of the prepared product and length of blanch, to the inactivation of enzymes and retention of ascorbic acid. Sources of bacterial infection in commercial factories also have been studied and recommendations made for control. The nature of the freezing process is such that the costs are higher than for canned foods. Consequently it is important that the highest quality be packed. The foregoing factors all contribute to the production of a quality product.

The relationship of size of piece of product to blanching time is given in Table 27.

TABLE 27—BLANCHING TIMES FOR VEGETABLES FOR FREEZING

Vegetable	Blanching time
	min.
Asparagus—	
Small (5/16 in. diameter or less at butt)	2
Medium (6/16 to 9/16 in. dia. at butt)	3
Large (10/16 in. dia. and larger at butt)	4
Beans, Green and Wax—	
Small (Less than 18½/64 in. dia. or Sieve No. 2 and smaller)	1–1½
Medium (18½/64 to 24/64 in. dia. or No. 3 and 4)	2–3
Large (24/64 in. dia. and larger or No. 5 and larger)	3–4
Beets—	
Small, whole (1¼ in. dia. or less)	3–5
Diced (1¼ to 2¼ in. dia.)	3
Cook in boiling water 2 min., peel, dice and blanch *or* cook through, then dice.	
Broccoli. Cut into pieces not more than 1 in. thick	2–3
Cabbage. (Summer) Chop coarsely	1–1½
Cauliflower. Break into flowerettes or curds not over 2 in. in length by 1½ in. dia.	3
Corn. (Cut or whole kernel) Blanch on cob, cool, then cut	2–3
Corn-on-cob—	
Small (Less than 1-5/8 in. dia. at butt)	7
Medium (1-5/8 to 2 in. dia. at butt)	9
Large (Over 2 in. dia. at butt)	11
Peas	1–1½
Spinach	1½
Swiss Chard	2

NOTE:—The blanching times given in this table will result in negative to trace peroxidase activity if carried out in boiling water (210-212°F.) or in steam at 208°F. under proper conditions. With steam blanching it is important that the temperature does not fall below 204°F. and that the trays or belt used for blanching are uniformly loaded with raw material at the rate of ¾ to 1½ pounds per square foot depending on the product and results of the enzyme tests. There must be ample supply of boiling water or steam. Steam blanching is more exacting in its control, and may even take from ½ to 1 minute longer blanching time than water, for the same product. Nevertheless, for most products steam blanching has certain advantages and when properly done is generally to be preferred to water blanching.

Following blanching, the product should be immediately cooled by dipping or spraying with cold water. The temperature of the blanched material must be reduced quickly to as low a point as possible. A temperature in the neighbourhood of 40°F. is desirable before packaging. For best retention of quality and high nutritive value, freezing should follow immediately.

Nutritive Value of Fruits

In co-operation with the B.C. Fruit Growers Association, an extensive project involving the chemical analysis of tree fruits shipped from the Okanagan has been carried on for four years. The samples were commercially-packed lots of the various fruits picked up at the packing houses throughout the Okanagan Valley. Thus, the nutritional value of fruits as regularly supplied to the consumer has been determined. After checking the amount of waste involved in skins, pits, stems, cores, etc., the following chemical constituents were determined: total solids, water insoluble solids, soluble solids (refractometer), acid, pH, sugars, ash, alkalinity of ash, pectin, tannin, ascorbic acid and carotene (vitamin A).

Some of the outstanding findings concerning the nutritive value of British Columbia tree fruits are summarized in the following paragraphs.

Sweet cherries have a high sugar content and are one of the best sources of minerals found in tree fruits. They have a slightly higher acid content on the average than winter apples but are significantly lower in this constituent than apricots or prunes and contain slightly less than peaches. Sweet cherries taste sweet because of their relatively high sugar content in relation to acid content. With regard to ascorbic acid content, Lambert and the new variety, Van, were outstanding, giving values greater than those reported in the literature for sweet cherries. These varieties appear to be good sources of ascorbic acid. The vitamin C content of the Bing, Royal Ann and Deacon varieties was equal or greater than that reported for these varieties grown elsewhere. However, they can be considered as only poor to fair sources of this vitamin.

Apricots supply a fair amount of sugar and have a high mineral content with a high potential alkalizing value. Apricots were found to be the richest source of pectin of all the fruits analysed in this study and may be termed an excellent source of this constituent. This is advantageous from a dietetic viewpoint. The ascorbic acid values of British Columbia grown apricots were very similar to values found in the United States. Apricots are only a fair source of vitamin C, but were found to have a high content of provitamin A, a few ounces supplying one's daily requirement of Vitamin A.

Peaches contain a fairly good amount of sugar and have only a slightly lower ash content than apricots and cherries. Peaches were found to be very good in pectin content. They are only a fair source of ascorbic acid, being about equal to apricots.

Italian prunes supply a good amount of sugar and are an excellent source of pectin, being practically equal to apricots in this regard. Mineral content of prunes is good but they contain little ascorbic acid.

Apples were found to be a good source of sugar. They contain a fairly good supply of pectin. While apples have a good alkalizing value and are a source of essential minerals, they are not so rich in these respects as most of the stone fruits. Summer and early fall apples differ from winter varieties in being lower in sugar and markedly higher in acid.

It is unfortunate, but true, that the commercial varieties of high vitamin C content such as Wagener are of lesser market value than the popular market varieties, McIntosh and Delicious. However, a new red apple variety, Jubilee, developed by the Summerland Experimental Station has a consistently good ascorbic acid content as well as fine market characteristics. It keeps well even in common storage. It is a winter apple of good flavour and quality with a marketable storage life at 32°F. to March. The ascorbic acid content of this variety is well retained in storage. As a source of Vitamin C, Jubilee is five or more times as good as McIntosh, and at least twice as rich as Delicious or Stayman.

Pears are very similar to apples in composition except that they are somewhat lower in sugar and very low in acid. The outstandingly low acid content of pears, which is only equalled by the Delicious variety of apples, might make this fruit desirable in the diet of people who suffer from hyperacidity. Pears contain a fairly large amount of pectin. They are low in ascorbic acid content.

Besides the definite food values which can be accurately measured, fruits provide important esthetic characteristics such as palatability, variety of flavour and colour, aroma and eye appeal, which are of great importance in nutrition. These factors are difficult to evaluate but most certainly contribute materially to the pleasure of eating and the effective assimilation of food.

Average values for several constituents found in British Columbia tree fruits, are given in Table 28.

TABLE 28—COMPOSITION AND NUTRITIVE VALUE OF PRINCIPAL COMMERCIAL VARIETIES OF BRITISH COLUMBIA TREE FRUITS[1]

(All data refer to fresh, raw, edible portion. Constituents are given in per cent by weight; in International Units (I.U.) in the case of vitamin A value; and in milligrams (mg.) per 100 grams (3½ ounces) in the case of ascorbic acid (vitamin C).)

Kind of fruit	Total refuse	Total solids	Soluble[2] solids	Water insoluble solids	pH	Total[3] acid	Sugar as invert			Ash	Alkalinity[4] of ash	Tannin	Pectin as calcium pectate	Vitamin A value	Ascorbic acid
							Total	Reducing	Sucrose						
	%	%	%	%		%	%	%	%	%		%	%	I.U.	mg.
Apples—															
Summer and Early Fall Varieties	29·6	13·72	11·7	1·55	3·01	1·15	9·21	8·06[5]	1·72[5]	0·20[5]	24[5]	0·035[6]	0·66	.....	.....
Late Fall and Winter Varieties	25·1	15·17	13·7	1·35	3·51	0·48	11·82	8·39	3·38	0·22	32	0·027	0·57	74	6·9
Apricots—All Varieties	8·1	13·27	11·7	1·59	3·86	1·36	7·41	1·87	5·60	0·64	89	0·042	0·98	3228	8·8
Cherries—All Varieties	11·0	21·64	21·2	1·33	3·99	0·69	13·60	13·03	0·10	0·58	79	0·141	0·24	103	9·4
Peaches—All Varieties	13·0	13·11	12·1	1·16	3·65	0·81	8·96	2·45	6·35	0·43	62	0·053	0·74	1313	6·6
Pears—All Varieties	21·5	16·08	13·6	2·08	3·93	0·32	9·53	7·89	1·84	0·28	41	0·025	0·59	20	3·9
Plums—All Varieties	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	350	2·4
Prunes—Italian or Fellenberg Variety	5·8	17·68	15·9	1·15	3·43	1·24	10·47	4·65	5·39	0·45	61	0·122	0·93	1263	2·8

[1] This is a highly condensed table from data presented in bulletin, "Chemical Composition and Nutritive Value of British Columbia Tree Fruits", in press.

[2] By refractometer.

[3] Calculated as predominant acid which is malic in all cases except pears. Latter calculated as anhydrous citric acid.

[4] Milliliters of 0·1 Normal acid required to neutralize the ash from 100 grams of fresh material.

[5] Results of limited analyses of Wealthy variety only.

[6] Data from limited analyses of Wealthy and Duchess varieties.

VEGETABLE CROPS

C. A. Hornby

The production of vegetable seeds, cannery and fresh market crops in the southern interior of British Columbia developed rapidly over the past twelve years. The projects conducted at this Station in connection with these crops were directed for many years by the late W. M. Fleming. The death of this experienced officer in 1945, and the fact that his assistant was absent for several years on war service and postgraduate work, interfered seriously with vegetable investigations. In spite of these happenings, the vegetable crops work has progressed steadily along the lines of foundation seed production, variety testing, irrigation and nutrition experiments.

Foundation Seed Production

To promote the production of heavy yielding, high quality vegetable crops, extensive work has been done to make first-class Canadian seed available. Varieties of vegetables are processed by suitable plant breeding methods until they have attained the desirable genetic purity to allow them to be classed as Foundation Stock seed which is the base for Canadian registered and certified seed. In 1937, there were fourteen varieties which had been or were being processed at this Station. During some of the War years, this groundwork was utilized to produce relatively large stocks of seed when the country required them. In 1943, some 912 pounds of Foundation Stock seed of 14 varieties of vegetables were requested from this Station for the Dominion Seed Production Program.

The list of varieties grown for Foundation seed changes as the commercial production progresses. For example, the Zucca melon which became so useful in the processing trade during the War is now on the reserve seed list because the demand for this crop has retracted in postwar years. Other varieties were dropped and replaced with more desirable ones for current production. The present assignments of varieties for Foundation Stock seed production at this Station are as follows:

FIG. 22—A GOOD STRAIN OF SWEET SPANISH ONION

William May, who has had charge of the vegetable garden for many years, is shown inspecting the crop. 1942.

Giant Stringless Green Pod bean; Chantenay 37 (Long) and Imperator (Long Top) carrots; Green Seeded citron; Cubit cucumber; Marjoram; Sage; Summer Savory; Thyme; Hales Best muskmelon; Klondyke watermelon; Mountain Danvers and Southport Red Globe onions; California Wonder, King of the North, and Hungarian Paprika peppers; Connecticut Field and Sugar pumpkins; Scarlet Globe (Medium Top) radish; Earliana 8040, Longred, Sentinel, Signet, Sioux, Stokesdale No. 4 and Sugawara tomatoes; and Long Green Trailing vegetable marrow. Davis Perfect cucumber, Sweetheart lettuce, Zucca melon and Clarks Early tomato are on the reserve list. Good stocks of nearly all of these varieties are available from the Dominion Horticulturist, Central Experimental Farm, Ottawa.

As the climate in parts of the interior of B.C. is suitable for growing blight-free bean seed, this Station has been co-operating with the Division of Horticulture at the Central Experimental Farm in the production of blight-free Foundation Stock seed of bean varieties such as Stringless Green Pod, Round Pod Kidney Wax and Masterpiece.

The dividends from the early breeding work conducted several years ago are still being realized. For example, the strain of Hales Best muskmelon, which had been selected for many years, was well adapted for the production of a high quality crop in the Okanagan Valley, but it was not until 1947 that growers fully realized the merits of this stock, and began to make full use of the Foundation seed available.

An essential part of the Foundation seed production program is the verification trials, whereby samples of all stocks are grown and checked for trueness to type before granting Foundation Stock seed status to any lot of seed. This Station has undertaken such trials each year, with special attention to the heat loving crops grown by other institutions in Canada as well as at Summerland.

Variety Trials of Vegetables

To ascertain the varieties best adapted to the climate and growers' purpose, it is necessary to evaluate many new introductions. For specialized large-scale production of vegetables such as tomatoes, growers are interested not only in varieties but also in strains within a variety, and in turn with stocks of the strains

FIG. 23—TOMATO VARIETY TRIAL PLOTS

From fifty to seventy-five tomato varieties, strains and hybrids are tested each year. 1946.

which are in greatest demand. To be sure that an introduction which is superior to the usual varieties for this area does not go unnoticed, a large number of trials have been made each year. In the last twelve years, these tests included 2 asparagus, 8 bush bean, 5 pole bean, 19 lima bean, 6 soybean, 10 beet, 19 cabbage, 31 cantaloupe, 22 carrot, 2 cauliflower, 2 citron, 33 sweet corn, 37 cucumber, 34 onion, 7 okra, 12 pea, 3 parsnip, 43 pepper, 7 radish, 3 spinach, 196 tomato, 15 vine crops (pumpkin, squash, vegetable marrow), and 14 watermelon varieties. By the time many stocks and strains of some varieties have been evaluated, the preceding figures are multiplied. For example, the 196 varieties of tomatoes involved testing some 765 different samples of seed.

From these trials the following table has been developed. The "standard varieties" are ones which have been grown with success for several years. The "newer varieties" are the promising introductions which appear to be adaptable and important for commercial production in this area, and will probably merit classification as "standard varieties" shortly.

TABLE 29—VEGETABLE VARIETIES FOR THE OKANAGAN VALLEY

Vegetable	Standard Varieties	Newer Varieties
Asparagus	Mary Washington	
Beans, Bush	Round Pod Kidney Wax Pencil Pod Wax Stringless Green Pod	Tendergreen Rival
Beans, Pole	Blue Lake	Improved Blue Lake 65
Beans, Lima	Henderson Bush	Triumph Fordhook 242 Peerless
Beets	Detroit Dark Red Short Top Detroit Dark Red Medium Top	
Cabbage	Golden Acre Copenhagen Market Danish Ballhead	
Carrots	Red Cored Chantenay Nantes Imperator	Nancy
Cantaloupe	Hales Best	
Celery	Utah	
Citron	Green Seeded	
Corn	Dorinny Banting Golden Bantam Golden Cross	Spancross Marcross Carmelcross
Cucumber	Early Fortune Davis Perfect Delcrow Snow Pickling National Pickling	Cubit Marketer
Egg Plant	Black Beauty	
Lettuce	New York 12 New York 55 Imperial 44	Great Lakes
Marrow (Vegetable)	Long Green Trailing White Bush	

TABLE 29—VEGETABLE VARIETIES FOR THE OKANAGAN VALLEY—*Concluded*

Vegetable	Standard Varieties	Newer Varieties
Onions	Yellow Globe Danvers No. 33. Yellow Globe Danvers No. 44. Yellow Globe Danvers No. 55. Mountain Danvers Portugal Sweet Spanish Ebenezer	Early Yellow Globe
Parsnips	Hollow Crown	
Peas	Thomas Laxton English Wonder	
Peppers	California Wonder King of the North	
Potatoes	Warba Irish Cobbler Katahdin Netted Gem Green Mountain	
Pumpkin	Sugar Connecticut Field	
Radish	Scarlet Globe	
Spinach	Giant Nobel Bloomsdale King of Denmark	Viking
Squash	Des Moines Hubbard Golden Hubbard	Buttercup
Swiss Chard	Lucullus	
Tomatoes	Earliana Clarks Early John Baer	Wisconsin 55 Longred Stokesdale No. 4
Watermelon	Klondyke	

In a very short period, Cubit and particularly Marketer cucumbers appear to have attained a firm place in commercial production. The new Lima bean varieties may establish production of this crop for processing in this area. The newer tomato varieties are not well established as yet because the Earliana and Clarks Early varieties have suited growers' purposes very well. The Ferry Morse 498 strain of Earliana gives a large pack of acceptable early fruit, and this variety and Clarks Early appear to be well adapted to the dual purpose of shipping early harvests for fresh fruit and sending later fruit to the canneries.

The fact that the recommended varieties are in many cases relatively old ones, suggests that the best procedure to obtain superior introductions for this area will be to develop them here by breeding for specially adapted varieties and strains.

Irrigation of Vegetables

The handling of irrigation water for production of vegetable crops required experimental evidence on which to base recommendations for suitable practices. The 1933-35 experiment with cantaloupes was repeated from 1936 to 1938 with tomatoes, and in 1939 and 1940 with onions. This series of experiments was designed to ascertain the amounts of water required and the frequency of applications necessary for highest commercial production. The water was applied

through a special measuring device. Thus, the amounts of water used on the replicated plots were determined accurately. The different crops varied in amounts of water required.

The results of these experiments can be summarized briefly to show which amounts of water and intervals between irrigations gave the best crops. Using a light sandy loam soil which was well supplied with organic matter, excellent cantaloupe crops were obtained by applying one-half to one acre inch of water per week during the growing season. Unnecessarily large applications of water, especially during the early part of the season retarded production; and longer intervals than one week between irrigations reduced the crop slightly.

The tomato crops needed more water than the cantaloupes. Table 30 shows a summary of three years' data from trials on replicated plots where measured quantities of water were applied.

TABLE 30—INFLUENCE OF IRRIGATION PRACTICE ON THE YIELD OF MARKETABLE TOMATOES

Water applied per week (inches)				Total for season (inches)	Average yield per plant (pounds)			
June	July	Aug.	Sept.		1936	1937	1938	Mean
½	1	1	1	13	48·0	46·9	53·3	49·4
½	1	1½	1½	16	51·4	42·7	53·7	49·3
¾	¾	¾	¾	11½	47·1	45·4	53·4	48·6
¾	1½	2	2	22½	51·8	42·9	50·3	48·3
1	1	1	1	15	39·2	42·0	49·8	43·7
1½	1½	1½	1½	22	43·7	41·6	44·9	43·4
2	2	2	2	30	43·0	40·2	43·9	42·4
½	½	½	½	7½	33·4	38·2	48·4	40·0

Yields were influenced by the season; however, the mean yields indicated that good results were obtained by applying one-half to three-quarters acre inches per week in June, followed by three-quarters to two inches during the heat of the summer. The heavier applications of water in June, when the plants were making rapid early growth, appeared detrimental; and one-half acre inch of water per week throughout the season was insufficient to produce a consistently large crop.

A demonstration of this work on the Illustration Station in Osoyoos showed that on light soil, the application of one inch per week in June and one and one-half inches in July and August maintained the plants without wilting during a period when temperatures ranged above 90°F. to 102°F. Thus growers who had wanted to apply eighteen inches per month could see that less than half that amount was required for the commercial crop of tomatoes.

The irrigation experiments with onions were carried on for two years. In Table 31 is a summary of the influence of amounts of water used on the yield of marketable onions.

TABLE 31—INFLUENCE OF IRRIGATION PRACTICE ON YIELD OF MARKETABLE ONIONS

Water applied per week (inches)		Average yield of plot containing 300 ft. of onion row (pounds)		
May	June to August	1939	1940	Mean
1	2	158·1	147·5	152·8
½	1	169·4	115·5	142·4
2	2	120·0	114·0	117·0
1½	1½	123·0	100·1	111·5
1	1	121·9	87·7	104·8
½	½	109·3	53·7	81·5

As was the case with tomatoes, the practice of light irrigations in the early season followed by heavier applications as the onions grew larger gave the best results. In the onion plots, it was noted that when the ground was loose and dry in the spring at the time of seeding, one-half inch of water per week was not sufficient to settle the soil and promote germination. The application of one inch at the first irrigation was considered necessary to promote even germination. Applications of about one inch per week in May followed by one and one-half inches per week in June appear to be desirable.

Nutrition

Many growers have stated that yields and quality of crops have declined in recent years. In 1938 and 1939, crops were examined in all major areas of this Valley and from the history, it appeared obvious that organic matter and nitrogen were often too low to expect first-class crops. This survey showed that tomato crops invariably gave high yields of high grade fruit when grown where an alfalfa crop had been incorporated in the soil. The War years curtailed work on the rotation experiments with vegetables, but general experience on the Station plots indicates that barnyard manure applied at the rate of 20 tons per acre is an effective and economical method of maintaining fertility, where manure can be obtained at reasonable cost. The use of green manure crops can be effective in building up organic matter, and it is recommended that such a crop be ploughed or disked down one year out of three. Rotations should be practised on vegetable crop lands. Crop residues, old hay or straw, and sawdust have been used as sources of organic matter.

Having made sure that the soil is well supplied with organic matter, the use of chemical fertilizers is still necessary for supplying nitrogen, and on very light soils phosphorus and potassium as well. Soil samples from many truck crop fields in this Valley were analysed and the data indicated that most of these soils were well supplied with available nutrients except for nitrogen and boron. The general recommendation for most Interior soils is to use 400 to 600 pounds per acre of ammonium phosphate (16-20-0) to obtain good crops of tomatoes, cantaloupes, onions, root crops, and cabbage family crops. On light sandy or peat soils, it is advisable to use about 1000 pounds per acre of 8-10-5. This complete fertilizer is also recommended for potatoes at the rate of 500 to 1000 pounds per acre. For celery grown on muck soils an 0-10-6 fertilizer at 1000 pounds per acre plus 500 pounds of sulphate of ammonia is recommended. Boron is required for all vegetable land in this area, and boric acid must be applied in amounts suitable to the crop to be grown. Detailed recommendations on boron requirements of various vegetables are available.

The fertilizer experiments conducted in 1937, 1938, 1939 and 1940 to study the "breakdown" or deterioration of quality in tomatoes gave no positive information on the cause of this soft, watery condition of fruits which appears to be correlated with spells of hot, dry weather. However, these experiments further demonstrated the need for rotations which would promote the restoration and maintenance of the humus content of the soil. They also confirmed the necessity of supplying adequate quantities of nitrogen and boron for vegetable crops in the irrigated areas of British Columbia.

ORNAMENTAL HORTICULTURE

R. C. Palmer

The ornamental grounds at this Station serve a double purpose. They provide a recreational centre and also act as a testing ground for plant materials.

The magnificent specimen trees, attractive shrubberies, gay flower borders and spacious lawns create an atmosphere of peace and restfulness enjoyed by thousands of visitors from many miles around. The grounds are kept open to

the public at all times including Sundays and holidays. During the summer months, there are many days on which over a thousand people visit the grounds. Most of these visitors appreciate this privilege and co-operate in keeping the ornamental area clean and attractive.

The ornamental plantings provide a wealth of information on the adaptability of a wide variety of plant materials to the soil and climatic conditions which prevail in the Okanagan and adjacent areas. The plantings are arranged to suggest how these materials can be used to good advantage in home beautification. It is recognized that ornamentals play a most important part in developing the character of a people and the stability of a nation. In a country where homes are surrounded with well-kept gardens, the owners tend to be happy and industrious.

With the above thoughts in mind, the following pages of this report are devoted to presentation of information which it is hoped will encourage home owners to take up gardening as a hobby, with consequent enrichment of their own lives as well as beautification of the countryside. Suggestions regarding varieties and cultural methods based on experience at this Station are presented in the simplest possible language. Nevertheless, it is hoped that the recommendations embodied in the following pages will prove of interest and value also to experienced gardeners and assist them in their efforts to raise to perfection the ornamental plant materials adapted to this region.

The Making and Upkeep of a Lawn

There is nothing that adds more charm and restfulness to a garden than a well cared for lawn. It is attractive in itself. Furthermore, it provides the setting for beds and borders of flowers. Inquiries indicate that many householders in the Okanagan and adjacent territory lack information on how to make and maintain a good lawn. The following recommendations are based on experience with the Station lawns.

Prepare the Seed-bed Thoroughly.—As the lawn constitutes a permanent feature of the garden, it is worth-while to give the site special preparation. If the house has been built recently, it may be that the soil excavated for the foundations has been spread where it is planned to make the lawn. This subsoil is poor material on which to establish grass. For best results it should be removed to a depth of six inches and replaced with good topsoil.

It is a good plan to dig up the land rough in the fall, allow it to weather all winter, then in the spring use a broad-tined digging fork to break up the lumps and make the soil as smooth as possible. Leave it for a time so that the surface may dry out when it will be ready for the most important chore in making a lawn, and one that is often neglected; viz., treading. Every inch of the site should be given a good treading. When this is done, re-tread at right angles. This will do more to solidify the site than any method of rolling ever devised.

After the site has been well firmed, the final levelling may be done. Use of a straight-edge and level are justified with lawns which are to be used for games such as bowls or tennis. However, gently undulating lawns are often an advantage where peace and restfulness are the aim and where the contour of the land makes it necessary to have a lawn slope gently away from the house. As a final preparation for the seed, take an iron rake and work up half an inch of the surface soil. Make this as fine as possible.

Use Good Grass Seed.—One of the most satisfactory lawn grasses for the Okanagan is Kentucky Blue. This grass has a pleasing colour and is comparatively easy to cut. However, it is slow in becoming established and does not grow well in shady locations. Chewing's Fescue is another excellent lawn grass well adapted to light soils and tolerant of shade. Lawns sown with a mixture

of equal parts of these two grasses at the rate of five pounds of seed per thousand square feet have given good results. For small lawns where cost of seed is not important, seeding at double the above rate is desirable as a good stand of grass helps to choke out weeds. Use only first-grade seed. It is the cheapest in the end.

Sow the Seed Uniformly.—Divide the seed into two equal portions. Stretch strings at eight-foot intervals over the site. Choose a calm day in April or September. Sow the seed as evenly as possible. After going over the site one way, place the strings at right angles and repeat with the other half of the seed. Rake the seed in carefully and roll gently. If the soil is dry at the time of seeding, the seed-bed should have a thorough sprinkling and then be covered to a depth of one inch with a mulch of clean straw which should be removed on a dull day after the grass has commenced to show through.

Mow the Lawn Carefully.—The success of a lawn depends largely on the treatment it receives in the early stages. Special care should be taken to avoid letting the grass suffer from drought. There is a tendency to use the mower too soon on young grass. If this is done, the grass is torn out by the roots. Allow the young grass to grow four inches high the first cutting, have the mower sharp and the blade raised as high as possible. In subsequent cuttings gradually lower the blade. Established lawns should be cut at least twice a week during the growing season. The mower will take care of the annual weeds but perennials should be destroyed by use of 2, 4-D weed killer.

Feed the Grass Regularly.—If the soil for a new lawn has been properly prepared, no fertilizer is necessary or desirable the first year. Even with established lawns, it is possible to apply more fertilizer than is desirable. However, lawns respond favourably to intelligent feeding. A light dressing of ammonium nitrate applied with a grass seeder early in June gives excellent results.

Water the Lawn Intelligently.—A good soaking once a week is preferable to light sprinkling at more frequent intervals. It is an excellent plan to check the amount and distribution of water applied. This is easily done by placing empty tomato cans in a line at three foot intervals from the sprinkler. Turn on the water and after it has run for an hour measure the height of water in each can. An application of one inch of water at a time is usually sufficient to wet the soil thoroughly to the depth occupied by grass roots.

Growing Annual Flowers from Seed

Many flowers are very easy to raise from seed, but to ensure success in this, one of the most interesting of all gardening operations, it is essential to pay attention to a few important details. The seed-bed should be well prepared, firmed, levelled and thoroughly watered the day before the seeds are planted. With regard to depth of planting, it is a good rule to cover the seeds with three times their diameter of soil. Most amateurs plant flower seeds much too thickly. Small seeds may well be mixed with five times their volume of fine sand in order to ensure evenness of sowing.

Hardy Annuals.—The following annuals can be expected to give good results when sown directly in the garden during April or May: candytuft, clarkia, cosmos, annual delphinium, dimorpotheca, mignonette, nasturtium, nemesia, nolana, ursinia, phacelia, statice and helichrysum. All that is necessary is to prepare a firm seed-bed, sow the seed thinly, cover with fine soil, and make sure that the surface is never permitted to dry out before the young seedlings have become well established. Don't be afraid to thin out surplus plants, and be merciless with weeds.

Tender Annuals.—Such flowers as asters, stocks and antirrhinum may well be started in flats or pots in the greenhouse or kitchen window in March, the young seedlings being later transplanted to cold frames so as to provide sturdy plants which can be set in their final positions during May. The following suggestions are offered as a guide to amateurs who wish to raise their own tender annuals.

Mixing the Soil.—Use fresh clean soil. Avoid using the same soil year after year as this procedure favours development of the fungus which causes "damping off" of seedlings. A good compost for raising flower seeds may be made up as follows: 2 parts garden loam, 2 parts leaf mould or peat, and 1 part clean sharp sand. Put these ingredients through a quarter-inch sieve and mix thoroughly. If this operation can be done a few weeks before the soil is required, so much the better.

Preparing the Seed Flats.—Pots or flats necessary for the seed-sowing operation should be properly cleaned. Place a good layer of rough siftings in the bottom of each pot or flat to ensure perfect drainage. Avoid the use of any kind of manure. Fill up the flats to within one-quarter inch of the top with the prepared compost, pressing it down firmly to ensure an even surface. Water thoroughly. After standing twelve hours the flats will be ready for the sowing of the flower seeds.

Sowing the Seed.—Sow the seed thinly and evenly over the surface. Very fine seed should not be covered but simply pressed into the soil. Larger seeds may well be covered to three times their diameters. The flats should be covered with newspaper until the seed germinates. No watering should be necessary until after germination takes place. However, if the soil shows signs of drying out, it should be thoroughly watered, as a wet surface with dry soil underneath is not conducive to healthy growth in the seedlings.

Pricking Off the Seedlings.—After the seedlings have made two or three leaves, they should be transplanted into flats containing a compost similar to that in which the seeds were germinated. Sweet alyssum, ageratum, pansies and other dwarf-growing plants should be set 1 inch apart. Petunias, asters, stocks, marigolds, etc., should be placed 2 or 3 inches apart each way. After pricking off, the young plants should be shaded for a few days, and then placed in a light, well ventilated position in order to ensure development of strong stocky plants ready to set out in their permanent positions about the middle of May.

Hints on Planting the Perennial Border

The perennial border is sometimes called the "backbone" of the garden. Like other backbones, it presents the most attractive appearance when kept well covered. To achieve this effect requires thorough preparation of the soil and a wise choice of plant materials. There is nothing like a generous application of well-rotted barnyard manure for building up the soil in a new border or renovating an old one. Dig in the manure and tread well, as it is important that the soil be firm around the young plants.

There is a long list of perennials and biennials adapted for use in British Columbia gardens. Bearded iris, peonies, phlox and Michaelmas daisies are such old favourites and of such easy culture that they are found in almost every garden. The important thing is to secure good varieties. There are so many excellent new varieties coming on the market that a list soon goes out of date, but the following old favourites have proved very satisfactory at Summerland:

Bearded Iris.—Souvenir de Madame Gaudichau (blue-purple), Pioneer (red-purple), Lent A. Williamson (lavender-violet), Albert Victor (light-blue), Lord Lambourne (old rose), Jacquesiana (smoky).

Peony.—Felix Crousse (red), Festiva Maxima (white), Baroness Schroeder (flesh), Madame Jules Dessert (pink), Lady Alexandra Duff (pink).

Phlox.—Daily Sketch (pink), Sweetheart (red).

Michaelmas Daisy.—Barr's Pink (tall), Frikarti (blue).

Then there are a host of plants such as pinks, pyrethrum, delphinium, hollyhock, calliopsis, oriental poppy, Shasta daisy, campanula, and columbine, which can be readily raised from seed. Here again it is important to secure improved varieties. Seed sown in a well prepared seed-bed in shallow drills in May or June and kept well watered will produce fine strong plants to be set in the border in September.

To add variety to the border and prolong the period of bloom, good use can be made of the following less common perennials:

Alyssum saxatile.—This showy plant with its masses of yellow bloom in early spring is often found in rockeries but grows equally well in the perennial border. Sow seed thinly where it is to remain.

Plume Poppy (Bocconia cordata).—A tall-growing plant with bold foliage suitable for the back of the border. Propagates readily by suckers.

Globe Thistle (Echinops ritro).—Strong grower with handsome silvery foliage and steel blue flowers. Propagated by seed or suckers.

Helenium, Moorheim Beauty.—Splendid for both cut flowers and border effect. Grows about 3 feet high and produces a profusion of intense red daisy-like flowers through the summer. Propagated by division.

Coral Bells (Heuchera sanguinea).—The vivid coral red flowers are produced over a long season. Easily raised from seed or by division.

Evening Primrose (Oenothera Missouriensis).—Low-growing plant producing large yellow flowers. Raised from seed.

Chinese Bellflower (Platycodon Mariesi).—Large bell-like blue or white flowers on plants from one to two feet high. Can be raised from seed.

Mourning Bride (Scabiosa Fischeri).—This scabious has deep violet-blue flowers borne on stiff stems over a long blooming season. Propagated from seed.

FIG. 24—VIEW OF THE ORNAMENTAL GROUNDS
The beds and borders are gay with bloom from May to November. 1946.

Sea Lavender (Statice caspia).—This perennial statice is very useful for making bouquets and is also effective in the border.

Thalictrum dipterocarpum.—Beautiful blue flowers borne in light graceful sprays. Grows to a height of 4 feet. Thrives best in a sheltered location. Raised from seed.

Globe Flower (Trollius Ledebouri).—This tall growing trollius is easily raised from seed. It prefers a moist situation.

Russian Sage (Perowskia atriplicifolia).—Grows to a height of 3 feet producing light graceful sprays of soft lavender blue flowers over a long blooming season. Very much at home in the Okanagan.

The distribution of perennial plants in the border is largely a matter of the gardener's personal preference. Some like large clumps of each variety to give bold masses of colour. Others prefer a scattering of small clumps of many kinds of flowers so as to produce some colour throughout the border over a long blooming season.

If the border is a wide one, good use can be made of a few small growing evergreens such as Oriental Arbor Vitae and Savin Juniper. Flowering shrubs of neat habit such as the Japanese Quince and Double-flowered Almond also have their place. Even larger growing shrubs like Golden Bells and Van Houtte Spiraea can often be used to advantage in the background.

Geraniums and How to Propagate Them

The geranium beds on the Station grounds provide a wealth of colour throughout the summer. In fact, these beds are the envy and admiration of visitors from far and near. This brilliant display is produced at comparatively small expense. About three thousand plants are used in the beds. These are all young plants raised from cuttings made the previous autumn.

The method used in raising the plants is simple. Cuttings from 4 to 6 inches long are made from young terminal growths, care being taken to make the cut just below a node. All leaves are removed except three near the growing point. At this stage a very important detail is to be noted. The cuttings are spread out on the bench for 24 hours. This dries up the sap exuded from the base of the cuttings and so reduces the danger of "damping off". The cuttings are then inserted about 2 inches apart in flats filled with a very open compost. The compost is made of one part loam and two parts sand. This material is faced off with half an inch of washed sand. In planting the cuttings with a dibber, the sand is carried down so that the base of each cutting is surrounded by a layer of clean sand.

After planting, the flats of cuttings are thoroughly watered and placed in a warm sunny position. This encourages rooting and gives fine stocky plants which are easy to carry through the winter. During November and December the flats are placed in a well lighted position and kept rather dry. About New Year, the rooted cuttings are transferred to 3-inch pots and by mid-March they are ready for the planting-out pots.

These planting-out pots are made from equal parts of cow manure, peat and clay. As they are prepared in winter when weather conditions are unsuitable for outdoor work, very little expense is involved. When planting out time arrives in May, the pot as well as the plant is set in the beds. Thus, the plant receives no check from the transplanting. The pot soon disintegrates and permits roots to grow through it. Handled in this way, geraniums give a longer period of summer bloom than any other plant grown at the Summerland Station.

The variety, "National", originated by the late J. H. Glass of Penticton, is one of the finest scarlet geraniums in existence. The compact free-blooming

habit of the plant makes it very suitable for bedding out and also for use as a pot plant. Sturdy young plants which have grown in beds all summer may be brought into the house in October. Grown in a sunny window, they produce bloom throughout the winter. As to treatment, geraniums are not at all fastidious. The two things to avoid are frost and soil saturation. Pots 5 inches in diameter are suitable for geraniums. To avoid getting too much foliage at the expense of bloom, give them plenty of light and avoid over-watering.

Hardy Chrysanthemums are Easy to Grow

Hardy chrysanthemums thrive in many sections of Canada. They produce a wealth of bloom during the autumn months after most garden flowers have been destroyed by early frosts. Experience at Summerland indicates that the cultural requirements of chrysanthemums are very simple; plenty of sunshine, an adequate supply of plant food and moisture, division of the plants each spring, and perhaps most important of all, good drainage.

The chrysanthemum is a sun-loving plant. Given a generous supply of water it will thrive in the hottest location. Under shady conditions, the plants tend to grow tall and spindly. Excellent blooms can be secured from plants set in any good garden soil.

With most varieties, the best results are obtained by starting new plants each spring. By early May, the old plants have usually sent out a number of new shoots at the base of which a few small roots have developed. At this time, the old crowns may well be dug up. This makes it easy to remove the new shoots and replant them. They should be set about 18 inches apart, making sure that the soil is pressed firmly about them and kept moist for the next 10 days. Where large numbers of plants are involved it is worth while to make a temporary cutting bed in which the plants may be set 3 inches apart in rows 6 inches apart. This makes it easy to keep the young plants watered until they are well rooted, after which they may be set in their permanent positions.

When the plants reach a height of about a foot, they should be tipped back to encourage branching. The bed should be kept watered during the summer. Towards the end of August, it is a good plan to apply a top dressing of a fertilizer mixture with analysis of 8-10-5, at the rate of a handful to each half dozen plants. Care should be taken to keep the fertilizer off the leaves and to water thoroughly after application.

Many excellent varieties of hardy chrysanthemum are now available. The so-called cushion or azaleamums such as Bronze Queen, Pink Pearl and Ruby Red begin blooming very early and continue over a long season. They are dwarf in habit and very suitable for use as edgings to borders.

In the medium height, mid-season varieties, the following can be highly recommended: Eugene Wander (yellow), Connie Hall (pink), Olive Longland (apricot), and Fred F. Rockwell (orange scarlet).

The recently developed Korean varieties have proved very popular. They flower somewhat later than those listed above. The flowers are comparatively small but are borne in great profusion and include a wide range of very beautiful colours. Some of the attractive single varieties are Apollo (terra-cotta), Ceres (chamois-yellow), Hebe (pink), and Nancy Copeland (spectrum-red). There are also excellent double varieties such as Burgundy (wine-red), Autumn Lights (bronze) and Pink Radiance, the glowing colour of which is well described by the name.

Of still more recent introduction are the Nipponicum hybrids such as Burma (buff) and Carnival (burnt orange). These varieties produce fully double flowers of exquisite colour and in addition they have luxuriant dark green foliage.

Where especially large blooms are desired, varieties such as Conqueror (red), Mayland Yellow and Bronze Buttercup may be grown. For best results these varieties require disbudding, the number of blooms being reduced by removing surplus buds as soon as they appear.

All the above varieties have proved hardy at Summerland where they survive without special winter protection provided they are planted in a well drained location.

Succulents for the Hot Sandy Bank

On the Station grounds there is a fairly large plantation of succulents including cacti. Although they have to compete with a riot of colour in other sections of the ornamental area, these desert plants fully hold their own in interest and enquiries from visitors.

When one realizes that these plants are not mere freaks of nature, but rather the result of a tremendous struggle for existence, under the most adverse circumstances, one is led to admiration for their tenacity to life.

Gardeners interested in desert plants can build up a collection quite rapidly at little expense, as these succulents can be propagated readily from leaf or stem cuttings. It is important to let the cutting dry thoroughly at the base after which it can be rooted by standing it on dry sand.

In a plant family so large as the succulents, it is somewhat of a problem to give a list that is within the range of a beginner, without omitting some that are well worthy of growing. However, the following list includes a few of the easily grown and readily obtainable kinds:

List of Succulents Suitable for the Beginner

Sedum murale	Euphorbia splendens
Sedum hispanicum	Agave americana variegata
Sempervivum arachnoideum	Aloe arborescens
Sempervivum tectorum	Portulaca in variety
Echeveria secunda glauca	Ferocactus acanthodes
Echeveria elegans	Opuntias in endless variety
Crassula arborescens	Coryphantha exsudans
Crassula falcatus	Cephalocereus senilis
Bryophyllum tubiflorum	Pachycereus marginatus
Euphorbia caput Medusae	Cereus peruvianus

The Sedums and Sempervivums are hardy and Portulaca is an annual. The remaining varieties in the above list should be kept in a dry frost-free place in winter. It is a good plan to plant these tender varieties in pots using a lean mixture with plenty of sand to ensure good drainage.

Desert plants thrive best when set outdoors in a sunny position from the middle of May to mid-October. It is not necessary to take the plants out of the pots. Plunge the pots just below ground level, and if you wish the bed to present a natural desert landscape, give it a good coating of sand. A few large boulders judiciously placed will add to the effect. For proof of this statement you are invited to visit the Station where you will find succulents and cacti planted in a miniature "Death Valley", thriving in the hot sand amid boulders, deer antlers, and the bleached bones of a past generation.

Begonias for the Shady Corner

There are many plants which grow to advantage in a shady location, for example, primulas, auriculas, Virginia bluebells, trollius, columbine, Japanese anemones and Christmas roses. But for brightening up a dull corner there is nothing in the same class with modern tuberous begonias. Plant breeders have made amazing improvements in tuberous begonias, with the result that

it is now possible to secure at reasonable prices strains which produce ruffled, camellia-and rose-shaped flowers in a wide range of colours. For size and beauty of form, the named strains such as Santa Barbara, Santa Clara, Fascination, Atomic Gold, Red Triumph and Sunset must be seen to be believed. There are also very free-flowering pendulous forms which are excellent for window boxes.

Tuberous begonias are commonly raised from seed but the seeds are so minute that a special technique is necessary to grow them. On this account, the beginner is well advised to leave the raising of tubers to growers who make a specialty of this operation. The tubers can be purchased from florists with full cultural instructions.

Experience at Summerland indicates that the following points are of paramount importance in securing success with tuberous begonias:—

(1) Purchase good tubers. The finest obtainable are usually the best value for the money.

(2) Start the tubers in a sunny window in the house early in March, planting them just below the surface in a loose soil containing plenty of peat. Keep the soil moist but not wet. Good drainage is essential.

(3) Transplant to the outdoor bed or window box early in May after the danger of frost is over. By this time the plants should be well developed with buds showing.

(4) Prepare the bed well, digging out the roots of competing trees or shrubs to a depth of at least a foot. Mix plenty of peat or leaf mould with the soil. It is important that the soil be loose in texture. In the bottom of each hole well below the position where the tuber will rest, mix a tablespoonful of dried blood or some poultry manure.

(5) Set the young plants about 18 inches apart each way. Be careful to have the leaves point towards the front of the bed. The flowers tend to point in the same direction as the leaves.

(6) Keep the soil moist but not wet.

Attention to these simple requirements ensures a continuous display of bloom from early June until frost comes in October.

While tuberous begonias will grow well in shade, they give even better results when grown in beds or window boxes facing east, where they have the benefit of the morning sun but are in the shade during the rest of the day. The extra light promotes maximum flower development in proportion to leaf area.

When frost comes, the plants should be dug up, the stems broken off close, the tubers washed free of soil and then allowed to dry a couple of days before being stored in dry peat in a cool frost-free place. After a rest period, they will be ready to start again the following March.

Some Easily Grown Lilies

Lilies have the reputation of being difficult to grow. This is true of some kinds but there are several species and varieties which are especially well adapted to Okanagan conditions. Given their simple requirements, these lilies provide gay splashes of colour in the garden during July, when spring flowers are over and annuals have not yet come into their full glory.

Good drainage is the primary requirement of all lilies. If the soil is not naturally well drained, it is essential to remedy the situation before planting the bulbs. In moving lilies it is important to avoid damaging the fleshy roots at the base of the bulb. Provided these roots are not injured, lilies can be moved successfully in early spring, in summer after blooming or in the autumn. The shorter the time they are out of the ground, the better they will behave after moving. As a general rule, lilies give good results when planted at a depth of 3 times the diameter of the bulb.

Most lilies thrive in a sunny location but they appreciate a ground cover of some low growing plant such as petunia to keep the soil cool. Similarly, they respond well to a thick mulch of peat or well rotted manure. Care should be taken, however, to avoid digging manure into the soil where lilies are to be planted. This practice encourages the development of basal rot on the bulbs.

FIG. 25—AN EFFECTIVE PLANTING OF REGAL LILIES

Many species of lily are well adapted for use in Okanagan gardens. 1944.

Lilium regale is largely responsible for the rapidly increasing interest in lily culture. This species is native to the hill country of Tibet, where the soil and climatic conditions are somewhat similar to those found in the Okanagan. Probably this explains why Regal thrives in the valleys of the southern interior of B.C. It is so much at home that it has seeded itself and become naturalized on this Station.

An interesting and valuable group of lilies has been produced by hybridizing *L. regale, L. sargentiae* and *L. sulphureum*. Some of the resulting seedlings are even more vigorous than Regal and have larger flowers of heavier texture and deeper colour. Many of them bloom later than Regal, thus extending the flowering season of these handsome trumpet lilies.

The Coral lily, *L. pumilum,* and the Morning Star lily, *L. concolor*, are two early flowering, low growing lilies suitable for use in the rockery. The dainty spikes of these lilies carry from 3 to 8 blooms of glowing scarlet colour. In Coral, the florets are nodding and the petals reflexed, whereas in Morning Star the blooms are held erect. Both these lilies are highly satisfactory as cut flowers.

L. Davidi is a vigorous, dependable lily of Turk's Cap type with cinnibar-red florets. It grows to a height of 6 feet and the stem is strong and wiry enough to stand without staking.

A few years ago the so-called "Stenographer" lilies, Brenda Watts, Lillian Cummings and Edna Kean, were introduced by Miss I. Preston of the Central Experimental Farm, Ottawa. These lilies are the result of crossing *Lilium Willmottiae* with an upright-flowering variety. They are hardy, vigorous lilies in which the florets tend to face directly outwards rather than up or down, which makes them very showy.

Pollen from the Stenographer lilies has been used at Summerland on *Lilium Davidi* to produce another group of seedlings showing further variation in form and colour. From several thousands of these, two have been selected and named Skyrocket and Sultan. Skyrocket produces a tall, well proportioned spike carrying numerous brilliant vermilion-red florets. With Sultan, on the other hand, the florets are oxblood-red. Both these varieties are hardy, vigorous and easily propagated from bulblets on the underground stems.

The flowering parts on lilies are so large and easily recognized that anyone interested can become a lily breeder. It is a simple matter to transfer the pollen from the stamens of the male parent to the stigma of the flower which it is planned to use as the female. When a successful cross has been made, seeds develop and the pod fills out. When the pods have matured and begun to crack open, they should be gathered and put away in a bag in a dry place. Some day in the winter, the seeds can be removed from the pods.

Excellent germination has been secured by sowing lily seeds in shallow flats in the greenhouse early in February. A sunny window in the kitchen would likely give the same results. By May, the young lily seedlings have developed several leaves and produced a small bulb. At this time, the seedlings can be transplanted to a place in the garden where they can be given a generous mulch of peat and kept watered throughout the summer. With good treatment, some seedlings bloom the second year but it is usually two years before many blooms appear. It is then that the lily breeder receives his reward. The satisfaction which comes from originating an entirely new and superior variety cannot be described; it must be experienced.

Roses for Every Garden

There should be roses in every Okanagan garden. Modern varieties combine hardiness and vigour with beauty of form, richness of colour, exquisite fragrance and long blooming season. Experience at Summerland indicates that the essentials for successful rose culture are few and simple: good varieties, plenty of sunshine, rich soil and adequate moisture. They respond well to heavy feeding and are benefited by a thick mulch of well rotted manure or compost.

The dry air characteristic of the interior valleys of British Columbia discourages development of fungus diseases with the result that in these areas it is seldom necessary to spray roses for mildew or black spot. On the other hand, two or three applications of a good insecticide early in the spring are desirable to control aphids and leafhoppers.

To guard against winter injury, it is a good plan to hill up Hybrid Tea roses with earth before winter sets in. Similarly, it is a wise precaution to take down climbing roses, cut out the old wood and cover the young growth with fir boughs or other loose material. It is important to give the rose garden a thorough irrigation in the autumn, as injury is likely to result if roses are permitted to go into the winter with the soil in a dry condition.

Plant breeders are producing such a steady stream of marvelous new roses that any list is sure to go out of date in a few years. Nevertheless, rose lovers who grow the following proved varieties will not be disappointed. They are comparatively hardy, vigorous growers with good foliage. Given reasonable care they can be counted on to produce a large number of blooms of good form and substance. Furthermore, several of them possess real rose fragrance:

Hybrid Teas for the Rose Bed

Betty Uprichard (carmine)
Charlotte Armstrong (pink)
Crimson Glory
Etoile de Hollande (red)
Dainty Bess (single pink)
Dickson's Red
Hector Deane (cochineal)
McGredy's Sunset (gold)
McGredy's Yellow
Mrs. Sam McGredy (copper)
Peace (pink and yellow)
Picture (pink)

Polyanthas for Continuous Bloom

Betty Prior (carmine)
Dagmar Spath (white)
Donald Prior (red)
Else Poulsen (pink)
Pinocchio (double pink)
Poulsen's Yellow

Bush Roses for the Shrubbery

Agnes (pale amber)
Austrian Copper (single copper)
F. J. Grootendorst (crimson)
Frau Karl Druschki (white)
Persian Yellow
Rosa Hugonis (sulphur yellow)

Climbers for the Arbour

Doubloons (yellow)
Dr. Van Fleet (pink)
Glen Dale (cream)
Paul's Scarlet (red)

Shrubs for Year-Round Effect

Shrubs may be used to very good advantage in the foundation planting—that essential connecting link between house and lawn. They are also useful for hedges, screens, windbreaks and as a background for flower borders. Most shrubs give the best effect when planted in groups of 3, 5 or more, rather than as single specimens. Furthermore, they are much easier to care for when planted in groups rather than dotted singly about the lawn. It is most important to give each shrub sufficient room to develop its natural beauty. Five feet apart for small growing varieties and 10 feet apart for strong growers is close enough. When in doubt, plant farther apart.

Residents of the Okanagan are fortunate in that there are many kinds of shrubs which are well adapted to this area. In fact, the following list of 5 dwarf evergreens, 5 low-growing deciduous and 10 tall-growing deciduous shrubs is perhaps more noteworthy for the varieties which are omitted than for those which are included. However, in making the selection, preference has been given to shrubs which present an attractive appearance for many months of the year and require the minimum of attention with respect to pruning.

There are many dwarf evergreens well adapted for use in the foundation planting. The following have been found especially useful at Summerland:

Juniperus horizontalis.—The nursery form of this species known as the Andorra juniper makes a dense mat about a foot high. The foliage is bright green in summer but turns a rich plum colour in autumn.

Juniperus Sabina.—The most popular nursery form of this juniper is often sold under the name *J. tamariscifolia.* This plant makes a neat mound about 2 feet high. The foliage is a beautiful bright green and of very fine texture.

Juniperus chinensis.—The Pfitzer juniper, a form of this species, is perhaps the most widely planted of all junipers. It is a strong grower, making a large spreading plant about 4 feet in height. The foliage is somewhat coarse but maintains its fresh green colour throughout the winter.

Thuya orientalis.—There are many nursery forms of the Oriental Arbor Vitae, one of the most satisfactory being the Golden Biota. This is one of the few golden shrubs which does not burn under Okanagan conditions. It is a slow grower and maintains a symmetrical shape without trimming.

Pinus mugo.—Dwarf forms of the mountain pine can be used to give character to the foundation planting. The foliage is dark green in colour and the plants make a broad mound about 5 feet in height.

There are a number of low-growing deciduous shrubs which can be used to good purpose in the foundation planting. The following are worthy of special mention:

Daphne Mezereum.—The February daphne grows best in a northern exposure. The deep pink flowers appear very early in the spring before the leaves and are sweetly scented.

Deutzia gracilis.—There are white and pink forms of this dwarf deutzia, both of which are very free flowering.

FIG. 26—PENTAGON MOCK ORANGE

The originator, George Robinson, is shown admiring a branch of this excellent variety.

Philadelphus, Manteau d'hermine.—Most varieties of Mock Orange are strong growers and present a somewhat ungainly appearance except when in bloom. However, this variety is quite dwarf and neat in habit. The double flowers are very showy.

Berberis Thunbergii.—The purple-leaved form of this Japanese barberry presents an attractive appearance throughout the summer and carries red berries in winter.

Cotoneaster horizontalis.—This low growing cotoneaster has red berries which are very effective in winter. It is sometimes injured by low temperatures but is well worth growing even if some winter protection is necessary.

There are so many tall growing shrubs with desirable characteristics that it is very difficult to make a selection, but the following provide bloom at various seasons of the year and are seldom troubled by insects or diseases:—

Forsythia intermedia.—This is one of the best of the golden bells. It is hardy in the South Okanagan except for the occasional severe winter when the temperature falls lower than 15 degrees below zero. Branches taken into the

house early in December can be brought into bloom for Christmas, provided they are given a complete over-all bath in water for an hour or so every few days to keep the buds from drying out.

Kolkwitzia amabilis.—This shrub is well named beauty bush. It carries a wealth of bloom over a comparatively long season; the foliage is attractive throughout the summer and the arching branches present a pleasing effect even in winter.

Spiraea Vanhouttei.—The Van Houtte spiraea is deservedly one of the most popular of all shrubs. It is not only exceptionally beautiful when in bloom but also shows to good advantage throughout the summer and winter months.

Philadelphus, Pentagon.—This mock orange was raised from seed by George Robinson of Penticton. In contrast with the stiff erect habit of most varieties, Pentagon has graceful arching branches. The flowers are semi-double and borne in great profusion.

Buddleia alternifolia.—The fountain buddleia grows especially well in the Okanagan and should be used more extensively where a large specimen shrub is required. The blooms are carried on the previous year's wood so that pruning should be delayed until immediately after the bloom period.

Cornus florida.—This showy dogwood is hardier than *Cornus Nuttalli,* the species native to the coastal areas of B.C. The flowers on *Cornus florida* are somewhat smaller than those on the native species but are borne in even greater numbers.

Cotinus coggygria.—The smoke tree never fails to attract the attention of visitors to this Station. It is best grown on comparatively poor soil, as heavy feeding causes it to make strong growth which is subject to winter injury.

Tamarix pentandra.—This shrub is often sold under the name *Tamarix aestivalis* which indicates its summer blooming characteristic. It is a drought resister, well adapted for use on dry gravel banks.

Viburnum fragrans.—The Korean snowball has the unique habit of beginning to bloom in November, resting a while during mid-winter, starting again early in the spring and continuing over a long period. The flowers are very sweet scented.

Acer palmatum.—There are several very attractive nursery forms of the Japanese maple. They have finely cut, fern-like leaves which maintain an attractive purple colouring in summer and turn brilliant scarlet in autumn.

With so many good shrubs to choose from, the home owner will be well advised to avoid the few which do not thrive in this area. The climatic conditions in the Okanagan Valley and adjacent territory are too severe for most of the broad-leaved evergreens such as holly, laurel and cotoneaster. The soil in semi-arid regions tends to be neutral to slightly alkaline, with the result that acid-loving plants such as azaleas and heaths make poor growth. Variegated and golden shrubs are likely to be burned by the sun.

Trees Which Thrive in the Okanagan

The native trees of the Okanagan and adjacent valleys are mainly pines on the lower levels, with firs, spruce, larch and juniper at higher elevations. There are a few deciduous trees in the low-lying areas near the lakes and along streams, but there is room for the planting of many more trees both for shade and windbreak purposes. Where irrigation is available, many beautiful species of deciduous and evergreen trees can be grown.

In planting trees, it is well to bear in mind the size which they will attain at maturity. Except where trees are planted to provide a dense screen or shelter-belt, they should be given plenty of room to develop their natural shape.

FIG. 27—EVERGREENS IN WINTER

Pyramidal Norway Spruce on left, Colorado Blue Spruce in centre and Bull Pine on right. 1946.

From a long list of evergreens growing well on the Station grounds, the following have been selected as worthy of special mention:

Pinus ponderosa.—The native yellow or bull pine is a very decorative tree. In fact, the beauty of the ornamental grounds at this Station is enhanced greatly by fine specimens of this native conifer. Seedlings can be moved from the wild. In this connection, however, it should be pointed out that only very small trees should be transplanted. Furthermore, care must be taken to prevent the roots from drying out, because if they are exposed for even a short time, a gum forms which prevents passage of water through the roots with the result that the tree dies.

Pseudotsuga Douglasii.—The native Douglas fir is also an exceptionally handsome tree. Seedlings vary greatly in colour and form with the result that fine specimens can be grown from small plants selected from wild areas.

Picea pungens.—Colorado blue spruce owes its popularity as an ornamental to propagation of blue forms. When raised from seed most of the plants have green coloured foliage. These seedling trees are excellent for windbreak purposes and often make more symmetrical growth than the grafted forms.

Picea excelsa.—Norway spruce has fine needles of a soft green colour. It is a fast growing tree useful for windbreak purposes. The pyramidal form makes very effective specimen trees.

Abies concolor.—The white fir makes a very symmetrical tree. There are blue as well as green forms which are equally beautiful.

There are many locations where a small, rather than a large deciduous tree is required. The following are suggested where space is a limiting factor:—

Acer ginnala.—The Amur maple is one of the most ornamental small trees. No matter what the character of the season the leaves always turn brilliant red in autumn. Moreover, this tree is quite attractive throughout the summer as the small finely cut leaves give a very pleasing appearance.

Eleagnus angustifolia.—The Russian olive makes a very effective tree, the dark coloured bark contrasting strikingly with the grey foliage. This tree is a drought resister which makes it useful for planting where little water is available.

Ginkgo biloba.—The maidenhair tree is actually a conifer although it drops its fern-like leaves during the winter. This tree is especially interesting owing to the fact that it is the sole representative of a prehistoric flora. While it eventually attains large size, it is a slow grower and for this reason can be used where space is limited.

Tilia cordata.—The European linden makes a very symmetrical tree with dainty foliage.

Sorbus aucuparia.—The mountain ash or rowan tree as it is often called is one of the most ornamental small trees. It is hardy, of neat habit and bears attractive fruit.

Where there is ample room for really large trees, the following can be recommended:—

Acer saccharinum.—Wier's cutleaved form of the silver maple is especially desirable on account of its graceful form. It is a very vigorous tree and grows rapidly to large size.

Acer platanoides.—The Norway maple is a smaller tree than the silver maple but good specimens attain a height of 30 feet. The nursery form known as Schwedleri is especially desirable as the leaves are purple in the early spring, turning to dark green during the summer and to brilliant yellow in autumn.

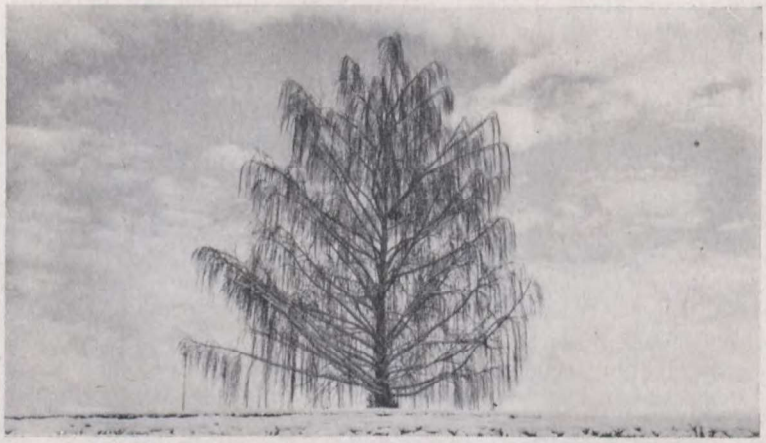


FIG. 28—CUT-LEAVED WEEPING BIRCH TREE IN WINTER

Many trees and shrubs are as beautiful in winter as they are in summer. 1946.

Betula pendula.—The cutleaved form of the European weeping birch is deservedly popular as a specimen tree. Those on the lawn at this Station present a very striking appearance in both summer and winter.

Quercus coccinea.—The scarlet oak is a most satisfactory tree, the foliage being very ornamental in the summer and turning to brilliant scarlet in the autumn. This species grows quite rapidly and attains large size so that it should be given plenty of room to develop.

Fagus sylvatica.—The European beech is a slow grower but eventually makes a large tree. The purple leaved form can be used to give variety of colour to the planting.

Simple Plant Labels

The garden takes on a new interest when the plants therein are neatly labelled. Each plant becomes endowed with personality, the name revealing its place in the botanical family and often something of its history and origin.

This business of labelling need not be an expensive procedure. Durable labels can be made very cheaply. They need not be unsightly. When properly made they are neat and inconspicuous, yet easily read.

Wooden labels are the cheapest to begin with, but they generally prove expensive in the long run, as they soon rot where they touch the soil. Furthermore, their shape usually necessitates writing lengthwise of the label which makes the inscription difficult to read.

A very inexpensive metal label can be made from strips of light gauge galvanized iron about an inch wide and ten or twelve inches long. Merely bend over the upper two inches of the strip at right angles. This forms the face of the label which can be written on with metallic ink applied with a glass pen. Information regarding preparation of metallic ink can be secured from this Station. The ink eats into the galvanize, making a black legend against the bright label. The remainder of the galvanized iron strip forms the stem of the label. It can be made more rigid by bending it in the form of a V throughout its length. By tilting the face of the label at an angle with the stem, the inscription can be placed so that it is easily read from eye level. Scraps of galvanized iron can be used and the labels made up at home in the winter months. They can be produced for about a cent each.

Where larger labels of this type are required, they can be made of two pieces of galvanized iron, the stem being fastened to the lower centre of the face with two small rivets. Stems 18 inches in length and faces 3 by 2 inches have been found very useful for labelling trees and shrubs. These labels can be made up for about five cents each, including the cost of labour.

DAIRY CATTLE

J. E. Miltimore

The development of the present herd of Jersey cattle at the Summerland Station is an excellent example for the practical breeder. In breeding livestock, it is essential that the breeder have a clearly defined goal and an inflexible determination to achieve it.

The objective at Summerland has been to secure a herd that conformed to breed type and that would have the stamina to maintain high production during a long useful lifetime. With this aim in view, six good foundation cows were selected and persistent culling of their offspring has resulted in a herd combining the desired characteristics with a high degree of uniformity. These results could only be achieved with a very careful supervision of feeding and management.

During the past twelve years, 41 Silver Medals, 12 Gold Medals and 1 Medal of Merit have been awarded to animals in the herd. This notable achievement is remarkable because of the small size of the herd which is limited to from 14 to 17 cows; although the constant culling that keeps the herd at this number contributes to the high average production. Cows that finished lactations in 1948 produced an average of 9,395 pounds of milk and 553 pounds of fat in an average lactation of 338 days, No correction is made for heifers which constitute 20 to 30 per cent of the milking herd.

That progress is being made is indicated by the yearly production figures presented in Table 32.

TABLE 32—HERD AVERAGE PRODUCTION PER COW PER YEAR

Year	Cows in Herd	Pounds of Milk	Per cent Fat	Pounds of Butterfat	Butterfat Index
1937	13	7,382·1	5·75	420·2	1·15
1938	14	8,005·4	5·66	452·9	1·25
1939	14	8,363·3	5·79	482·4	1·24
1940	16	8,427·9	5·66	477·3	1·26
1941	10	8,761·8	5·67	497·0	1·22
1942	15	7,938·7	5·76	456·7	1·27
1943	15	9,544·7	5·73	547·2	1·38
1944	15	8,558·8	5·73	490·4	1·41
1945	16	8,619·9	5·85	499·5	1·35
1946	14	8,907·6	5·77	510·0	1·34
1947	16	8,704·0	5·90	509·0	1·36
1948	11	9,395·0	5·93	553·0	1·38

For the five-year period prior to 1938, the butterfat produced per cow, per lactation, averaged 446 pounds whereas the average for the five years prior to 1949 was 521 pounds. Including all cows in the herd, regardless of age, disease or injury, this represents an average annual increase per cow of over six pounds of butterfat. This improvement is confirmed by a marked increase in the index of butterfat production. The index of butterfat is a means of expressing the butterfat yield in relation to the total number of days between calvings for any given lactation.

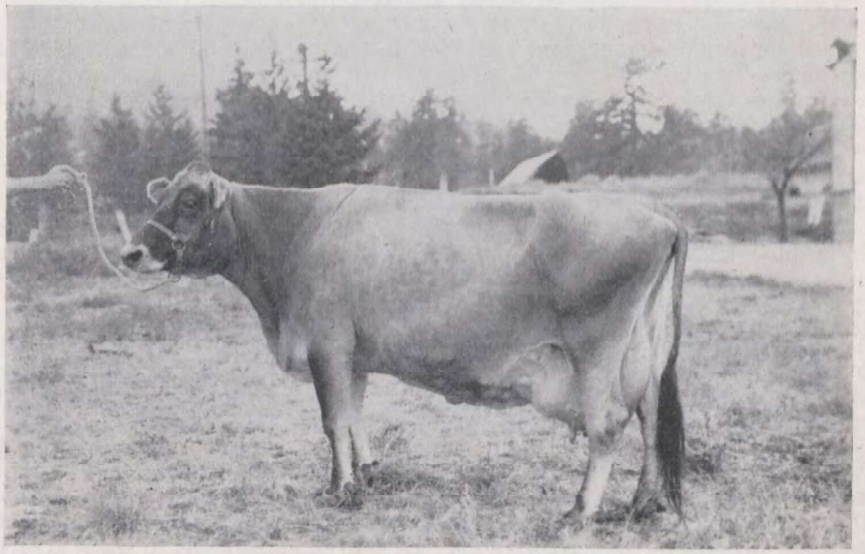


FIG. 29—SUMMERLAND STANDARD FLO

This 15-year-old cow from Sunflower Flora by Oxford Sultan's Standard, classified "Very Good". Flo has completed twelve R.O.P. records which average 603 pounds of butterfat. 1948.

High levels of production should not be encouraged to the point where the cows are "burned out" by forcing them beyond the yield that their particular bodies were designed to produce. The number of high lifetime records made at Summerland is evidence that the cows are not forced. Calgarth Starlight was World's Champion Lifetime Butterfat Producer in 1938 with

133,642 pounds of milk and 7,757 pounds of fat. A daughter, Summerland Standard Glow, at 13 years of age had produced an average of 530 pounds of fat per lactation for 10 lactations. Glow has not won any medals but she has been giving a high average production and is currently working on her eleventh lactation. Had this cow been heavily fed, higher records could likely have been made but her period of usefulness would have been considerably shortened, and her lifetime yield reduced. Also fewer calves would have been left to carry on this highly desirable type of production.

That cows in the herd at Summerland are not forced above their normal production level is evidenced by the list of lifetime records shown in Table 33. Three of these cows are still adding to their records.

TABLE 33—LIFETIME RECORDS OVER 4,000 POUNDS BUTTERFAT

Name of Cow	Number of Cow	Pounds of Milk	Pounds of Butterfat
Calgarth Starlight	17479	133,642	7,757
Summerland Standard Flo	79669	123,036	7,239
Summerland Hamlet Starlight	53426	121,396	6,621
Summerland Standard Glow	84594	105,426	5,852
Summerland Favourite Sparkle	97525	79,491	4,434
Summerland Favourite Twinkle	97520	71,586	4,206

Those responsible for the breeding program have appreciated the immeasurable value of the best cows and have adopted a breeding plan whereby the blood of the outstanding cows is carried in the herd through selection of their more promising offspring. Today every cow in the herd is a fairly closely related descendant of the two most outstanding foundation cows, Calgarth Starlight and Sunflower Flora. With few exceptions, the heifers are kept until they have completed their first lactations. The record they make in their first year serves as a fairly accurate indication of future production. The first calf heifers are either retained or sold as breeding stock on this basis, depending of course on their conformation and breeding. One hundred and three well-bred heifers and 83 bulls have been sold as breeding stock to dairymen in B.C. Herd sires are tested and then selected so that they will increase and perpetuate the hereditary characteristics of high production carried by the better foundation cows.

The soundness of a plan whereby only proven sires are used cannot be over-emphasized. An unproven sire is an unknown factor and any breeding program is plagued with sufficient problems without the deliberate addition of another. A prospective sire is usually bred to heifers. The resulting bull calves are destroyed and the heifers raised and bred. When the first daughters of these young bulls have finished a lactation period, their records are compared with their dams'. If over a large number of dam-daughter pairs the daughters are higher producers than their dams, the bull is considered to have a certain amount of breeding worth. The actual breeding value of the bull depends on the extent of the increased production in conjunction with various factors such as conformation and the consistency with which the bull can increase production.

There are many aspects to the competent care of the dairy herd. Regularity, kindliness and alertness on the part of the herdsman are very important. Changes in routine should be made gradually. Feeds should not vary from day to day. Milking times should always be the same. Water should always be conveniently available and in winter it should be warm enough so that the cows drink all they require.

The Summerland herd receives high quality feed. During the winter, they are fed either corn silage or alfalfa and apple silage, along with mangels; and cull apples are included with the mangles as long as the supply lasts. The hay consists of a grass and alfalfa mixture in which the alfalfa predominates. The irrigated hay is cut before it is mature to assure maximum protein and vitamin A content. The grain fed varies in constituents depending on the season. In winter, a mixture of oat chop, bran and linseed meal is fed in a ratio of 4:4:1 respectively. However, when the cows are pasturing green rapidly-growing irrigated grasses and legumes, the high-protein and relatively expensive linseed meal is omitted from the ratio. One to two per cent iodized salt is included in the grain ration and one per cent of a commercial mineral mix is added to ensure adequate supplies of calcium, phosphorus, iron and trace elements, such as copper, manganese and cobalt. Approximately one pound of grain is fed for each three pounds of milk produced per day. Twenty-five to thirty pounds of mixed mangels and apples are fed daily with about 15 pounds of silage and 20 pounds of hay. The amounts fed are determined by the size and stage of lactation of the cow concerned and by the season. Some cows give relatively large yields from a given level of feeding whereas others give lower yields. These lower yielding cows are less efficient feeders and are culled.

FIG. 30—THE SUMMERLAND STATION JERSEY HERD ON PASTURE

With good management, irrigated pastures have a carrying capacity of from 2 to 3 cows per acre. 1940.

The herd is regularly tested each year for tuberculosis and contagious abortion. Any suspicious premature calving warrants immediate isolation of the individual concerned and thorough testing for contagious abortion. Similar treatment is given any other suspicious condition in the herd. Mastitis is kept to a bare minimum. Adequate, carefully spread bedding and prompt attention to the milking machine are two factors of importance in the control of mastitis. The keen eye of the herdsman saves many a minor or major disaster.

In all industries, the artistic touch is becoming increasingly prominent. Such is the case with dairy cattle where an effort is being made to combine desirable conformation with high production. While production and utility

have been given special emphasis at this Station, there still has been a noticeable trend toward the standard-type Jersey cow. The standards are such that improvement in conformation and increase in production should go together. A cow closely conforming to the standard should be stronger, wear better and so last longer than a cow of indifferent type. As an illustration that the conformation of the herd has improved, in 1942, nine animals were officially classified "Good" of better, whereas in 1948 all classified animals in the herd classified "Good Plus" or better, with none in the lower category of "Good".

FORAGE CROPS

J. E. Miltimore

Experimental work with forage crops at this Station has centred around the pasture, hay and silage requirements of dairy cattle. Most farming in the South Okanagan, involves dairying only whereas in the North Okanagan, grain growing is an important part of farm enterprise. Information has been gathered on the varieties of grasses, legumes and corn best adapted to South Okanagan conditions. In all experimental work, attention has been paid to the economic feasibility of given crops and practices. For example, root crops are not considered an economical feed for dairy cattle where irrigated pastures, corn silage and good alfalfa hay can be grown to advantage.

Pastures

Pastures are recognized as the cheapest and most nutritious food for livestock. Where dairying is the primary enterprise, pastures containing green, growing legumes and grasses are essential to economical production. Whereas at one time many types of grasses and legumes were included in a pasture seed mix, the recent trend has been to simple mixes containing one or two grasses and a legume. At Summerland a mixture of orchard grass 5 pounds, brome 10 pounds and Ladak alfalfa 10 pounds, sown at these rates per acre, has given good yields. For heavier soils, Ladino clover sown at one pound per acre increases pasture yield. If moisture supplies are limited, one pound per acre of common white clover may be sown. When either Ladino or white clover are included in the seed mix, the alfalfa may be left out completely or only 5 pounds included, depending on the type of pasture desired. If common white clover is included in the seed mix, the pasture must be closely grazed to enable the clover to develop and grow. Alfalfa, however, will not stand close grazing and will soon be killed out if grazed too closely. This is the chief disadvantage of alfalfa as a pasture legume.

Bloating is often a serious problem when pastures contain a high percentage of legumes. There is some evidence that the tendency to bloat is considerably reduced when common white clover is the legume in use, rather than alfalfa. At this Station, some bloating has occurred in pastures containing two-thirds grasses and only one-third alfalfa.

A well prepared seed-bed is essential to an even catch. Seed is expensive and any seeds that do not germinate represent money wasted. The seed-bed should be firm in order to assure that the seed is at the required depth. Desirable depth of seeding varies slightly with climatic and soil conditions but usually three-quarters of an inch is deep enough. Young seedlings root quite readily if the seed-bed is firm and properly worked. The soil should not be lumpy nor too fine but in good tilth to assure adequate soil aeration and readily available soil moisture. Fall ploughing and working down in the fall appears to be the most satisfactory procedure for seed-bed preparation. Fall cultivation is desirable as it relieves the usual rush of work during the spring, and the seeding date may be advanced. Early seedings usually have sufficient winter moisture available in the soil to tide them over until irrigation water is supplied. Since winter precipitation in the B.C. Dry Belt is light, fall working gives no undue

loss of soil nutrients from leaching, as might be the case in areas of heavier rainfall. Exposed fields should not be worked down fine after ploughing because of the danger of wind erosion.

It is the practice at this Station to grow an annual pasture crop such as sudan grass for one year before seeding the land to perennial grasses and legumes. This gives weed seeds a chance to germinate and be killed, resulting in a clean pasture.

Regardless of the suitability of the seed mixture and the stand obtained, yields are usually unsatisfactory unless proper management is practised. Pastures are most palatable and nutritious when they are bright green in colour and growing rapidly. The value of green growing pastures can be seen by examining milk yields. In the spring months, herds give high yields. These yields decline as the pastures decline; slower growing, paler green pastures result in lower milk yields. Where irrigation water is available, pastures can be kept growing strongly all summer. By applying the water with sprinklers, excellent results have been secured even on light, gravelly hillsides. This method of irrigation eliminates erosion and makes it easy to establish new seedings.

Application of fertilizer to irrigated pastures at intervals during the growing season is good practice. Growth can often be stimulated greatly by this procedure. If grasses predominate, legumes may be encouraged by application of phosphates. Fall applications of 200 pounds of ammonium phosphate per acre followed by light applications of ammonium nitrate in the late spring and summer seasons have revitalized pastures to a remarkable extent.

Intensity of grazing is a management factor that merits special attention. Pastures under sprinkler irrigation at this Station have carried three cows per acre until June. Carrying capacity from June until September is 2 cows per acre. Thus one-third of the pasture area is not required for pasture until June. This "extra" pasture land is either cut for hay or seeded to an annual pasture if that particular field is being renewed and had been ploughed the previous fall. This arrangement makes full use of the surplus pasture during the flush spring season. Despite the intensity of grazing, some plants, notably orchard grass, tend to mature in clumps. To remedy this, the pastures are mowed about once a month. When pastures decline in September they are supplemented by feeding corn, which is cut green.

Silage

Pasture is not available during winter months in the B.C. Dry Belt but silage can be used to help replace it. Silage more closely resembles pasture than any other feed which can be produced in this area. It is an economical, nutritious and highly palatable feed. Ensilage is usually made from mature corn as corn cures without use of preservatives and large yields can be obtained. The hybrid; Canada 625, has consistently given high yields in tests of corn varieties and hybrids at this Station. In 1948, four months after the planting date of May 10, all ears of this hybrid were well filled. Yields per acre of several other hybrids grown in 1947 are shown in Table 34.

TABLE 34—CORN VARIETY TRIALS, 1947

Variety	Tasseling Date	Silking Date	Yield per Acre in Tons
Canada 355	August 1	August 10	18·6
Canada 606	August 15	August 26	20·3
Pride D66	August 7	August 16	20·8
Dekalb 240	August 10	August 17	18·2
Dekalb 65	August 9	August 20	17·5
Canada 531	August 8	August 17	18·9

Planted—June 8 and 10; Emerged—June 14-16; Harvested—September 23.

Table 34 indicates rather small differences in the yields of the various hybrids. The late seeding date and the fact that all hybrids were harvested at once probably reduced the yield of late-maturing hybrids.

Sprinklers have proved satisfactory as a means of applying irrigation water to corn. Good results were obtained by leaving one row blank for each sprinkler placing. Risers 8 feet high were used after the corn reached three feet. Attached rods were sunk in the ground to hold the risers upright.

FIG. 31—A GOOD CROP OF SILAGE CORN

Hybrid Canada 625 gives heavy yields of silage corn in areas where there is a long growing season. Hybrids Canada 531 and 335 are suitable for short season areas. 1940.

Preparation of the land for corn is nearly as important as for a grass and legume seeding. A heavy application of manure is worked into the soil the previous autumn and 200 pounds of ammonium phosphate applied about ten days before seeding.

Alfalfa hay and apples have been used as silage with excellent results. The apples are chopped with the hay and blown into the silo. A proportion of 60:40 alfalfa hay to apples or 80:20 wilted alfalfa to apples by weight has been satisfactory. Silage made in this manner has sometimes been stored in the same silo above corn silage. When this has been the case, the corn silage has been made more palatable. The explanation is that the juice from the apples and alfalfa silage runs down into the corn silage. Ordinarily corn silage is not relished after the cows have been turned on pasture but when apple-alfalfa silage was ensiled on top of corn silage, cows on pasture showed obvious relish for the corn silage. Analyses showing the comparative composition of corn and apple-alfalfa silage are presented in Table 35.

TABLE 35—COMPOSITION OF ALFALFA-APPLE SILAGE COMPARED WITH CORN SILAGE

(Feed Constituents Expressed as Percentage of Dry Matter)

Kind of silage	Fat	Crude Fibre	Mineral	Protein	Carbo-hydrates
Corn	1·05	27·03	8·22	7·37	56·33
Alfalfa-Apple	1·49	26·62	4·64	10·97	56·28

The data presented in Table 35 indicate that alfalfa-apple silage has advantages in nutrient composition. The nearly 50 per cent higher protein content is important, as protein supplements are the most expensive of the major dairy ration components. The fat content was also materially higher in the alfalfa silage.

Hay

Hay is third in terms of nutrition and economy, following pasture and silage. Dairy cattle, fed ample quantities of choice alfalfa hay, have a good opportunity to show their production potential. Alfalfa mixed with grasses tends to give high yields of well balanced hay which cures readily. Alfalfa and grass hays are less likely to lodge than alfalfa alone. If hay has to be stacked or coiled, alfalfa hay will not shed water as well as a grass-and-alfalfa hay mixture.

The same seed combination is used at Summerland for hay as for pasture—orchard grass 5 pounds, brome 10 pounds and Ladak alfalfa 10 pounds per acre. Ladino and common white clovers are not tall growing enough to be included in hay seed mixes. Seed-bed preparation and fertilization are largely the same for hay and pastures. However, for hay fields it is even more desirable that the land surface be smooth.

Care is taken to cut the hay at the desired stage of maturity. When the alfalfa starts to bloom, it is cut. In this way, nutritious and palatable hay is obtained and three crops are secured. All moisture and soil nutrients, that are used by hay after the bloom is well started, are wasted as they are not available for the next crop and the present crop decreases in value the longer it is left uncut.

Hay crops have responded well to application of irrigation water by the sprinkler method. A new seeding was so situated that a portion of the field area was sprinkled and the remainder was irrigated by the furrow method. A stronger stand was obtained where the seeding was sprinkled. The area irrigated by furrows was badly eroded whereas there was no erosion with sprinklers. Furthermore, under sprinklers there was less tendency for the hay to turn brown from lack of moisture on shallow soils.

After pasture there is silage and after silage there is hay. After hay there is grain. The feeds just mentioned are listed in their order of economic importance for the dairyman. Each one is more expensive than the one previously mentioned. Dairy cattle can manufacture milk from any of these feeds. Therefore, the wise dairyman will give special attention to his pastures.

LIST OF PUBLICATIONS 1937-1948

In addition to numerous mimeographed circulars and a great many popular articles printed in newspapers and monthly periodicals, the following bulletins and papers of a more technical nature have been published during the past 12 years:—

Tobacco, Fruit Varieties, Rootstocks and General Topics

Palmer, R. C. and Hewetson, F. N.
Stock and Scion Relationships in Some Four Year Old Apple Trees.
Sci. Agr. 17:9, 1937.

Mann, A. J.
Tobacco in British Columbia.
Canada Dept. Agr. Pub. 669, Farmers' Bull. 87, 1940.

Palmer, R. C.
Dwarf and Semi-Dwarf Apple Trees.
Proc. Wash. State Hort. Assoc., 1942.

Mann, A. J.
Framework Stocks for Apple Trees.
Proc. Wash. State Hort. Assoc., 1945.

Palmer, R. C.
The Working Tools of an Agrologist.
Agr. Inst. Rev. 1:6, 1946.

Mann, A. J. and Keane, F. W. L.
The Spartan and Jubilee Apples.
Fruit Varieties and Hort. Digest 3:1, 1948.

Palmer, R. C.
Bird's Eye View of Research.
Agr. Inst. Rev. 3:6, 1948.

Orchard Nutrition, Soils and Irrigation

Wilcox, J. C.
Field Studies of Apple Tree Growth and Fruiting I. Sampling and Measuring Terminal Shoots.
Sci. Agr. 17:563-572, 1937.

Wilcox, J. C.
Field Studies of Apple Tree Growth and Fruiting II. Correlations between Growth and Fruiting.
Sci. Agr. 17:573-586, 1937.

Wilcox, J. C.
Field Studies of Apple Tree Growth and Fruiting III. Some Observations on the Measurement of Tree Vigour.
Sci. Agr. 17:657-669, 1937.

Wilcox, J. C.
Effects of Some Field Plot Treatments on Drought Spot and Corky Core of the Apple.
Sci. Agr. 18:300-314, 1938.

Wilcox, J. C.
Soil Moisture Studies I. Some Factors Affecting the Moisture Holding Capacity and Its Determination.
Sci. Agr. 20:140-149, 1939.

Wilcox, J. C.
Adjusting Apple Yields for Differences in Size of Tree.
Sci. Agr. 21:139-148, 1940.

Wilcox. J. C. and Spilsbury, R. H.
Soil Moisture Studies II. Some Relationships between Moisture Measurements and Mechanical Analysis.
Sci. Agr. 21:459-472, 1941.

Wilcox, J. C. and Spilsbury, R. H.
Soil Moisture Studies III. An Application of Soil Moisture Measurements to Soils Classification.
Sci. Agr. 21:473-478, 1941.

***Orchard Nutrition, Soils and Irrigation**—Concluded*

Wilcox, J. C. and Woodbridge, C. G.
Some Effects of Excess Boron on the Storage Quality of Apples.
Sci. Agr. 23:332-341, 1942.

Wilcox, J. C.
Some Factors Affecting Apple Yields in the Okanagan Valley. I. Tree Size, Tree Vigour, Biennial Bearing and Distance of Planting.
Sci. Agr. 25:189-213, 1944.

Wilcox, J. C.
Some Factors Affecting Apple Yields in the Okanagan Valley. II. Soil Depth, Moisture Holding Capacity and pH.
Sci. Agr. 25:739-759, 1945.

Wilcox, J. C. and Knight, A. T.
Some Factors Affecting Apple Yields in the Okanagan Valley. III. Root Distribution.
Sci. Agr. 25:760-775, 1945.

Wilcox, J. C.
Orchard Irrigation in British Columbia.
Canada Dept. Agr. Pub. 779, Farmers' Bull. 134, 1946.

Wilcox, J. C. and Walker, Joy.
Some Factors Affecting Apple Yields in the Okanagan Valley. IV. Organic Matter Content of Soil.
Sci. Agr. 26:460-467, 1946.

Wilcox, J. C.
Establishing an Undertree Sprinkler Schedule in Orchards.
Proc. Washington State Hort. Assoc. 42:241-244, 1946.

Wilcox, J. C.
Uniformity of Water Distribution by Undertree Orchard Sprinklers.
Proc. Washington State Hort. Assoc. 42:245-250, 1946.

Wilcox, J. C.
Determination of Electrical Conductivity of Soil Solution.
Soil Sci. 63:107-117, 1947.

Wilcox, J. C., Hoy, B. and Palmer, R. C.
Orchard Fertilizer Tests in the Okanagan Valley.
Sci. Agr. 27:116-129, 1947.

Wilcox, J. C. and Swailes, G. E.
Uniformity of Water Distribution by Some Undertree Orchard Sprinklers.
Sci. Agr. 27:565-583, 1947.

Wilcox, J. C.
Sprinkler Irrigation of Orchards in British Columbia.
Canada Dept. Agr. Pub. 797, Farmers' Bull. 144, 1947.

Wilcox, J. C.
Soil Conservation and Land Use in Southern British Columbia.
Agr. Inst. Rev. 2:401-403, 1947.

Wilcox, J. C.
Soil Sampling Technique in Orchards.
Sci. Agr. 28:321-332, 1948.

Fruit Thinning, Pruning, Harvesting and Storage

Palmer, R. C. and Fisher, D. V.
Apple Thinning Investigations, 1920-1935.
Canada Dept. Agr. Pub. 579, Tech. Bull. 10, 1937.

Fisher, D. V.
A Three-Year Study of Maturity Indices for Harvesting Italian Prunes.
Proc. Am. Soc. Hort. Sci. 37:183-186, 1939.

Fisher, D. V.
Storage of Delicious Apples in Artificial Atmospheres.
Proc. Am. Soc. Hort. Sci. 37:459-462, 1939.

Fisher, D. V. and Britton, J. E.
Apple Waxing Experiments.
Sci. Agr. 21:70-79, 1940.

Fruit Thinning, Pruning, Harvesting and Storage—Concluded

Fisher, D. V. and Britton, J. E.
Thinning as a Means of Correcting Biennial Bearing in Apples.
Sci. Agr. 21:105-114, 1940.

Fisher, D. V. and Britton, J. E.
Maturity Studies with Sweet Cherries.
Sci. Agr. 20:497-503, 1940.

Fisher, D. V. and Britton, J. E.
Maturity and Storage Studies with Peaches.
Sci. Agr. 21:1-17, 1940.

Britton, J. E., Fisher, D. V. and Palmer, R. C.
Apple Harvesting and Storage in British Columbia.
Canada Dept. Agr. Pub. 724, Farmers' Bull. 105, 1941.

Fisher, D. V. and Palmer, R. C.
A Continuous Apple Thinning Experiment Conducted from 1920-1939.
Proc. Am. Soc. Hort. Sci. 38:193-195, 1941.

Palmer, R. C., Britton, J. E. and Fisher, D. V.
Soil Maintenance and Pruning Methods for Peaches and Apricots.
Canada Dept. Agr. Pub. 721, Tech. Bull. 34, 1941.

Fisher, D. V. and Embree, J. J.
Automatic Control Apparatus for Maintaining Near-Constant Suction Pressure with an Electrically-Controlled Vacuum Pump.
Proc. Am. Soc. Hort. Sci. 42:473-474, 1943.

Britton, J. E., Fisher, D. V. and Palmer, R. C.
The Influence of Some Horticultural Practices on Bitter Pit in Okanagan Grown Apples.
Sci. Agr. 23:651-675, 1943.

Fisher, D. V.
Mealiness and Quality of Delicious Apples as Affected by Growing Conditions Maturity and Storage Techniques.
Sci. Agr. 23:569-588, 1943.

Fisher, D. V.
Controlled Atmosphere Storage Helps Keep Fruit Fresh.
Food Ind. 15:70-72 and 122-124, 1943.

Palmer, R. C.
The Influence of Amount of Crop and Harvesting Maturity on Bitter Pit in Okanagan Grown Newtown Apples.
Proc. Am. Soc. Hort. Sci. 43:63-68, 1943.

Fruit and Vegetable Processing

Atkinson, F. E.
A Home Cider Press.
Canada Dept. Agr. Pub. 530, Circ. 112, 1938.

Atkinson, F. E.
Operation and Construction of Domestic Canneries in B.C.
Canada Dept. Agr. Pub. 648, Farmers' Bull. 76, 1939.

Atkinson, F. E. and Strachan, C. C.
Summarized Report—Results of Experiments, Fruit and Vegetable Products Laboratory, 1929-1940.
Canada Dept. Agr., 1942.

Strachan, C. C.
Factors Influencing Ascorbic Acid Retention in Apple Juice.
Canada Dept. Agr. Pub. 732, Tech. Bull. 40, 1942.

Atkinson, F. E. and Strachan, C. C.
Home Processing of Fruits and Vegetables.
Canada Dept. Agr. Pub. 744, Farmers' Bull. 114, 1942.

Atkinson, F. E. and Strachan, C. C.
Production of Juices—Their Manufacture, Chemical Aspects and Laboratory Control.
Canada Dept. Agr. Pub. 813, Tech. Bull. 68, 1948.

Atkinson, F. E.
Fruit and Vegetable Processing.
Can. Chem. & Metal. 21:5, 1937.

***Fruit and Vegetable Processing**—Concluded*

Atkinson, F. E.
The Manufacture of Sulphurous Acid from Crude Sulphur for Bleaching Cherries.
Can. Hort. and Home Mag., 1938.

Atkinson, F. E. and Strachan, C. C.
Preparation of Fruit Juices.
Can. Food Packer 10:8, 1939.

Atkinson, F. E. and Strachan, C. C.
Chemical Constituents of Some Fruits Grown in B.C.
Sci. Agr. 20:6, 1940.

Atkinson, F. E. and Strachan, C. C.
Candying of Fruit in British Columbia with Special Reference to Cherries.
Fruit Products J. 20:5-10, 1941.

Atkinson, F. E. and Strachan, C. C.
Preservation of Fruits with Sulphur Dioxide in British Columbia.
Fruit Products J. 21:1-5, 1941-1942.

Atkinson, F. E. and Strachan, C. C.
Canadian Dehydration of Tree Fruits.
Food in Canada 3:6, 1943.

Strachan, C. C.
Determining Oxygen in Gas-Packed Dehydrated Vegetables.
Food in Canada, 2:5, 1942.

Atkinson, F. E. and Strachan, C. C.
Whither Canada's Apple Industry? No. 3. Apple Juice, Syrup and Concentrate.
Food in Canada 4:11, 1944.

Strachan, C. C. and Embree, J. J.
Improved Technics for Making Gas-Pack Tests.
Food Industries 16:12, 1944.

Strachan, C. C. and Atkinson, F. E.
Ascorbic Acid Content of Tomato Varieties and Its Retention in Processed Products.
Sci. Agr. 26:2, 1946.

Strachan, C. C. and Moyls, A. W.
A Simple Method for Estimating Ascorbic Acid in Fortified Apple Juice.
Food in Canada 6:8, 1946.

Strachan, C. C.
Uniform Quality in Tomato Products Calls for Control of Finishing Point.
Food in Canada 6:8, 1946.

Atkinson, F. E.
Storage and Ripening of Fruit for Canning.
The Canner 103:10, 1946.

Atkinson, F. E.
Quality in Tomato Juice. *Part I.* The Tomato Juice.
Can. Food Packer 17:7, 1946.

Strachan, C. C.
Quality in Tomato Juice. *Part II.* Results of Vitamin Analyses.
Can. Food Packer 17:8, 1946.

Strachan, C. C.
The Value of Fruit Cut-out Tests.
Can. Food Packer 17:10, 1946.

Atkinson, F. E. and Strachan, C. C.
Small Single-Line Fruit Canneries in B.C.
Can. Food Industries, 19:4, 1948.

Strachan, C. C.
Product Quality as Influenced by Enzymes.
Can. Food Industries 19:8, 1948.

Atkinson, F. E.
Important Factors in Canning Italian Prunes.
Can. Food Industries 19:9, 1948.

LIST OF ACTIVE PROJECTS

Animal Husbandry

A-58	Record of Performance (Dairy and Dual-Purpose Breeds)
A-59	Periodic Cost of Rearing Dairy Females
A-93	Tuberculosis in Cattle—Control of
A-217	Cost of Maintaining Herd Sires
A-456	Periodic Cost of Rearing Dairy Males
A-503	Breeding Jersey Cattle
A-660	Serum Test of Contagious Abortion
A-813	Feed Cost of Milk and Butterfat Production

Field Husbandry

F-305	Meteorological Records
F-369	Commercial Fertilizer Formulae for Pastures
F-412	Commercial Fertilizer Formulae for Hay

Forage Crops

Ag 1	Corn Variety Test for Ensilage Purposes
Ag 16	Roots—Variety Test
Ag 267	Pasture Grasses—Variety Test of

Irrigation and Nutrition of Orchards

H-411	Irrigation of Orchards
H-759	Root Growth Studies of Trees and Plants
H-830	Tree Fruits—Fertilizer and Nutritional Studies
H-837	Tree Fruits—Methods of Soil Management
H-968	Quality of Irrigation Water
H-969	Optimum Soil Reaction and Salt Content

Varieties, Breeding, Pollination and Propagation of Fruit Trees

H-815	Tree Fruits—Variety Experiment
H-827	Tree Fruits—Breeding
H-829	Tree Fruits—Double Working
H-834	Tree Fruits—Pollination
H-836	Tree Fruits—Rootstock Investigations
H-979	Tree Fruits—Production of Foundation Stock

Thinning, Pruning, Harvesting and Storage of Fruits

H-832	Tree Fruits—Methods and Dates of Harvesting
H-838	Fruit Storage Investigations
H-839	Tree Fruits—Thinning Experiment
H-973	Rodent Extermination in Fruit Cold Storage Houses
H-974	Bleach Treatment for Stained Apple Boxes
H-975	Pear Black-End Investigations
H-976	Physiology of Fruit in Storage
H-977	Mechanical Refrigeration of Fruit Storage Houses

Fruit and Vegetable Products

H-775	Freezing Fruits and Vegetables
H-865	Chemical Analysis of Horticultural Products
H-868	Glaceing of Fruit
H-873A	Canning Tests of Fruits and Vegetables—Varieties
H-873B	Canning Tests of Fruits and Vegetables—Heat Penetration
H-873C	Canning Tests of Fruits and Vegetables—Peeling
H-874	Wine Making
H-922-1	Fruit and Vegetable Juice Investigations
H-922-2	Concentration of Fruit Juices
H-942A	Packaging Dried Fruits
H-971	Jam Manufacture
H-972A	Pickle Manufacture—Cherry Olives

Vegetables

H-102	Corn—Variety Experiment
H-219	Vegetable Seed—Test for Trueness to Name and Type
H-638	Soil and Air Temperatures in Relation to Plant Growth
H-795	Leguminous Vegetables—Variety Experiment
H-801	Verification Trials for Vegetable Crops
H-803	Root Vegetables—Variety Experiment
H-804	Leafy Vegetables—Variety Experiment
H-805	Vegetable Vine Crops—Variety Experiment
H-806	Solanaceous Vegetables—Variety Experiment
H-818	Processing and Production of Foundation Seed
H-822	Solanaceous Vegetables—Breeding and Selection

Flowers

H-261	Annuals—Variety Experiment
H-274	Herbaceous Perennials—Variety Experiment
H-298	Hedges—Variety Experiment
H-307	Trees—Ornamental and Shelter—Variety Experiment
H-790	Shrubs—Flowering and Ornamental—Variety Experiment
H-796	Bulbous Plants—Variety Experiment
H-797	Flowering Bulbs—Variety Experiment
H-799	Greenhouse Plants—Variety Experiment
H-825	Perennial Flowers, Breeding and Selection
H-842	Trees and Shrubs, Propagation
H-844	Annual Flowers, Breeding and Selection
H-850	Annual Flowers—Variety Experiment (Greenhouse)

OTTAWA
EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
KING'S PRINTER AND CONTROLLER OF STATIONERY
1951

10M—14456—1 : 51