

Diseases and Pests of Vegetable Crops in Canada

Edited by

Ronald J. Howard • J. Allan Garland • W. Lloyd Seaman



To the amateur biologists and professional plant pathologists and entomologists
whose studies and publications on vegetable diseases and pests have provided the foundation for this book.

In the 19th century, information on identifying and controlling diseases and pests was provided largely by self-taught naturalists, often clergy, through local agricultural societies and colleges and through reports published by government boards of agriculture. The Entomological Society of Canada (founded in 1863, incorporated in 1871 as the Entomological Society of Ontario, and re-established in 1951) frequently included information on economic entomology in its reports. Regional colleges of agriculture (the first founded in 1859 at Sainte-Anne-de-la-Pocatière) provided instruction in pest management, and *Le Naturaliste canadien*, founded in 1868, included articles on diseases and pests. Expert advice was provided by universities, beginning in 1874 with the Ontario Agricultural College, which produced a series of bulletins from 1886. Research and extension on a national scale began in 1886 with the formation of the Experimental Farms of the Dominion Department of Agriculture, with William Saunders as director and James Fletcher as entomologist and botanist. Fletcher and his successors, botanist H.T. Güssow and entomologist C.G. Hewitt, established laboratories of plant pathology and entomology across Canada; the department also introduced several series of bulletins and other publications, including *Canadian Plant Disease Survey* (1920) and the *Canadian Insect Pest Review* (1923). The Quebec Society for the Protection of Plants, founded in 1908 by naturalists and biologists interested in plant diseases and insect and weed pests, published annual reports in English and in French that were widely distributed in Quebec and elsewhere. In 1918 Canadian plant pathologists met to form the Canadian Division of the American Phytopathological Society, which in 1929 became the Canadian Phytopathological Society. The following list of publications is representative of advisory contributions of that period on diseases and pests of vegetable crops.

- 1868 **Bustin, W.** The potato disease. *J. Agric. Nova Scotia* 1:314-315.
- 1869 **Provancher, L.** Les pommes de terre et leur maladie; L'anthomye de l'ognon. *Nat. Can. (Que.)* 1:37-44; 155-157.
- 1872 **Beadle, D.W.** *Canadian Fruit, Flower, and Kitchen Garden*. James Campbell & Son, Toronto. 391 pp.
- 1891 **Fletcher, J.** Recommendations for the prevention of damage by some common insects of the farm, the orchard and the garden. Dorn. Can. Dep. Agric. Exp. Farms Bull. 11.
- 1891 **Fyles, T.W.** Kitchen-garden pests and how to deal with them. Pages 44-50 in 21st Annu. Rep. Entomol. Soc. Ont., 1891.
- 1892 **Shaw, T., and C.A. Zavitz.** Weeds and modes of destroying them. Ont. Agric. Coll. Bull. 85.
- 1893 **Panton, J.H.** Remedies for common plant and insect foes. Ont. Agric. Coll. Bull. 87.
- 1895 **Craig, J., and J. Fletcher.** 1. Spraying for the prevention of fungous diseases; 2. Injurious insects; 3. Potato diseases [potato blights, potato scab]; 4. Black knot of the plum and cherry. Dorn. Can. Dep. Agric. Exp. Farms Bull. 23.
- 1904 **Harrison, F.C., and B. Barlow.** Some bacterial diseases of plants prevalent in Ontario. Ont. Agric. Coll. Bull. 136.
- 1905 **Fletcher, J.** Insects injurious to grain, fodder crops, root crops and vegetables. Dorn. Can. Dep. Agric. Exp. Farms Bull. 52.
- 1906 **Lochhead, W., and T.D. Jarvis.** The common fungus and insect pests of growing vegetable crops. Ont. Agric. Coll. Bull. 150.
- 1907 **Harcourt, R., and H.L. Fulmer.** Insecticides and fungicides. Ont. Agric. Coll. Bull. 154.
- 1909 **Bethune, C.J.S.** Insects affecting vegetables; and **Eastham, J.W., and J.E. Howitt.** Fungus diseases affecting vegetables. Ont. Agric. Coll. Bull. 171.
- 1909 **Giissow, H.T.** A serious potato disease occurring in Newfoundland. Dorn. Can. Dep. Agric. Exp. Farms, Div. Bot. Bull. 63.
- 1909 **Swaine, J.M.** Injurious insects of the Montreal area in 1908. Pages 17-23 in 1st Annu Rep. Que. Soc. Prot. Plants.
- 1912 **Hewitt, C.G.** Legislation in Canada to prevent the introduction and spread of insects, pests and diseases destructive to vegetation, with regulations regarding the importation of vegetation into Canada. Dorn. Can. Dep. Agric. Exp. Farms Div. Entomol. Bull., 2nd Ser. 11.
- 1913 **Gorham, R.P.** Insecticides and fungicides for orchards and garden crops. N.B. Dep. Agric. Bull. 2.
- 1914 **Fraser, W.P.** Storage rots of potatoes and other vegetables. Pages 50-51 in 6th Annu Rep. Que. Soc. Prot. Plants.
- 1914 **Eastham, J.W.** Powdery scab of potatoes. Dorn. Can. Dep. Agric. Exp. Farms Div. Bot. Farmers' Circ. 5.
- 1916 **Eastham, J.W., and M.H. Ruhmann.** Diseases and pests of cultivated plants; and **Hoy, B.** Sprays and spraying. B.C. Dep. Agric. Bull. 68.
- 1916 **Murphy, P.A.** The black leg disease of potatoes. Dorn. Can. Dep. Agric. Exp. Farms Div. Bot. Cire. 11.

- 1917 **Gibson, A.** Common garden insects and their control. Can. Dep. Agric. Entomol. Br. Circ. 9.
- 1917 **Jackson, V.W.** Potato diseases in Manitoba. Man. Agric. Coll. Ext. Bull. 14 (Part II).
- 1918 **Howitt, J.E., and D.H. Jones.** The more important fungus and bacterial diseases of vegetables in Ontario. Ont. Agric. Coll. Bull. 258.
- 1918 **Maheux, G.** The protection of plants. Que. Dep. Agric. Bull. 42.
- 1918 **McCubbin, W.A.** The diseases of tomatoes. Dorn. Can. Dep. Agric. Exp. Farms Div. Bot. Bull., 2nd Ser. 35.
- 1920 **Dickson, B.T.** Diseases of the potato. Pages 67-103 in 14th Annu. Rep. Que. Soc. Prot. Plants.
- 1921 **Cutler, G.H., and G.B. Sanford.** Potato diseases. Univ. Alberta Coll. Agric. Field Husb. Circ. 7.
- 1922 **Caesar, L.** The cabbage maggot. Ont. Agric. Coll. Bull. 289.
- 1922 **Gibson, A., and W.A. Ross.** Insects affecting greenhouse plants. Dorn. Can. Dep. Agric. Bull., N.S. 7.
- 1923 **Treherne, R.C.** Root maggots and their control. Dorn. Can. Dep. Agric. Pamphlet, N.S. 32.
- 1924 **Vanterpool, T.C.** The stripe or streak disease of tomatoes in Quebec. Pages 116-123 in 16th Annu. Rep. Que. Soc. Prot. Plants.
- 1926 **Racicot, H.N.** A spotting and shrinking of potatoes in storage. Pages 55-56 in 18th Annu. Rep. Que. Soc. Prot. Plants.
- 1927 **Gingras, P.** La pyrale du maïs. *Rev. Inst. Agric. Oka* 1:228-230.
- 1928 **Baribeau, B.** Inspection et certification de la pomme de terre. *Rev. Inst. Agric. Oka* 2:2-7.
- 1929 **Howitt, J.E., D.R. Sands and D.H. Jones.** Fungus and bacterial diseases of vegetables. Ont. Agric. Coll. Bull. 345.
- 1929 **Hurst, R.R.** Studies in potato diseases. 1. Late blight and rot of potatoes caused by the fungus *Phytophthora infestans* (Mont.) de Bary. Dom. Can. Dep. Agric. Bull., N.S. 119.
- 1932 **Dustan, A.G.** Vegetable insects and their control. Dom. Can. Dep. Agric. Bull., N.S. 161.

Recognition also is extended to **J.C. Walker** for *Diseases of Vegetable Crops* (1952) and to **C. Chupp** and **A.F. Sherf** for *Vegetable Diseases and their Control* (1960), classic textbooks on vegetable diseases in North America; and to **I.L. Connors** for *An Annotated Index of Plant Diseases in Canada* (1967).

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Edited by Ronald J. Howard, J. Allan Garland and W. Lloyd Seaman



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Contents

Diseases and Pests of Vegetable Crops in Canada	1
Contents	6
Foreword.....	39
Acknowledgments	41
Introduction.....	53
PART 1 Vegetable Crop Production and Management	55
1 CROP PRODUCTION.....	57
Tables 1.1-1.4	57
▶ 1.1 Importance of vegetable crops	57
Table 1.1. Farm value of potato and other vegetable crops in Canada	57
▶ 1.2 Field and garden vegetable crops.....	57
Table 1.2a. Commercially significant vegetable crops in Canada	58
Table 1.2b. Common and scientific names of vegetable crops.....	59
▶ 1.3 Protected vegetable crops	63
▶ 1.4 Insects as pollinators of vegetable crops.....	64
Table 1.4. Pollination requirements of vegetable crops grown in Canada	65
2 CROP LOSSES AND THEIR CAUSES.....	67
Figures 2.3a-q; 2.3T1	67
Tables 2.3a-d	67
▶ 2.1 Types of crop losses	67
Production losses	67
Post-harvest losses	67
▶ 2.2 Causes of crop losses.....	68
▶ 2.3 Pathogens and other pests <i>Figs. 2.3a-q; 2.3T1</i>	69
Identification.....	69
Bacteria and actinomycetes	69
Fungi.....	69
Viruses and viroids	70
Virus-like pathogens (wall-less prokaryotes).....	70
Nematodes	70
Table 2.3a. Host ranges of economically important nematode pests on vegetable crops in Canada.....	71
Insects.....	72
Mites and spiders	73
Table 2.3b. Characteristics of major groups of insects associated with vegetable crops in Canada	73
Table 2.3c. Key to the principal orders of insects associated with vegetable crops in Canada	73
Centipedes and millipedes	74

Symphylans	74
Slugs and snails	74
Sowbugs and pillbugs	75
Weeds (<i>Figs. 2.3a-q</i>)	75
Table 2.3d. Weeds commonly occurring in vegetable crops in Canada	75
2.3T1 Parasitic higher plants; yellow strands of dodder, <i>Cuscuta</i> sp., entwining a sugar beet plant.	77
Parasitic higher plants.....	77
▶ 2.4 Climate and environment.....	77
Pest distribution	77
Environment-related disorders.....	78
Chemical injury	78
Nutritional disorders	78
Additional references	78
3 DISEASE AND PEST MANAGEMENT	79
Figures 3.7 to 3.13; 3.2T1; 3.2T2; 3.14T1	79
▶ 3.1 Integrated pest management	79
▶ 3.2 Monitoring <i>Figs. 3.2T1, 3.2T2</i>	80
3.2T1 Monitoring; sticky traps, such as the yellow one shown here in a carrot field, are used to trap insects such as the carrot rust fly, aphids, leafhoppers and thrips; in the greenhouse, blue traps are more attractive than yellow ones to the western flower thrips and may be less attractive, and therefore less harmful, to beneficial insects.	81
3.2T2 Monitoring; carrot weevil adults may be monitored with traps made of wooden plates spaced 3 mm apart and containing a carrot as bait at the base.	81
▶ 3.3 Cultural practices.....	82
Escape and prevention	82
▶ 3.4 Resistant cultivars.....	82
Pathogen resistance.....	82
Insect and mite resistance	82
Future possibilities.....	82
▶ 3.5 Biological control	83
Concepts and practices	83
▶ 3.6 Beneficial plants (allelopathy)	84
▶ 3.7 Beneficial insects, mites and pathogens <i>Figs. 3.7a-z</i>	85
Predators.....	85
Parasites.....	86
▶ 3.8 Chemical control.....	87
Pesticides.....	87
Environmental impact.....	88
▶ 3.9 Management by exclusion and regulation	88
Legislative control measures	88

► 3.10 Foreign diseases and pests	88
Potato gangrene	88
Potato viruses.....	88
Columbia root-knot nematode <i>Figs. 3.10a,b</i>	89
Potato-rot nematode <i>Fig. 16.37</i>	89
Pepper weevil <i>Figs. 24.13a-e</i>	89
Potato tuberworm <i>Fig. 3.10c</i>	89
Sweetpotato whitefly <i>Figs. 3.10d-g</i>	90
Tomato pinworm <i>Fig. 3.10h</i>	90
► 3.11 Introduced diseases and pests	90
Bacterial ring rot <i>Figs. 16.1a-e</i>	91
Potato wart <i>Figs. 16.21a-d</i>	91
Potato spindle tuber <i>Figs. 16.28a,b</i>	91
Potato virus Y ^N <i>Figs. 3.1 1a-c; 16.27b</i>	91
Potato cyst nematodes <i>Fig. 16.36</i>	91
Golden nematode <i>Globodera rostochiensis</i> (Wollenweb.) Behrens	91
Pale cyst nematode <i>Globodera pallida</i> (Stone) Behrens.....	91
Colorado potato beetle <i>Figs. 16.44a-d</i>	91
European corn borer <i>Figs. 12.16a-h</i>	92
Japanese beetle <i>Fig. 3.11d</i>	92
Brown garden snail <i>Fig. 3.11e</i>	92
► 3.12 Management of nematode pests <i>Fig. 3.12</i>	92
Monitoring.....	92
Cultural practices.....	92
Resistant cultivars.....	93
Biological control	93
Chemical control.....	93
► 3.13 Management of weed pests <i>Fig. 3.13</i>	94
Monitoring.....	94
Cultural practices.....	94
Biological control	94
Chemical control.....	94
Crop injury from herbicide drift or soil residues.....	94
Future trends in weed management	95
► 3.14 Managing diseases and pests in home vegetable gardens <i>Fig. 3.14T1</i>	95
3.14T1 European earwig feeding injury to squash	96
Monitoring.....	96
Cultural practices.....	96
Resistant cultivars.....	98
Biological control	98

Chemical control.....	98
PART 2 Diseases and Pests of Field-grown Crops.....	100
4 ASPARAGUS	102
Figures 4.1 to 4.10; 4.6T1	102
Fungal diseases	102
▶ 4.1 Botrytis blight (gray mold) <i>Figs. 4.1a,b</i>	102
▶ 4.2 Fusarium crown and root rot <i>Figs. 4.2a-e</i>	102
▶ 4.3 Phomopsis blight (stem blight)	104
▶ 4.4 Phytophthora spear rot.....	104
▶ 4.5 Purple spot stemphylium leaf spot <i>Figs. 4.5a-c</i>	104
▶ 4.6 Rust <i>Figs. 4.6a,b; 4.6T1</i>	105
4.6T1 Rust; disease cycle of <i>Puccinia asparagi</i>	106
Viral diseases	107
▶ 4.7 Miscellaneous viral diseases	107
Asparagus virus I	107
Asparagus virus II.....	107
Tobacco streak virus	107
Non-infectious diseases.....	108
▶ 4.8 Miscellaneous disorders <i>Fig. 4.8</i>	108
Autotoxicity	108
Cold injury	108
Insect pests	108
▶ 4.9 Asparagus aphid <i>Fig. 4.9</i>	108
▶ 4.10 Asparagus beetles <i>Figs. 4.10a-e</i>	109
Asparagus beetle <i>Crioceris asparagi</i> (L.).....	109
Spotted asparagus beetle <i>Crioceris duodecimpunctata</i> (L.).....	109
▶ 4.11 Other insect pests <i>Figs.</i>	110
Green peach aphid <i>Myzus persicae</i> (Sulzer).....	110
Onion thrips <i>Thrips tabaci</i> Lindeman	110
Variegated cutworm <i>Peridroma saucia</i> (Hübner).....	110
Additional references	110
Bean see 15 Pea and bean.....	110
5 BEET, CHARD, SPINACH	111
Figures 5.1 to 5.17; 5.6T1; 5.7T1; 5.15T1	111
Bacterial diseases.....	111
▶ 5.1 Scab <i>Fig. 5.1</i>	111
Fungal diseases	111
▶ 5.2 Aphanomyces root rot <i>Fig. 5.2</i>	111
▶ 5.3 Cercospora leaf spot <i>Fig. 5.3</i>	112

▶ 5.4 Downy mildew <i>Figs. 5.4a,b</i>	113
▶ 5.5 Fusarium wilt <i>Figs. 5.5a-d</i>	114
▶ 5.6 Phoma leaf spot and root rot <i>Fig. 5.6T1</i>	115
5.6T1 Phoma leaf spot and root rot; disease cycle of <i>Phoma betae</i>	116
▶ 5.7 Pythium root rot <i>Fig. 5.7T1</i>	117
5.7T1 Pythium root rot and damping-off; disease cycle of <i>Pythium</i> spp. on vegetable crops.	117
▶ 5.8 Rhizoctonia root rot <i>Figs. 5.8a,b</i>	118
▶ 5.9 White rust <i>Fig. 5.9</i>	119
Viral diseases	120
▶ 5.10 Spinach blight <i>Fig. 5.10</i>	120
Non-infectious diseases	121
▶ 5.11 Heart rot (boron deficiency)	121
Nematode pests	121
▶ 5.12 Northern root-knot nematode <i>Fig. 6.20</i>	121
▶ 5.13 Root-lesion nematode <i>Fig. 16.38T1</i>	121
▶ 5.14 Sugarbeet cyst nematode <i>Figs. 5.14a,b</i>	122
Insect pests	122
▶ 5.15 Beet leafhopper <i>Figs. 5.15; 5.15T1</i>	122
5.15T1 Beet leafhopper; adult (left), and genitalia of female (center) and male (right), ventral view..	123
▶ 5.16 Flea beetles <i>Fig. 5.16</i>	123
Redheaded flea beetle <i>Systema frontalis</i> (Fabricius)	123
Other flea beetles	123
▶ 5.17 Other insect pests <i>Figs. 5.17a-f</i>	123
Aphids	123
Beet webworm.....	123
Leafminers	123
White grubs	124
Additional references	124
6 CARROT	125
Bacterial diseases	125
▶ 6.1 Bacterial leaf blight <i>Figs. 6.1a,b</i>	125
▶ 6.2 Bacterial soft rot <i>Fig. 6.2</i>	126
▶ 6.3 Crown gall <i>Fig. 6.3</i>	127
▶ 6.4 Scab <i>Fig. 6.4</i>	127
Fungal diseases	128
▶ 6.5 Alternaria leaf blight <i>Figs. 6.5a,b</i>	128
▶ 6.6 Black root rot (black mold) <i>Figs. 6.6a-c</i>	129
▶ 6.7 Black rot <i>Fig. 6.7</i>	130
▶ 6.8 Cavity spot <i>Fig. 6.8</i>	131

▶ 6.9 Cercospora leaf blight <i>Figs. 6.9a-d</i>	133
▶ 6.10 Crater rot <i>Fig. 6.10</i>	134
▶ 6.11 Crown rot (rhizoctonia canker) <i>Figs. 6.11a-c</i>	135
▶ 6.12 Fusarium dry rot <i>Fig. 6.12</i>	136
▶ 6.13 Pythium root dieback <i>Figs. 6.13a,b</i>	137
▶ 6.14 Rubbery brown rot <i>Fig. 6.14</i>	138
▶ 6.15 Sclerotinia rot (white mold) <i>Figs. 6.15a,b</i>	139
▶ 6.16 Violet root rot <i>Fig. 6.16</i>	140
Viral-like diseases	141
▶ 6.17 Aster yellows <i>Figs. 6.17a-c</i>	141
Non-infectious diseases	142
▶ 6.18 Growth cracks <i>Fig. 6.18</i>	142
▶ 6.19 Heat canker <i>Figs. 6.19a-c</i>	142
Nematode pests	142
▶ 6.20 Northern root-knot nematode <i>Figs. 6.20</i>	142
▶ 6.21 Root-lesion nematode <i>Fig. 16.38T1</i>	144
Insect pests	144
▶ 6.22 Aster leafhopper <i>Figs. 11.23a,b</i>	144
▶ 6.23 Carrot rust fly <i>Figs. 6.23a-e; 3.2T1</i>	145
▶ 6.24 Carrot weevil <i>Figs. 6.24a-d; 3.2T2</i>	146
▶ 6.25 Cutworms <i>Figs. 6.25a-c; 11.26; 18.35a-g</i>	147
▶ 6.26 Other insect pests <i>Figs. 6.26; 12.21a,b</i>	148
White grubs	148
Wireworms	148
Additional references	148
7 CELERY, CELERIAC	149
Figures 7.1 to 7.22	149
Bacterial diseases	149
▶ 7.1 Bacterial leaf spot (northern bacterial blight) <i>Figs. 7.1a,b</i>	149
Fungal diseases	150
▶ 7.2 Brown spot <i>Fig. 7.2</i>	150
▶ 7.3 Cercospora blight (early blight) <i>Figs. 7.3a,b</i>	151
▶ 7.4 Damping-off <i>Fig. 7.4</i>	152
▶ 7.5 Fusarium yellows <i>Figs. 7.5a-c</i>	153
▶ 7.6 Pink rot (white mold) <i>Figs. 7.6a,b</i>	154
▶ 7.7 Septoria blight (late blight) <i>Figs. 7.7a-g</i>	155
Viral and viral-like diseases	156
▶ 7.8 Aster yellows <i>Figs. 7.8a,b</i>	156
▶ 7.9 Heart mosaic <i>Figs. 7.9a-c</i>	156

Non-infectious diseases.....	157
▶ 7.10 Blackheart <i>Figs. 7.10a,b</i>	157
▶ 7.11 Chlorosis <i>Fig. 7.11</i>	157
Magnesium deficiency	157
Manganese deficiency	157
▶ 7.12 Cracked stem (boron deficiency) <i>Figs. 7.12a,b</i>	158
▶ 7.13 Spongy petiole (pithiness) <i>Fig. 7.13</i>	158
▶ 7.14 Stringiness	159
Nematode pests	159
▶ 7.15 Northern root-knot nematode <i>Figs. 7.15a,b</i>	159
▶ 7.16 Root-lesion nematode <i>Fig. 16.38T1</i>	159
Insect pests	160
▶ 7.17 Aphids <i>Figs. 16.41a,b</i>	160
Green peach aphid <i>Myzus persicae</i> (Sulzer).....	160
Other aphids.....	160
▶ 7.18 Aster leafhopper <i>Figs. 11.23a,b</i>	160
▶ 7.19 Carrot rust fly <i>Figs. 6.23a,c,e</i>	160
▶ 7.20 Carrot weevil <i>Fig. 7.20</i>	160
▶ 7.21 Tarnished plant bug <i>Figs. 7.21 a-e; 18.42b-e</i>	161
▶ 7.22 Other insect pests <i>Figs. 7.22a,b; 8.40b-f</i>	162
Caterpillars	162
▶ 7.23 Slugs <i>Figs. 11.27a-c</i>	162
Additional references	162
Corn see 12 maize	Error! Bookmark not defined.
8 CRUCIFERS BROCCOLI, BRUSSELS SPROUTS, CABBAGE, CAULIFLOWER, RADISH, RUTABAGA, TURNIP	163
Figures 8.1 to 8.47	163
Bacterial diseases	164
▶ 8.1 Bacterial leaf spot (peppery leaf spot) <i>Figs. 8.1a,b</i>	164
▶ 8.2 Black rot <i>Figs. 8.2a-f</i>	165
▶ 8.3 Head rot <i>Figs. 8.3a-c</i>	166
▶ 8.4 Scab <i>Figs. 8.4a-c</i>	167
Fungal diseases	168
▶ 8.5 Alternaria diseases <i>Figs. 8.5a,b</i>	168
Black leaf spot	168
Gray leaf spot	168
▶ 8.6 Blackleg <i>Figs. 8.6a-d</i>	170
▶ 8.7 Black root <i>Fig. 8.7</i>	171
▶ 8.8 Clubroot <i>Figs. 8.8a-c</i>	172
▶ 8.9 Damping-off <i>Fig. 8.9</i>	173

▶ 8.10 Downy mildew <i>Figs. 8.10a-e</i>	173
▶ 8.11 Fusarium wilt (yellows) <i>Figs. 8.11a,b</i>	174
▶ 8.12 Powdery mildew <i>Fig. 8.12</i>	176
▶ 8.13 Rhizoctonia diseases <i>Figs. 8.9, 8.13a-e</i>	176
Damping-off	176
Wirestem	176
Root rot (crater rot)	176
Bottom rot	176
Head rot	176
▶ 8.14 Sclerotinia rot (cottony soft rot) <i>Fig. 8.14</i>	178
▶ 8.15 White rust <i>Fig. 8.15</i>	179
Viral diseases	180
▶ 8.16 Turnip mosaic <i>Figs. 8.16a-c</i>	180
Non-infectious diseases	181
▶ 8.17 Black speck of cauliflower <i>Fig. 8.17</i>	181
▶ 8.18 Brown bead <i>Fig. 8.18</i>	181
▶ 8.19 Growth cracks <i>Fig. 8.19</i>	181
▶ 8.20 Hollow stem <i>Fig. 8.20</i>	181
▶ 8.21 Intumescence (edema, enation, neoplasm, thrips pustule) <i>Figs. 8.21 a-c</i>	182
▶ 8.22 Tipburn, internal browning <i>Figs. 8.22a,b</i>	182
Nutritional disorders	183
▶ 8.23 Boron deficiency (brown heart, mottled heart, raan, water core) <i>Figs. 8.23a-d</i>	183
▶ 8.24 Magnesium deficiency <i>Fig. 8.24</i>	184
▶ 8.25 Molybdenum deficiency (whiptail) <i>Figs. 8.25a,b</i>	184
▶ 8.26 Sulfur deficiency <i>Fig. 8.26</i>	184
Storage disorders	185
▶ 8.27 Black midrib <i>Fig. 8.27</i>	185
▶ 8.28 Black speck of cabbage (pepper spot, spotted necrosis) <i>Figs. 8.28a,b</i>	185
▶ 8.29 Gray speck <i>Fig. 8.29</i>	186
▶ 8.30 Necrotic spot <i>Fig. 8.30</i>	186
▶ 8.31 Vein streaking <i>Fig. 8.31</i>	186
▶ 8.32 Frost-induced disorders <i>Figs. 8.32a-e</i>	187
Black blotching	187
Black spot	187
Epidermal detachment	187
Frost blemishing	187
Redheart	187
▶ 8.33 Other storage disorders	188
Dormancy	188
Ethylene	188

Maturity	188
Nematode pests	188
▶ 8.34 Northern root-knot nematode <i>Fig. 6.20</i>	188
▶ 8.35 Root-lesion nematode <i>Fig. 16.38T1</i>	188
▶ 8.36 Stubby-root nematodes	188
▶ 8.37 Sugarbeet cyst nematode <i>Figs. 5.14a,b</i>	189
Insect pests	189
▶ 8.38 Alfalfa looper <i>Fig. 8.38</i>	189
▶ 8.39 Aphids <i>Figs. 8.39a,b; 16.41a,b</i>	189
Cabbage aphid <i>Brevicoryne brassicae</i> (L.)	189
Green peach aphid <i>Myzus persicae</i> (Sulzer)	189
Turnip aphid <i>Lipaphis erysimi</i> (Kaltenbach)	189
Turnip root aphid <i>Pemphigus populitransversus</i> (Riley)	189
▶ 8.40 Cabbage looper <i>Figs. 8.40a-f; 3.7x-z</i>	190
▶ 8.41 Cabbage maggot <i>Figs. 8.41 a-g</i>	191
▶ 8.42 Diamondback moth <i>Figs. 8.42a-g</i>	193
▶ 8.43 European earwig <i>Figs. 8.43a-d</i>	194
▶ 8.44 Flea beetles <i>Figs. 8.44a-e; 10.14a,b</i>	195
Cabbage flea beetle <i>Phyllotreta albionica</i> (LeConte)	195
Crucifer flea beetle <i>Phyllotreta cruciferae</i> (Goeze)	195
Garden flea beetle <i>Phyllotreta robusta</i> LeConte	195
Hop flea beetle <i>Psylliodes punctulata</i> Melsheimer	195
Horseradish flea beetle <i>Phyllotreta armoraciae</i> (Koch)	195
Striped flea beetle <i>Phyllotreta striolata</i> (Fabricius)	195
▶ 8.45 Imported cabbageworm <i>Figs. 8.45a-f</i>	197
▶ 8.46 Purple-backed cabbageworm <i>Figs. 8.46a-g</i>	198
▶ 8.47 Red turnip beetle <i>Figs. 8.47a-c</i>	199
▶ 8.48 Other insect pests <i>Figs. 16.49c-e</i>	200
Leatherjackets	200
White grubs	200
Other pests	200
▶ 8.49 Gray garden slug <i>Figs. 11.27c; 18.43</i>	200
Additional references	200
9 CUCURBITS (CUCUMBER, MELON, PUMPKIN, SQUASH, ZUCCHINI)	202
Figures 9.1 to 9.22	202
Bacterial diseases	202
▶ 9.1 Angular leaf spot <i>Figs. 9.1a,b; 22.1</i>	202
▶ 9.2 Bacterial wilt <i>Figs. 9.2a,b</i>	203
Fungal diseases	204

▶ 9.3 Anthracnose <i>Figs. 9.3a-c</i>	204
▶ 9.4 Choanephora rot	205
▶ 9.5 Fusarium foot rot <i>Fig. 9.5</i>	206
▶ 9.6 Fusarium wilt <i>Figs. 9.6a,b; 22.9a,b</i>	207
▶ 9.7 Gray mold <i>Figs. 9.7; 22.10a-d</i>	208
▶ 9.8 Leaf blights <i>Figs. 9.8a,b; 22.12a,b</i>	209
Alternaria leaf blight	209
Ulocladium leaf spot	209
▶ 9.9 Leaf rot (pink mold rot) <i>Fig. 22.13</i>	210
▶ 9.10 Powdery mildew <i>Fig. 9.10</i>	210
▶ 9.11 Pythium fruit rot (leak)	210
▶ 9.12 Pythium root rot <i>Figs. 22.7a-d</i>	211
▶ 9.13 Scab (gummosis) <i>Figs. 9.13; 22.16</i>	211
▶ 9.14 White mold (sclerotinia rot) <i>Figs. 9.14a-c; 22.18a-d</i>	212
Viral and viral-like diseases	213
▶ 9.15 Cucumber mosaic <i>Figs. 9.15; 22.20a,b</i>	213
▶ 9.16 Zucchini yellow mosaic <i>Figs. 9.16a-c; 22.24a,b</i>	213
▶ 9.17 Other viral and viral-like diseases <i>Figs. 9.17a,b</i>	214
Aster yellows Aster yellows mycoplasma-like organism	214
Cucumber necrosis Cucumber necrosis virus	214
Watermelon mosaic Watermelon mosaic virus	214
Non-infectious diseases	214
▶ 9.18 Cold injury <i>Figs. 9.18a-c</i>	214
Nematode pests	215
▶ 9.19 Northern root-knot nematode <i>Fig. 22.30d</i>	215
▶ 9.20 Root-lesion nematode <i>Fig. 16.38T1</i>	215
Insect pests	215
▶ 9.21 Cucumber beetles <i>Fig. 9.21</i>	215
Spotted cucumber beetle <i>Diabrotica undecimpunctata howardi</i> Barber	215
Striped cucumber beetle <i>Acalymma vittatum</i> (Fabricius)	215
▶ 9.22 Other insect pests <i>Figs. 9.22 a-c</i>	216
European earwig	216
Melon aphid	216
Potato leafhopper	216
Seedcorn maggot	216
Squash bug	216
Squash vine borer	217
Tarnished plant bug	217
Cutworms	217
Wireworms	217

Additional references	217
10 HERBS AND SPICES	218
Figures 10.2 to 10.15	218
Fungal diseases	218
▶ 10.1 Canker of hop	218
▶ 10.2 Downy mildew of hop <i>Fig. 10.2</i>	218
▶ 10.3 Leaf scorch of parsley <i>Figs. 10.3a,b</i>	219
▶ 10.4 Leaf spots of parsley <i>Fig. 10.4</i>	220
Alternaria leaf spot <i>Alternaria dauci</i> (Kühn) Groves & Skolko	220
Phoma leaf spot <i>Phoma anethi</i> (Pers.:Fr.) Sacc. (synanamorph <i>Cercosporidium punctum</i> (Lacr.) Deighton)	220
Septoria leaf spot <i>Septoria petroselini</i> (Lib.) Desmaz.	220
▶ 10.5 Powdery mildew of hop, mint, sage and parsley <i>Fig. 10.5</i>	220
▶ 10.6 Pythium root rot of parsley <i>Figs. 10.6a,b</i>	221
▶ 10.7 Rust of mint <i>Figs. 10.7a,b</i>	222
▶ 10.8 Sooty mold of hop	223
▶ 10.9 Verticillium wilt of mint and hop <i>Figs. 10.9a-d</i>	223
▶ 10.10 Other fungal diseases of herbs <i>Figs. 10. 10a-c</i>	224
Viral and viral-like diseases	225
▶ 10.11 Aster yellows <i>Figs. 10.11 a, b</i>	225
▶ 10.12 Miscellaneous viral diseases <i>Fig. 10.12</i>	225
Broad bean wilt virus	225
Carrot motley dwarf (carrot mottle virus plus carrot red leaf virus)	225
Celery mosaic virus	225
Cucumber mosaic virus	225
Hop mosaic virus (hop latent virus)	225
Hop nettle head (arabis mosaic virus plus prunus necrotic ringspot virus)	225
Tomato spotted wilt virus	225
Insect pests	226
▶ 10.13 Aphids <i>Figs. 16.41a,b; 16.42a-c</i>	226
Carrot-willow aphid <i>Cavariella aegopodii</i> (Scopoli)	226
Green peach aphid <i>Myzus persicae</i> (Sulzer)	226
Hop aphid <i>Phorodon humuli</i> (Schrank)	226
Potato aphid <i>Macrosiphum euphorbiae</i> (Thomas)	226
Other aphids	226
▶ 10.14 Flea beetles <i>Figs. 10.14a, b</i>	227
Hop flea beetle <i>Psylliodes punctulata</i> Melsheimer	227
Horseradish flea beetle <i>Phyllotreta armoraciae</i> (Koch)	227
Other crucifer-feeding flea beetles <i>Phyllotreta</i> spp.	227
▶ 10.15 Other insect pests <i>Figs. 10.15a-c; 8.43b,cK</i>	227

Black swallowtails <i>Papilio</i> spp.....	227
Carrot rust fly <i>Psila rosae</i> (Fabricius)	227
European earwig <i>Forficula auricularia</i> L.....	227
Other pests	227
▶ 10.16 Mites and slugs <i>Fig. 11.27c</i>	227
Additional references	228
11 LETTUCE, CHICORY, ENDIVE.....	229
Figures 11.1 to 11.27; 11.24T1, T2.....	229
Bacterial diseases	230
▶ 11.1 Bacterial soft rots <i>Figs. 11.1 a, b</i>	230
Bacterial wilt (dry leaf spot)	230
Head rot (slime rot).....	230
▶ 11.2 Infectious corky root.....	230
▶ 11.3 <i>Pseudomonas</i> diseases <i>Figs. 11.3a-d</i>	231
Slime.....	231
Brown rot.....	231
Varnish spot.....	231
Butt rot.....	231
Head rot	231
Table 11.3 Key to differentiate fluorescent <i>Pseudomonas</i> species on lettuce.....	232
Fungal diseases	233
▶ 11.4 Anthracnose (ring spot), fire of endive <i>Fig. 11.4</i>	233
▶ 11.5 Black root rot <i>Fig. 11.5</i>	234
▶ 11.6 Bottom rot <i>Figs. 11.6a,b</i>	234
▶ 11.7 Damping-off, stunt <i>Figs. 11.7a-c</i>	235
▶ 11.8 Downy mildew <i>Figs. 11.8a, b</i>	236
▶ 11.9 Drop (white mold) <i>Figs. 11.9a-f</i>	237
▶ 11.10 Gray mold <i>Figs. 11.10a-f</i>	238
▶ 11.11 Phoma rot.....	240
▶ 11.12 Powdery mildew <i>Fig. 23.10</i>	240
▶ 11.13 Rust <i>Figs. 11.13a,b</i>	241
▶ 11.14 Septoria leaf spot	241
Viral and viral-like diseases.....	242
▶ 11.15 Asteryellows <i>Figs. 11.15a, b</i>	242
▶ 11.16 Big vein <i>Fig. 11.16</i>	243
▶ 11.17 Lettuce mosaic <i>Figs. 11.17a, b; 23.14</i>	243
▶ 11.18 Other viral diseases <i>Fig. 23.15</i>	244
Artichoke Italian latent virus	244
Beet mild yellowing virus.....	244

Beet western yellows virus	244
Chicory yellow mottle virus	244
Cucumber mosaic virus	244
Lettuce infectious yellows virus	244
Tomato spotted wilt virus	244
Non-infectious diseases.....	246
▶ 11.19 Nutrient disorders <i>Figs. 11.19a-c; 23.16</i>	246
Manganese deficiency	246
Manganese toxicity	246
Tipburn	246
▶ 11.20 Other disorders <i>Fig. 11.20</i>	246
Non-infectious corky root	246
Pink rib	246
Russet spot.....	246
Nematode pests	247
▶ 11.21 Northern root-knot nematode <i>Fig. 7.15b</i>	247
▶ 11.22 Root-lesion nematode <i>Fig. 16.38T1</i>	247
Insect pests	247
▶ 11.23 Aster leafhopper <i>Figs. 11.23a, b</i>	247
▶ 11.24 Lettuce aphid <i>Figs. 11.24T1, T2</i>	248
11.24T1 Lettuce aphid; photomicrographs of wingless (above) and winged adults, which are usually pale green; length 2-3 mm.	249
11.24T2 Lettuce aphid; A,B) scanning electron micrographs of third segment of antenna of wingless (A) and winged (B) adults; C) cornicle; D) tip of abdomen.	250
▶ 11.25 Other aphids.....	251
▶ 11.26 Other insect pests <i>Figs. 11.26; 8.40; 7.21</i>	251
Cabbage looper	251
Cutworms	251
Tarnished plant bug	251
Other pests	251
▶ 11.27 Slugs and snails <i>Figs. 11.27a-c; 3.11e</i>	251
Black slug <i>Arion ater</i> (L.).....	251
Brown garden snail <i>Helix aspersa</i> Müller	251
Gray garden slug <i>Deroceras reticulatum</i> (Müller)	251
Spotted garden slug <i>Limax maximus</i> L.	251
Additional references	252
12 MAIZE (SWEET CORN)	253
Figures 12.1 to 12.22; 12.21T1	253
Bacterial diseases	253
▶ 12.1 Stewart's wilt <i>Figs. 12.1 a-c</i>	253

Fungal diseases	254
▶ 12.2 Damping-off <i>Figs. 12.2a,b</i>	254
▶ 12.3 Ear and kernel rots <i>Figs. 12.3a-c</i>	255
Fusarium kernel rot.....	255
Gibberella ear rot	255
▶ 12.4 Eyespot <i>Fig. 12.4</i>	256
▶ 12.5 Rust, common <i>Fig. 12.5</i>	257
▶ 12.6 Smut, common <i>Figs. 12.6a,b</i>	258
▶ 12.7 Smut, head <i>Figs. 12.7a,b</i>	259
▶ 12.8 Stalk rots <i>Figs. 12.8a-d</i>	259
Diplodia stalk rot	259
Fusarium stalk rot	259
Gibberella stalk rot	259
Pythium stalk rot.....	260
▶ 12.9 Three- to five-leaf dieback <i>Figs. 12.9a-d</i>	261
Viral diseases	262
▶ 12.10 Maize dwarf mosaic <i>Figs. 12.10a,b</i>	262
Nematode pests	263
▶ 12.11 Stubby-root nematodes	263
Insect pests	263
▶ 12.12 Army worm <i>Figs. 12.12a-c</i>	263
▶ 12.13 Corn earworm <i>Figs. 12.13 a-d</i>	264
▶ 12.14 Corn leaf aphid <i>Fig. 12.14</i>	265
▶ 12.15 Corn rootworms <i>Figs. 12.15a-c</i>	265
Northern corn rootworm <i>Diabrotica barberi</i> Smith & Lawrence	265
Southern corn rootworm <i>Diabrotica undecimpunctata howardi</i> Barber.....	265
Western corn rootworm <i>Diabrotica virgifera virgifera</i> LeConte.....	265
▶ 12.16 European corn borer <i>Figs. 12.16a-h</i>	267
▶ 12.17 Fall army worm <i>Figs. 12.17a-e</i>	268
▶ 12.18 Flea beetles	269
Corn flea beetle <i>Chaetocnema pulicaria</i> Melsheimer.....	269
Toothed flea beetle <i>Chaetocnema denticulata</i> Illiger	269
▶ 12.19 Four-spotted sap beetle <i>Figs. 12.3c, 12.19</i>	269
▶ 12.20 Seedcorn maggot <i>Figs. 12.20a-c</i>	270
▶ 12.21 Wireworms <i>Figs. 12.21a,b,T1; 16.50</i>	270
Corn wireworm <i>Melanotus communis</i> (Gyllenhal).....	270
Other wireworms	270
12.21T1 Wireworm (below): larva of <i>Agriotes mancus</i>	271
Table 12.21 Key to some common wireworms damaging vegetable crops	271

▶ 12.22 Other insect pests <i>Figs. 12.22a,b</i>	272
Cutworms	272
European earwig	272
Grasshoppers	272
Potato stem borer	272
White grubs	272
Additional references	272
13 ONION, GARLIC, LEEK, SHALLOT, CHIVES	273
Figures 13.1 to 13.26	273
Bacterial diseases	273
▶ 13.1 Slippery skin <i>Fig. 13.1</i>	273
▶ 13.2 Soft rot (bacterial soft rot) <i>Figs. 13.2a,b</i>	274
▶ 13.3 Sour skin <i>Fig. 13.3</i>	275
Fungal diseases	276
▶ 13.4 Basal rot <i>Fig. 13.4</i>	276
▶ 13.5 Botrytis leaf blight <i>Figs. 13.5a,b</i>	277
▶ 13.6 Downy mildew <i>Figs. 13.6a-d</i>	278
▶ 13.7 Neck rots <i>Figs. 13.7a-d</i>	280
Neck rot (gray mold neck rot)	280
Mycelial neck rot	280
Small sclerotial neck rot	280
▶ 13.8 Pink root <i>Figs. 13.8a, b</i>	281
▶ 13.9 Purple blotch <i>Figs. 13.9a,b; 13.5b</i>	282
▶ 13.10 Smudge <i>Fig. 13.10</i>	283
▶ 13.11 Smut <i>Figs. 13.11a-c</i>	284
▶ 13.12 White rot <i>Figs. 13.12a-e</i>	285
Viral and viral-like diseases	286
▶ 13.13 Aster yellows <i>Fig. 13.13</i>	286
▶ 13.14 Viral diseases <i>Fig. 13.14</i>	287
Garlic mosaic (yellow streak)	287
Leek yellow stripe virus	287
Onion yellow dwarf	287
Shallot latent virus	287
Tomato black ring virus and tobacco mosaic virus	287
Non-infectious diseases	288
▶ 13.15 Herbicide injury <i>Figs. 13.15a-c</i>	288
▶ 13.16 Ozone injury <i>Fig. 13.16</i>	288
▶ 13.17 Sprout inhibitor injury <i>Fig. 13.17</i>	289
▶ 13.18 Sunscald	289

▶ 13.19 Tipburn (tip dieback) <i>Fig. 13.19</i>	290
▶ 13.20 Translucent scale <i>Fig. 13.20</i>	290
▶ 13.21 Wind, hail, pelting rain injury <i>Fig. 13.21</i>	290
Nematode pests	291
▶ 13.22 Northern root-knot nematode <i>Fig. 6.20</i>	291
▶ 13.23 Root-lesion nematode <i>Fig. 13.23</i>	291
▶ 13.24 Stem and bulb nematode <i>Fig. 13.24</i>	291
Insect pests	292
▶ 13.25 Onion bulb fly <i>Fig. 13.25</i>	292
▶ 13.26 Onion maggot <i>Figs. 13.26a-e</i>	293
▶ 13.27 Onion thrips <i>Fig. 22.35c</i>	294
▶ 13.28 Other insect pests.....	296
Shallot aphid <i>Myzus ascalonicus</i> Doncaster	296
Additional references	296
14 PARSNIP	297
Figures 14.2 to 14.7	297
Bacterial diseases	297
▶ 14.1 Scab <i>Fig. 6.4</i>	297
Fungal diseases	297
▶ 14.2 Iternsonilia canker <i>Figs.14.2a-c</i>	297
▶ 14.3 Phoma canker <i>Figs. 14.3a-d</i>	298
Nematode pests	299
▶ 14.4 Northern root-knot nematode <i>Fig. 6.20</i>	299
Insect pests	300
▶ 14.5 Carrot rust fly <i>Figs. 6.23a-e</i>	300
▶ 14.6 Carrot weevil <i>Figs. 6.24a-d</i>	300
▶ 14.7 Other insect pests <i>Fig. 14.7</i>	300
Black swallowtails <i>Papilio</i> spp.....	300
Cutworms	300
Wireworms	300
Mite pests	301
▶ 14.8 Two-spotted spider mite <i>Figs. 22.36e,f</i>	301
Additional references	301
15 PEA AND BEAN	302
15A PEA	302
Figures 15A.1 to 15A.15; 15A.2T1.....	302
Bacterial diseases	302
▶ 15A.1 Bacterial blight <i>Figs. 15A.1a,b</i>	302
Fungal diseases	303

▶ 15A.2 Ascochyta diseases <i>Figs. 15A.2a-g; 15A.2T1</i>	303
Ascochyta leaf and pod spot	303
Foot rot	303
Mycosphaerella blight	303
15A.2T1 Ascochyta diseases	304
▶ 15A.3 Damping-off, root rot, seed decay, seedling blight, wilt <i>Figs. 15A.3a-f</i>	305
▶ 15A.4 Downy mildew <i>Figs. 15A.4a-c</i>	306
▶ 15A.5 Powdery mildew <i>Figs. 15A.5a,b</i>	307
▶ 15A.6 Rust <i>Fig. 15A.6</i>	308
▶ 15A.7 Sclerotinia stem rot <i>Fig. 15A.7</i>	308
▶ 15A.8 Septoria leaf blotch <i>Fig. 15A.8</i>	308
Viral and viral-like diseases	309
▶ 15A.9 Miscellaneous viral and viral-like diseases <i>Figs. 15A.9a-g</i>	309
Alfalfa mosaic virus	309
Aster yellows mycoplasma-like organism	309
Bean yellow mosaic virus	309
Pea enation mosaic virus	309
Pea seed-borne mosaic virus	309
Pea streak virus	309
Pea stunt (red clover vein mosaic virus)	309
Non-infectious diseases	310
▶ 15A.10 Nutritional disorders <i>Fig. 15A.10</i>	310
Boron deficiency	310
Boron toxicity	310
Calcium deficiency	310
Iron deficiency	310
Magnesium deficiency	310
Manganese deficiency	310
Manganese toxicity	310
Nitrogen deficiency	310
Phosphorus deficiency	311
Potassium deficiency	311
▶ 15A.11 Other disorders <i>Figs. 15A.11a-d</i>	311
Cold injury	311
Herbicide injury	311
Water congestion	311
Nematode pests	311
▶ 15A.12 Northern root-knot nematode <i>Fig. 7.15b</i>	311
▶ 15A.13 Stem and bulb nematode	312
Insect pests	312

▶ 15A.14 Pea aphid <i>Fig. 15A. 14</i>	312
▶ 15A.15 Other insect pests <i>Figs. 15A.15</i>	313
Cutworms	313
Other caterpillars,	313
Pea leaf weevil.....	313
Pea moth.....	313
Pea weevil.....	313
Additional references	313
15B BEAN.....	314
Figures <i>15B.1 to 15B.19; 15B.7T1; 15B.9T1</i>	314
Bacterial diseases.....	314
▶ 15B.1 Bacterial blights <i>Figs. 15B.1a-i; 8.2f</i>	314
Bacterial brown spot.....	314
Common blight and fuscous blight	314
Halo blight.....	314
Fungal diseases	316
▶ 15B.2 Anthracnose <i>Figs. 15B.2a-d</i>	316
▶ 15B.3 Gray mold <i>Figs. 15B.3a,b</i>	317
▶ 15B.4 Root rots, damping-off, seed decay.....	318
▶ 15B.4 Black root rot <i>Fig. 15B.4</i>	318
▶ 15B.5 Fusarium root rot <i>Figs. 15B.5a-c</i>	318
▶ 15B.6 Pythium diseases <i>Fig. 15B.6</i>	319
▶ 15B.7 Rhizoctonia root rot <i>Figs. 15B.7; 15B.7T1</i>	319
15B.7T1 Rhizoctonia damping-off and canker; disease cycle of <i>Rhizoctonia solani</i> on vegetable crops.....	320
▶ 15B.8 Rust <i>Figs. 15B.8a,b</i>	321
▶ 15B.9 White mold <i>Figs. 15B.9a,b; 15B.9T1</i>	322
15B.9T1 White mold (sclerotinia rot); disease cycle of <i>Sclerotinia sclerotiorum</i> on vegetable crops	322
Viral diseases	323
▶ 15B.10 Bean common mosaic <i>Fig. 15B.10</i>	323
▶ 15B.11 Bean yellow mosaic <i>Fig. 15B.11</i>	324
Non-infectious diseases.....	325
▶ 15B.12 Nutritional disorders <i>Figs. 15B.12a-c</i>	325
Aluminum toxicity.....	325
Boron toxicity.....	325
Iron deficiency.....	325
Manganese deficiency	325
Nitrogen deficiency	325
Phosphorus deficiency	325
Zinc deficiency	326

▶ 15B.13 Other disorders <i>Figs. 15B.13a-e</i>	326
Baldhead.....	326
Herbicide injury.....	326
Ozone injury	326
Sunscauld.....	326
Wind injury.....	326
Nematode pests	327
▶ 15B.14 Northern root-knot nematode <i>Fig. 7.15b</i>	327
▶ 15B.15 Root-lesion nematode <i>Fig. 16.38T1</i>	327
▶ 15B.16 Stubby-root nematodes.....	327
Insect pests	327
▶ 15B.17 European corn borer <i>Figs. 12.16fg</i>	327
▶ 15B.18 Seedcorn maggot <i>Fig. 15B.18</i>	328
▶ 15B.19 Other insect pests <i>Figs. 15B. 19a, b</i>	328
Cutworms	328
European earwig.....	328
Mexican bean beetle	328
Additional references	329
16 POTATO.....	330
Figures 16.1 to 16.50; 16.2T1; 16.5T1; 16.11T1; 16.38T1; 16.43T1, T2; 16.44T1; 16.49T1, T2	330
Bacterial diseases.....	331
▶ 16.1 Bacterial ring rot (ring rot) <i>Figs. 16.1a-e</i>	331
▶ 16.2 Bacterial soft rot (soft rot) <i>Figs. 16.2a,b; 16.2T1</i>	333
16.2T1 Bacterial soft rot; disease cycle of <i>Erwinia</i> spp. on vegetable crops.....	334
▶ 16.3 Blackleg <i>Figs. 16.3a—c</i>	334
▶ 16.4 Pink eye (brown eye) <i>Figs. 16.4a,b</i>	336
▶ 16.5 Scab <i>Figs. 16.5a-c; 16.5T1</i>	336
Common scab	336
Acid scab	336
Russet scab	336
16.5T1 Common scab; disease cycle of <i>Streptomyces scabies</i> on potato.	338
Fungal diseases	339
▶ 16.6 Black dot <i>Figs. 16.6a,b</i>	339
▶ 16.7 Dry rot <i>Figs. 16.7a,b</i>	339
▶ 16.8 Early blight <i>Figs. 16.8a-c</i>	340
▶ 16.9 Fusarium wilt <i>Fig. 16.9</i>	341
▶ 16.10 Gray mold <i>Fig. 16.10</i>	341
▶ 16.11 Late blight <i>Figs. 16.11a-d; 16.11T1</i>	342
16.11T1 Late blight; disease cycle of <i>Phytophthora infestans</i> on potato and tomato.	343

▶ 16.12 Leak <i>Figs. 16.12a, b</i>	344
▶ 16.13 Phoma rot (button-hole rot, pocket rot) <i>Fig. 16.13</i>	345
▶ 16.14 Pink rot <i>Fig. 16.14</i>	345
▶ 16.15 Rhizoctonia canker (black scurf) <i>Figs. 16.15a-g</i>	345
▶ 16.16 Scab, powdery <i>Fig. 16.16</i>	346
▶ 16.17 Seed-piece decay <i>Figs. 16.17a-c</i>	346
▶ 16.18 Silver scurf <i>Figs. 16.18a-c</i>	347
▶ 16.19 Skin spot <i>Fig. 16.19</i>	348
▶ 16.20 Verticillium wilt <i>Figs. 16.20a-c</i>	348
▶ 16.21 Wart (canker) <i>Figs. 16.21a-d</i>	349
▶ 16.22 White mold <i>Fig. 16.22</i>	350
Viral and viral-like diseases	351
▶ 16.23 Aster yellows (haywire, purple dwarf, purple-top wilt) <i>Fig. 16.23</i>	351
▶ 16.24 Calico <i>Fig. 16.24</i>	351
▶ 16.25 Corky ring spot (spraing, stem mottle) <i>Figs. 16.25a,b</i>	352
▶ 16.26 Leafroll <i>Figs. 16.26a,b</i>	352
▶ 16.27 Mosaic diseases <i>Figs. 16.27a,b; 3.11a-c</i>	353
Potato virus A	353
Potato virus M	354
Potato virus S	354
Potato virus X <i>Fig. 16.27a</i>	354
Potato virus Y <i>Figs. 16.27b; 3.11a-c</i>	355
▶ 16.28 Spindle tuber <i>Figs. 16.28a,b</i>	355
▶ 16.29 Witches'-broom <i>Figs. 16.29a,b</i>	356
Non-infectious diseases	357
▶ 16.30 Blackheart <i>Fig. 16.30</i>	357
▶ 16.31 Growth cracks <i>Fig. 16.31</i>	357
▶ 16.32 Hollow heart <i>Fig. 16.32</i>	358
▶ 16.33 Jelly end rot	358
▶ 16.34 Other physiological disorders <i>Figs. 16.34a-n</i>	358
Genetic abnormalities	358
Herbicide injury	359
Internal black spot	359
Internal sprouting	359
Nutritional disorders	359
Secondary tubers	359
Stem-end browning	359
Tuber greening	360
Miscellaneous disorders	360
Nematode pests	360

▶ 16.35 Northern root-knot nematode <i>Fig. 16.35</i>	360
▶ 16.36 Potato cyst nematodes <i>Fig. 16.36</i>	360
Golden nematode <i>Globodera rostochiensis</i> (Wollenweb.) Behrens	360
Pale cyst nematode <i>Globodera pallida</i> (Stone) Behrens.....	360
▶ 16.37 Potato-rot nematode <i>Fig. 16.37</i>	361
▶ 16.38 Root-lesion nematode <i>Figs. 16.38; 16.38T1</i>	361
16.38T1 Root-lesion nematode; female.....	362
▶ 16.39 Stubby-root nematodes	363
Insect pests	363
▶ 16.40 Buckthorn aphid <i>Figs. 16.40a,b</i>	363
▶ 16.41 Green peach aphid <i>Figs. 16.41a,b</i>	364
▶ 16.42 Potato aphid <i>Figs. 16.42a-c</i>	365
▶ 16.43 Other aphids <i>Figs. 16.43; 16.43T1, T2</i>	366
Black bean aphid	366
Bulb and potato aphid	366
Crescent-marked lily aphid	366
Foxglove aphid	366
Melon aphid	366
Table 16.43 Key to wingless female aphids colonizing potato in Canada	366
16.43T1 Aphids; four species that occasionally infest potato.....	367
16.43T2 Aphids; body parts of wingless females described in Table 16.43.....	367
▶ 16.44 Colorado potato beetle <i>Figs. 16.44a-d; 16.44T1</i>	368
16.44T1 Colorado potato beetle; life cycle in regions with one generation.....	369
▶ 16.45 Potato flea beetle <i>Figs. 16.45a-c</i>	371
▶ 16.46 Potato leafhopper <i>Figs. 16.46a,b</i>	372
▶ 16.47 Potato stem borer <i>Figs. 16.47a,b; 12.22b</i>	373
▶ 16.48 Tuber flea beetle <i>Figs. 16.48a-c</i>	374
▶ 16.49 White grubs (June beetles) <i>Figs. 16.49a-e; 16.49T1, T2</i>	375
Common June beetle <i>Phyllophaga anxia</i> (LeConte)	375
Other June beetles <i>Phyllophaga</i> spp.	375
16.49T1 White grubs; larvae under sod.....	375
16.49T2 White grubs; life cycle of the common June beetle.....	376
▶ 16.50 Wireworms <i>Figs. 16.50; 12.21a,b, T1</i>	377
Dusky (or European) wireworm <i>Agriotes obscurus</i> (L.).....	377
Eastern field wireworm <i>Limonius agonus</i> (Say)	377
Wheat wireworm <i>Agriotes mancus</i> (Say)	377
▶ 16.51 Other insect pests <i>Figs.</i>	378
Aster leafhopper	378
Blister beetles	378

Cutworms	378
European corn borer	378
Grasshoppers	378
Potato psyllid	378
Potato scab gnat	378
Seedcorn maggot	378
Stalk borer	378
Tarnished plant bug	379
Other pests	379
▶ 16.52 Millipedes <i>Fig. 12.21T1</i>	379
▶ 16.53 Slugs <i>Figs. 11.27a-c</i>	379
Additional references	379
17 RHUBARB.....	380
Figures 17.1 to 17.9	380
Bacterial diseases	380
▶ 17.1 Crown gall <i>Fig. 17.1</i>	380
▶ 17.2 Red leaf (bacterial soft rot) <i>Figs. 17.2a,b</i>	380
Fungal diseases	381
▶ 17.3 Crown rot.....	381
▶ 17.4 Downy mildew	382
▶ 17.5 Gray mold	382
▶ 17.6 Leaf spots <i>Figs. 17.6a,b</i>	382
Ascochyta leaf spot.....	382
Ramularia leaf spot.....	382
▶ 17.7 Powdery mildew	383
▶ 17.8 Rust.....	383
Viral diseases	384
▶ 17.9 Miscellaneous viral diseases <i>Fig. 17.9</i>	384
Arabis mosaic virus	384
Cherry leaf roll virus.....	384
Cucumber mosaic virus	384
Strawberry latent ringspot virus.....	384
Turnip mosaic virus	384
Nematode pests	384
▶ 17.10 Northern root-knot nematode <i>Fig. 7.15b</i>	384
▶ 17.11 Pin nematodes.....	385
▶ 17.12 Sugarbeet cyst nematode <i>Fig. 5.14b</i>	385
Insect pests	385
▶ 17.13 Miscellaneous insect pests <i>Figs.</i>	385

Black bean aphid <i>Aphis fabae</i> Scopolì.....	385
European earwig <i>Forficula auricularia</i> L.....	385
Potato stem borer <i>Hydraecia micacea</i> (Esper).....	385
Rhubarb curculio <i>Lixus concavus</i> Say	385
Other pests	385
▶ 17.14 Slugs <i>Figs. 11.27a-c</i>	385
Additional references	385
18 TOMATO, EGGPLANT, PEPPER	386
Figures 18.1 to 18.43	386
Bacterial diseases	387
▶ 18.1 Bacterial canker <i>Figs. 18.1 a-c</i>	387
▶ 18.2 Bacterial soft rot <i>Fig. 18.2</i>	388
▶ 18.3 Bacterial speck <i>Figs. 18.3a,b</i>	388
▶ 18.4 Bacterial spot <i>Figs. 18.4a-f</i>	389
▶ 18.5 Bacterial wilt (brown rot, southern bacterial wilt)	390
Fungal diseases	391
▶ 18.6 Anthracnose <i>Figs. 18.6a-c</i>	391
▶ 18.7 Damping-off <i>Fig. 25.7</i>	392
▶ 18.8 Early blight (target spot) alternaria fruit rot <i>Figs. 18.8a-g; 25.9a,b</i>	392
▶ 18.9 Fusarium crown and root rot <i>Figs. 25. 10a d</i>	393
▶ 18.10 Fusarium wilt <i>Figs. 25.11a-c</i>	393
▶ 18.11 Gray mold (ghost spot) <i>Figs. 18.11a-c; 25.12a-d</i>	393
▶ 18.12 Late blight <i>Figs. 18.12a-d; 25.13a,b; 16.11T1</i>	394
▶ 18.13 Septoria leaf spot <i>Figs. 18.13a-c</i>	394
▶ 18.14 Verticillium wilt <i>Figs. 18.14a-c; 25.16a</i>	395
▶ 18.15 White mold <i>Figs. 18.15a-e</i>	395
Viral and viral-like diseases.....	396
▶ 18.16 Aster yellows	397
▶ 18.17 Cucumber mosaic <i>Figs. 18.17; 25.18a,b</i>	397
▶ 18.18 Tomato mosaic, single streak, double streak <i>Figs. 18.18a-e; 25.19a,b; 25.21 a-e</i>	397
▶ 18.19 Tomato spotted wilt <i>Figs. 24.8b,c; 25.22a-d</i>	398
▶ 18.20 Other viral diseases <i>Figs. 18.17; 25.19a,b; 25.21b</i>	399
Alfalfa mosaic	399
Potato virus X	399
Potato virus Y	399
Tobacco etch.....	399
Non-infectious diseases.....	399
▶ 18.21 Blossom-end rot (bottom rot) <i>Figs. 18.21 a-d; 24.9; 25.23</i>	399
▶ 18.22 Blotchy ripening <i>Figs. 18.22a,b</i>	400

▶ 18.23 Catface (stylar cork) <i>Fig. 18.23</i>	401
▶ 18.24 Cold injury.....	401
▶ 18.25 Growth cracks <i>Fig. 18.25</i>	401
▶ 18.26 Leafroll, herbicide injury <i>Figs. 18.26a-d</i>	402
▶ 18.27 Nutritional disorders <i>Figs. 25.24a,b</i>	402
▶ 18.28 Puffiness <i>Fig. 18.28</i>	402
▶ 18.29 Sunscald <i>Figs. 18.29a,b</i>	402
Nematode pests	403
▶ 18.30 Northern root-knot nematode <i>Fig. 18.30</i>	403
▶ 18.31 Root-lesion nematode <i>Fig. 16.38T1</i>	403
▶ 18.32 Stubby-root nematodes	403
Insect pests	403
▶ 18.33 Aphids <i>Figs. 16.40-16.43</i>	403
Green peach aphid <i>Myzus persicae</i> (Sulzer).....	403
Potato aphid <i>Macrosiphum euphorbiae</i> (Thomas).....	403
Other aphids.....	403
▶ 18.34 Colorado potato beetle <i>Figs. 16.44a-d; 16.44T1</i>	404
▶ 18.35 Cutworms <i>Figs. 18.35a-g; 6.25a-c; 11.26</i>	405
Variegated cutworm <i>Peridroma saucia</i> (Hübner).....	405
Other cutworms (see Table 18.35).....	405
Table 18.35 Cutworms commonly found in Canada	405
▶ 18.36 European corn borer <i>Figs. 18.36a,b</i>	406
▶ 18.37 Other caterpillars <i>Figs. 18.37a-c; 8.40; 12.13</i>	407
Cabbage looper.....	407
Corn earworm	407
Hornworms	407
▶ 18.38 Pepper maggot <i>Figs. 18.38a-g</i>	407
▶ 18.39 Sap beetles <i>Fig. 18.39</i>	409
▶ 18.40 Stink bugs <i>Figs. 18.40a,b; 3.7k,m</i>	409
▶ 18.41 Wireworms <i>Figs. 12.21a,b,T1; 16.50</i>	410
▶ 18.42 Other insect pests <i>Figs. 18.42a-m</i>	410
Crickets and grasshoppers	410
Flea beetles	410
Greenhouse whitefly	410
Tarnished plant bug	410
Vinegar flies	411
Western flower thrips	411
Other pests	411
▶ 18.43 Slugs <i>Figs. 18.43; 11.27a-c</i>	411
Additional references	411

PART 3 Diseases and Pests of Native Crops.....	412
19 FIDDLEHEAD (OSTRICH FERN).....	414
Figure 19.1.....	414
Fungal diseases	414
▶ 19.1 Gangrene <i>Fig. 19.1</i>	414
▶ 19.2 Other fungal diseases.....	414
Leaf blotch <i>Taphrina struthiopteris</i> Nishida.....	414
Rust <i>Uredinopsis struthiopteridis</i> StörmenDietel.....	414
Additional references	414
20 GINSENG	415
Figures 20.1 to 20.9.....	415
Fungal diseases	415
▶ 20.1 Alternaria blight <i>Figs. 20.1 a-c; 20.3a</i>	415
▶ 20.2 Botrytis blight <i>Fig. 20.2</i>	416
▶ 20.3 Damping-off, root rot, seed decay <i>Figs. 20.3a,b</i>	417
▶ 20.4 Disappearing root rot <i>Figs. 20.4a,b</i>	418
▶ 20.5 Phytophthora mildew and root rot <i>Fig. 20.5</i>	419
▶ 20.6 Rusted root (rusty root) <i>Fig. 20.6</i>	420
▶ 20.7 Sclerotinia white rot <i>Fig. 15B.9T1</i>	420
▶ 20.8 Verticillium wilt	420
Non-infectious diseases.....	421
▶ 20.9 Nutritional and other disorders <i>Figs. 20.9a-d</i>	421
Zinc deficiency	421
Phytotoxicity.....	421
Sunscauld.....	421
Nematode pests	421
▶ 20.10 Northern root-knot nematode.....	421
Insect pests	421
▶ 20.11 Miscellaneous insect pests	421
Cutworms	421
Thrips.....	421
Weevils.....	421
Wireworms	421
Other pests	422
▶ 20.12 Slugs <i>Figs. 11.27a-c</i>	422
Additional references	422
21 JERUSALEM ARTICHOKE	423
Figures 21.1 to 21.6.....	423
Bacterial diseases.....	423

▶ 21.1 Apical chlorosis <i>Figs. 21.1a,b</i>	423
Fungal diseases	424
▶ 21.2 Downy mildew <i>Fig. 21.2</i>	424
▶ 21.3 Powdery mildew <i>Fig. 21.3</i>	424
▶ 21.4 Rust <i>Fig. 21.4</i>	424
▶ 21.5 Sclerotinia wilt, stalk and tuber rot <i>Figs. 21.5a, b</i>	425
Insect pests	425
▶ 21.6 Stem borers <i>Fig. 21.6</i>	425
Additional references	426
PART 4 Diseases and Pests of Greenhouse Crops	427
22 GREENHOUSE CUCUMBER	429
Figures 22.1 to 22.36; 22.15T1; 22.31T1; 22.36T1	429
Bacterial diseases	430
▶ 22.1 Angular leaf spot <i>Figs. 22.1; 9.1a,b</i>	430
▶ 22.2 Bacterial wilt <i>Figs. 9.2a,b</i>	430
Fungal diseases	430
▶ 22.3 Anthracnose <i>Figs. 9.3a-c</i>	430
▶ 22.4 Black root rot <i>Figs. 22.4a,b</i>	430
▶ 22.5 Black rot	431
▶ 22.6 Choanephora rot	432
▶ 22.7 Crown and root rot, damping-off <i>Figs. 22.7a-d</i>	432
▶ 22.8 Downy mildew <i>Figs. 22.8a,b</i>	433
▶ 22.9 Fusarium wilt <i>Figs. 22.9a,b</i>	434
▶ 22.10 Gray mold <i>Figs. 22.10a-d</i>	434
▶ 22.11 Gummy stem blight <i>Figs. 22.11a-e</i>	435
▶ 22.12 Leaf blights <i>Figs. 22.12a,b; 9.8a,b</i>	436
Alternaria leaf blight <i>Alternaria</i> spp.	436
Ulocladium leaf spot <i>Ulocladium</i> spp.	436
▶ 22.13 Leaf rot (pink mold rot) <i>Fig. 22.13</i>	436
▶ 22.14 Penicillium stem rot <i>Figs. 22.14a,b</i>	436
▶ 22.15 Powdery mildew <i>Figs. 22.15a-d; 22.15T1</i>	437
22.15T1 Powdery mildew; disease cycle of <i>Sphaerotheca fuliginea</i>	438
▶ 22.16 Scab (gummosis) <i>Figs. 22.16; 9.13</i>	439
▶ 22.17 Verticillium wilt <i>Figs. 22.17a,b</i>	440
▶ 22.18 White mold (sclerotinia stem rot) <i>Figs. 22.18a-d</i>	440
Viral diseases	440
▶ 22.19 Beet pseudo-yellows <i>Fig. 22.19</i>	440
▶ 22.20 Cucumber mosaic <i>Figs. 22.20a,b; 9.15</i>	441
▶ 22.21 Cucumber necrosis	442

▶ 22.22 Cucumber pale fruit <i>Fig. 22.22</i>	443
▶ 22.23 Watermelon mosaic <i>Figs. 22.23; 9.17a,b</i>	443
▶ 22.24 Zucchini yellow mosaic <i>Figs. 22.24a,b; 9.16a-c</i>	444
Non-infectious diseases	444
▶ 22.25 Chilling injury, cold injury <i>Figs. 22.25a,b</i>	444
▶ 22.26 Nutritional disorders <i>Figs. 22.26a-g</i>	445
Boron	445
Calcium	445
Copper	445
Iron	445
Magnesium	445
Manganese	445
Molybdenum	445
Nitrogen	445
Phosphorus	446
Potassium	446
▶ 22.27 Premature fruit yellowing	446
▶ 22.28 Root death <i>Fig. 22.28</i>	446
▶ 22.29 Sudden wilting	447
Nematode pests	447
▶ 22.30 Root-knot nematodes <i>Figs. 22.30a-d</i>	447
Northern root-knot nematode	447
Southern root-knot nematodes	447
Insect pests	448
▶ 22.31 Fungus gnats <i>Figs. 22.31a-c; 22.31T1</i>	448
22.31T1 Fungus gnat (left), shore fly (center), and moth fly (right); compare wings, body shape and leg length; adults 2-3 mm long.	448
▶ 22.32 Greenhouse whitefly <i>Figs. 22.32a-d; 22.34d</i>	449
▶ 22.33 Melon (cotton) aphid <i>Figs. 22.33a,b</i>	450
▶ 22.34 Western flower thrips <i>Figs. 22.34a-i; 25.29</i>	450
▶ 22.35 Other insect pests <i>Figs. 22.35a-d; 9.21</i>	452
Caterpillars	452
Cucumber beetles	453
Leafminers	453
Onion thrips	453
Plant bugs,	453
Mite pests	453
▶ 22.36 Two-spotted spider mite <i>Figs. 22.36a-g; 22.36T1</i>	453
22.36T1 Two-spotted spider mite; indices (1-4) for leaf damage on greenhouse cucumber.	454
Additional references	455

23 GREENHOUSE LETTUCE	456
Figures 23.6 to 23.16	456
Bacterial diseases	456
▶ 23.1 Butt rot (head rot) <i>Figs. 11.3a-d</i>	456
▶ 23.2 Stem rot	457
▶ 23.3 Other bacterial diseases <i>Figs. 11.1a,b</i>	457
Fungal diseases	457
▶ 23.4 Anthracnose (ring spot), fire of endive <i>Fig. 11.4</i>	457
▶ 23.5 Bottom rot <i>Figs. 11.6a,b</i>	457
▶ 23.6 Damping-off, stunt <i>Figs. 23.6a,b</i>	458
▶ 23.7 Downy mildew <i>Figs. 11.8a,b</i>	458
▶ 23.8 Drop <i>Figs. 11.9a-e</i>	459
▶ 23.9 Gray mold <i>Figs. 23.9; 11.10a-f</i>	459
▶ 23.10 Powdery mildew <i>Fig. 23.10</i>	459
Viral and viral-like diseases	460
▶ 23.11 Aster yellows <i>Figs. 11.15a,b</i>	460
▶ 23.12 Big vein <i>Fig. 11.16</i>	460
▶ 23.13 Cucumber mosaic	460
▶ 23.14 Lettuce mosaic <i>Figs. 23.14; 11.17a,b</i>	460
▶ 23.15 Other viral diseases <i>Fig. 23.15</i>	461
Beet western yellows virus	461
Lettuce infectious yellows virus	461
Tomato spotted wilt virus	461
Non-infectious diseases	461
▶ 23.16 Tipburn <i>Figs. 23.16; 11.19c</i>	461
Insect pests	461
▶ 23.17 Aphids <i>Figs. 8.39; 11.24T1,T2;15A.14; 16.41; 16.43T1</i>	461
Black bean aphid <i>Aphis fabae</i> Scopoli	461
Cabbage aphid <i>Brevicoryne brassicae</i> (L.)	461
Green peach aphid <i>Myzus persicae</i> (Sulzer)	461
Lettuce aphid <i>Nasonovia ribisnigri</i> (Mordvilko)	461
Pea aphid <i>Acyrtosiphon pisum</i> (Harris)	461
▶ 23.18 Caterpillars <i>Figs. 8.40b-f</i>	462
Cabbage looper <i>Trichoplusia ni</i> (Hübner)	462
Other caterpillars	462
▶ 23.19 Other insect pests <i>Figs. 22.31 a-c; 26.29T1</i>	462
Fungus gnats	462
Other pests	462
▶ 23.20 Slugs <i>Figs. 11.27a-c</i>	462

Additional references	463
24 GREENHOUSE PEPPER.....	464
Figures 24.1 to 24.14	464
Fungal diseases	464
▶ 24.1 Damping-off <i>Fig. 24.1</i>	464
▶ 24.2 Fusarium stem and fruit rot <i>Figs. 24.2a-c</i>	465
▶ 24.3 Gray mold <i>Figs. 25.12a-c</i>	465
Viral diseases	466
▶ 24.4 Cucumber mosaic <i>Fig. 18.17</i>	466
▶ 24.5 Pepper mild mottle <i>Figs. 24.5a,b</i>	466
▶ 24.6 Tobacco mosaic	467
▶ 24.7 Tomato mosaic	468
▶ 24.8 Tomato spotted wilt <i>Figs. 24.8a-c</i>	468
Non-infectious diseases.....	469
▶ 24.9 Blossom-end rot <i>Figs. 24.9; 18.21c,d</i>	469
▶ 24.10 Sunscald <i>Fig. 18.29b</i>	469
Nematode pests	469
▶ 24.11 Northern root-knot nematode <i>Figs. 18.30; 25.26</i>	469
Insect pests	469
▶ 24.12 Green peach aphid <i>Figs. 24.12a-e</i>	469
▶ 24.13 Pepper weevil <i>Figs. 24.13a-e</i>	470
▶ 24.14 Western flower thrips <i>Figs. 24.14a-d; 18.42i</i>	471
▶ 24.15 Other insect pests.....	472
Caterpillars (loopers and other caterpillars).....	472
Leafminers	472
Chrysanthemum leafminer <i>Liriomyza trifolii</i> (Burgess)	472
Vegetable leafminer <i>Liriomyza sativae</i> Blanchard	472
Melon (cotton) aphid <i>Aphis gossypii</i> Glover	472
Onion thrips <i>Thrips tabaci</i> Lindeman.....	472
Plant bugs <i>Lygus</i> spp.	472
Mite pests	472
▶ 24.16 Two-spotted spider mite <i>Figs. 22.36a-g</i>	472
Additional references	472
25 GREENHOUSE TOMATO	474
Figures 25.1 to 25.32	474
Bacterial diseases	474
▶ 25.1 Bacterial canker <i>Figs. 25.1; 18.1a-c</i>	474
▶ 25.2 Bacterial speck <i>Figs. 18.3a,b</i>	476
▶ 25.3 Bacterial stem rot <i>Fig. 25.3</i>	476

▶ 25.4 Pith necrosis <i>Figs. 25.4a-c</i>	476
▶ 25.5 Stem necrosis <i>Fig. 25.5</i>	477
Fungal diseases	477
▶ 25.6 Corky root (brown root rot) <i>Figs. 25.6a,b</i>	477
▶ 25.7 Damping-off <i>Fig. 25.7</i>	478
▶ 25.8 Didymella stem canker <i>Fig. 25.8</i>	479
▶ 25.9 Early blight (target spot), alternaria fruit rot <i>Figs. 25.9a,b; 18.8b,c,f</i>	480
▶ 25.10 Fusarium crown and root rot <i>Figs. 25.10a-d</i>	480
▶ 25.11 Fusarium wilt <i>Figs. 25.11a-c</i>	482
▶ 25.12 Gray mold (ghost spot) <i>Figs. 25.12a-d; 18.11 a-c</i>	483
▶ 25.13 Late blight <i>Figs. 25.13a,b; 18.12a-d</i>	484
▶ 25.14 Leaf mold <i>Fig. 25.14</i>	484
▶ 25.15 Septoria blight (septoria leaf spot) <i>Figs. 25.15; 18.13a-c</i>	485
▶ 25.16 Verticillium wilt <i>Figs. 25.16a,b</i>	486
▶ 25.17 White mold <i>Figs. 18.15a-e</i>	486
Viral diseases	487
▶ 25.18 Cucumber mosaic <i>Figs. 25.18a,b; 18.17</i>	487
▶ 25.19 Double streak <i>Figs. 25.19a,b</i>	487
▶ 25.20 Tobacco mosaic	488
▶ 25.21 Tomato mosaic, single streak <i>Figs. 25.21a-e; 18.18a-e</i>	489
▶ 25.22 Tomato spotted wilt <i>Figs. 25.22a-d</i>	490
Non-infectious diseases	491
▶ 25.23 Blossom-end rot <i>Figs. 25.23; 18.21a-d</i>	491
▶ 25.24 Magnesium deficiency <i>Figs. 25.24a,b</i>	491
▶ 25.25 Other disorders <i>Figs. 25.25a-e; 18.22-18.28</i>	492
Blotchy ripening	492
Catface	492
Edema.....	492
Growth cracks (russetting).....	492
Puffiness	492
Nematode pests	492
▶ 25.26 Root-knot nematodes <i>Figs. 25.26; 18.30; 22.30a-d</i>	492
Northern root-knot nematode.....	492
Southern root-knot nematodes	492
Insect pests	493
▶ 25.27 Greenhouse whitefly <i>Figs. 25.27a-g; 3.10e</i>	493
▶ 25.28 Leafminers <i>Figs. 25.28a-e</i>	494
Chrysanthemum leafminer <i>Liriomyza trifolii</i> (Burgess)	494
Vegetable leafminer <i>Liriomyza sativae</i> Blanchard	494
▶ 25.29 Thrips <i>Figs. 25.29; 22.34e-g</i>	495

Onion thrips <i>Thrips tabaci</i> Lindeman.....	495
Western flower thrips <i>Frankliniella occidentalis</i> (Pergande)	495
▶ 25.30 Other insect pests <i>Figs.</i>	495
Aphids	495
Caterpillars	495
Mite pests	496
▶ 25.31 Tomato russet mite <i>Fig.</i> 25.31	496
▶ 25.32 Two-spotted spider mite <i>Figs.</i> 25.32; 22.36a-g	496
Additional references	497
PART 5 Diseases and Pests of Other Protected Crops	498
26 MUSHROOM.....	500
Figures 26.1 to 26.20; 26.29T1, 26.31T1	500
Bacterial diseases	500
▶ 26.1 Brown blotch (bacterial blotch) <i>Fig.</i> 26.1	500
▶ 26.2 Mummy <i>Fig.</i> 26.2	501
Fungal diseases	502
▶ 26.3 Cobweb (soft mildew) <i>Fig.</i> 26.3	502
▶ 26.4 Green mold <i>Figs.</i> 26.4a,b	502
▶ 26.5 Mat and confetti <i>Fig.</i> 26.5	503
Mat (vert de gris)	503
Confetti	503
▶ 26.6 Sepedonium yellow mold <i>Fig.</i> 26.6	504
▶ 26.7 Truffle <i>Fig.</i> 26.7	504
▶ 26.8 Verticillium disease (dry bubble, split stipe, verticillium spot) <i>Fig.</i> 26.8	505
▶ 26.9 Wet bubble <i>Fig.</i> 26.9	506
▶ 26.10 Other fungal diseases	507
Aphanocladium cap spot <i>Aphanocladium album</i> (G. Preuss) W. Gams	507
Gill mildew <i>Cephalosporium</i> spp.	507
Hormiactis cap spot <i>Hormiactis alba</i> G. Preuss	507
Shaggy stipe <i>Mortierella bainieri</i> Cost.....	507
Viral diseases	507
▶ 26.11 Miscellaneous viral diseases <i>Fig.</i> 26.11.....	507
La France	507
Other viral diseases.....	507
Weed molds	508
A. Molds chiefly in compost.....	508
▶ 26.12 Ink caps <i>Fig.</i> 26.12	508
▶ 26.13 Olive-green mold <i>Fig.</i> 26.13.....	509
▶ 26.14 Penicillium mold.....	510

▶ 26.15 Other molds in compost.....	510
B. Molds on compost and casing	510
▶ 26.16 Black whisker mold <i>Fig. 26.16</i>	510
▶ 26.17 Brown mold	511
▶ 26.18 Lipstick mold <i>Fig. 26.18</i>	511
▶ 26.19 Plaster molds <i>Fig. 26.19</i>	512
C. Molds chiefly in and on casing.....	512
▶ 26.20 Cinnamon brown mold (peat mold) <i>Fig. 26.20</i>	512
▶ 26.21 Nematode-trapping fungi	513
Non-infectious disorders	513
▶ 26.22 Hardcap (hardgill).....	513
▶ 26.23 Open veil	514
▶ 26.24 Rose comb	514
▶ 26.25 Stroma	514
▶ 26.26 Other abnormalities	514
Nematode pests	514
▶ 26.27 Parasitic nematodes	514
▶ 26.28 Saprophytic nematodes	515
Insect pests	516
▶ 26.29 Dark-winged fungus gnat <i>Fig. 26.29T1</i>	516
26.29T1 Dark-winged fungus gnat.	517
▶ 26.30 Gall midges.....	519
▶ 26.31 Phorid flies <i>Fig. 26.31T1</i>	519
26.31T1 Phorid fly; adult	520
Mite pests	521
▶ 26.32 Red pepper mites	521
Additional references	521
27 VEGETABLE SPROUTS	522
Figures 27.1 to 27.2; 27.2T1	522
Bacterial diseases.....	522
▶ 27.1 Bacterial soft rot of alfalfa sprouts <i>Figs. 27.1a,b</i>	522
27.2T1 Bacterial soft rot of bean sprouts.....	523
▶ 27.2 Bacterial soft rot of bean sprouts, physiological collapse <i>Figs. 27.2; 27.2T1</i>	523
Bibliography	525
Appendix Plant diagnostic laboratories in Canada	529
Glossary	531
Color plates.....	552
Index.....	953

Foreword

This compendium is intended for producers, extension personnel, students, diagnosticians and others interested in the diseases and pests of vegetable crops grown in Canada. It is patterned after *Diseases of Field Crops in Canada*, a companion volume published by the Canadian Phytopathological Society in 1984 and revised in 1988. *Diseases and Pests of Vegetable Crops in Canada* represents the combined efforts of plant pathologists, entomologists and vegetable specialists employed in or recently retired from careers in research, extension, teaching and regulation with provincial and federal governments, universities and other agencies.

This book was seven years in preparation and it is the product of an entirely voluntary effort. The presidents of the CPS and ESC, on behalf of the members they represent, extend thanks and congratulations to the editors, to the many contributors of text and illustrations, to the numerous reviewers of the manuscript, and to all others who assisted in making this publication a reality. We hope that it fulfills a need for current information on vegetable crop protection and that it will encourage further collaboration between the two sponsoring societies and foster closer cooperation in research and extension work between their members and the vegetable industry in Canada.

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A joint CPS/ESC Marketing Committee, initially chaired by Ieuan Evans (CPS), was co-chaired by Marilyn Dykstra (CPS) and Lloyd Dosdall (ESC) from 1991 to 1992, and since then by Marilyn Dykstra (CPS) and John Laing and Joe Shorthouse (ESC).

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Agriculture Canada (B.W. Lukey): 3.7c, 3.11d, 4.10a, 4.10b, 4.10c, 7.21a, 9.22c, 11.27a, 11.27b, 11.27c, 12.17e, 14.7, 18.42a

Agriculture Canada (L. St-Jean): 5.15, 5.16, 5.17d, 13.25, 15A.15, 15B. 19b

Alberta Agriculture, Food and Rural Development: 2.3m

Alberta Special Crops and Horticultural Research Center: 3.12, 3.13, 4.2a, 4.8, 4.10d, 5.1, 6.2, 6.6b, 6.6c, 6.9a, 6.9d, 6.14, 6.15a, 6.15b, 6.17b, 6.18, 6.25c, 7.7c, 7.7e, 7.7f, 7.7g, 8.4c, 8.9, 8.13a, 8.21c, 8.23d, 8.28b, 8.41b, 8.41c, 9.1a, 9.1b, 9.7, 9.14a, 9.14c, 9.18a, 9.18c, 10.9a, 10.9c, 10.10c, 10.11a, 10.11b, 11.1a, 11.9f, 11.17b, 11.19c, 11.23b, 12.2a, 12.7b, 12.9a, 12.9b, 12.9c, 12.9d, 13.12d, 15A.1a, 15A.1b, 15A.2g, 15A.3a, 15A.3b, 15A.3c, 15A.3d, 15A.3e, 15A.3f, 15A.4a, 15A.4c, 15A.9e, 15B.1a, 15B.1b, 15B.1d, 15B.1g, 15B.1i, 15B.3b, 15B.5a, 15B.5c, 15B.9a, 15B.11, 15B.12c, 15B.13a, 15B.13b, 15B.13d, 15B.13e, 15B.18, 16.1d, 16.2b, 16.3a, 16.4b, 16.5b, 16.5c (shallow scab), 16.8a, 16.8b, 16.11a, 16.12b, 16.15b, 16.17a, 16.17c, 16.18b, 16.18c, 16.20b, 16.22, 16.23, 16.24, 16.25a, 16.25b, 16.27a, 16.28a, 16.29a, 16.31, 16.34a, 16.34d, 16.34h, 16.34m, 16.34n, 16.43, 16.48a, 17.2a, 17.2b, 18.3a, 18.4a, 18.14c, 18.26a, 18.26b, 18.26c, 18.26d, 18.42h, 21.5a, 21.5b, 22.1, 22.7b, 22.7d, 22.9b, 22.10a, 22.10b, 22.10c, 22.10d, 22.11a, 22.11b, 22.11c, 22.11d, 22.12a, 22.12b, 22.15b, 22.15c, 22.15d, 22.17a, 22.17b, 22.18c, 22.20b, 22.24a, 22.25a, 22.26a, 22.26b, 22.26c, 22.26d, 22.26g, 22.28, 22.30a, 22.30b, 22.30c, 22.31a, 22.31b, 22.31c, 22.32a, 22.34a, 22.34b, 22.35a, 22.35b, 22.36b, 22.36c, 22.36d, 23.6a, 23.6b, 23.9, 23.10, 23.14, 23.16, 24.1, 24.12a, 24.14c, 25.1, 25.4a, 25.4b, 25.4c, 25.6a, 25.6b, 25.7, 25.9a, 25.10a, 25.11b, 25.11c, 25.12a, 25.12b, 25.12c, 25.16a, 25.19a, 25.19b, 25.21a, 25.21b, 25.21e, 25.23, 25.24a, 25.25a, 25.25e, 25.27a, 25.27g, 25.28c, 25.28b, 27.1a, 27.1b, 27.2 Allen, W.R.: 9.17a, 18.18a, 23.15, 24.8b, 25.22b, 25.22d

American Phytopathological Society: 5.6T1, 15A.10, 15A.2T1, 15B.7, 25.9b

Banks, E.: 13.12b, 13.12c, 13.12e

Bauduin, F.: 16.43T1

Beaulieu, C.: 16.5c (russet scab)

Beausoleil, J.M.: 12.20a

Bérard, L.S.: 8.21a, 8.22a, 8.27, 8.28a, 8.29, 8.30, 8.31, 8.32a, 8.32b, 8.32c, 8.32d, 8.32e

Boiteau, G.: 16.43T2, 16.44a, 16.44b, 16.44c, 16.44d, 16.44T1

Boivin, G.: 3.2T1, 3.2T2, 6.23b Bonn, W.G.: 12.1b

Brammall, R.A.: 20.1a, 20.1c, 20.2, 20.3a, 20.3b, 20.4b, 20.5

Brisson, J.-D.: 9.16c

British Columbia Ministry of Agriculture, Fisheries and Food: 3.7n

British Ministry of Agriculture, Fisheries and Food: 22.26e

Broadbent, A.B.: 18.42j, 18.42k, 18.42m

Buonassisi, A.J.: 20.9a, 20.9c, 20.9d

Canadian Phytopathological Society: 12.3b, 12.3c, 12.8b, 15A.2a, 15A.2b, 15A.2c, 15A.2d

Cerkauskas, R.F.: 5.5a, 5.5c, 7.3b, 7.5a, 7.5b, 7.5c, 7.7a, 7.7d, 9.3b, 10.4, 14.2b, 14.2c, 14.3a, 14.3b, 14.3c, 14.3d

Chang, K.F.: 5.5b, 5.5d, 11.13a, 11.13b

Christenson, D.R.: 15B.12b

Cloutier, C: 16.42a, 16.43T1

Cornell University Press: 22.36T1

Costello, R.A.: 24.13a, 24.13b, 24.13c

Crête, R.: 7.1a, 7.9b, 7.10a, 7.11, 13.3, 13.11b

Crozier, L.M.: 8.43a, 8.43b, 8.43c, 8.43d

Delbridge, R.W.: 8.2b, 8.19, 11.1b, 11.15a

Drijfhout, E.: 15B.10

Esau, R.: 2.3b, 2.3c, 2.3d, 2.3e, 2.3f, 2.3h, 2.3n, 15A.11a, 15A.11b

Evans, I.R.: 6.4, 6.19c, 8.2e, 8.3c, 8.6c, 8.8a, 8.16a, 8.16c, 8.17, 8.21b, 8.25a, 9.13, 9.14b, 9.15, 13.7c, 15A.5b, 15A.9b, 15A.9g, 15A.11d, 15B.2c, 15B.9b, 16.1a, 16.1b, 16.1c, 16.1e, 16.2a, 16.5a, 16.12a, 16.15a, 16.15c, 16.15e, 16.15f, 16.15g, 16.26b, 16.27b, 16.28b, 16.29b, 16.30, 16.34b, 16.34c, 16.34g, 16.34k, 18.3b, 18.12b, 18.23, 25.12d

Ferguson, G.M.: 9.16a, 9.16b, 25.24b

Foott, W.H.: 12.17d

Frowd, J.A.: 10.12

Fushtey, S.G.: 7.15a, 7.15b

Gates, L.F.: 22.23

Gillespie, D.R.: 22.31T1, 22.32b, 22.34d, 22.34i, 22.35c, 24.13d, 24.13e, 25.28a

Gindrat, D.: 10.3a, 10.3b

Goodwin, P.H.: 12.1a, 12.1c

Guppy, J.C.: 16.49T1

Hagedorn, D.J.: 15A.9c, 15A.9d Hall, R.: 15B.5b, 15B.6, 15B.8a, 15B.13c

Hampson, M.C.: 16.21b, 16.21c, 16.21d

Harris, L.: 8.38, 9.21

Herbut, M.J.: 3.7s, 3.10d, 3.10e, 3.10g, 8.42g, 16.48b, 16.48c, 22.33a, 22.33b, 22.35d, 22.36g, 24.12b, 24.12c, 25.28d, 25.28e

Hildebrand, P.D.: 8.3a, 8.3b, 8.8b, 8.10b, 8.10c, 8.10e, 8.13b, 8.13d, 8.13e, 8.14, 8.18, 8.22b, 13.5b

Hoes, J.A.: 21.2

Holliday, N.J.: 16.45a, 16.45c

Hopper, A.A.: 4.10e

Howard, R.J.: 6.1a, 6.1b, 6.5a, 6.5b, 6.17a, 6.17c, 6.19a, 6.19b, 6.20, 8.23c, 8.44d, 15A.3b, 15A.11a, 15A.11b, 15A.11c

Hudon, M.: 12.3a, 12.4, 12.13c, 12.14, 12.16a, 12.16b, 12.16c, 12.22b

Hunter, C.L.: 20.4a

Hussey, N.W.: 22.36T1

Jaques, R.P.: 3.7w, 3.7x, 3.7y, 3.7z, 8.40b, 8.40e, 8.40f, 8.45b

Jarvis, W.R.: 7.6a, 9.2a, 9.2b, 11.9c, 11.9e, 11.16, 13.7b, 18.15a, 18.15b, 18.15c, 18.15d, 18.15e, 22.4a, 22.4b, 22.7c, 22.8a, 22.8b, 22.11e, 22.14a, 22.14b, 22.16, 22.18a, 22.18d, 22.19, 22.20a, 22.30d, 24.9, 25.3, 25.10b, 25.13a, 25.13b, 25.15, 25.21c, 25.25b, 25.25c, 25.25d, 25.26

Johnson, D.A.: 10.2, 10.7a, 10.7b, 10.9d

Judd, G.J.R.: 18.38a, 18.38b, 18.38c, 18.38d, 18.38e, 18.38f, 18.38g

Kaethler, F.: 7.21b, 7.21d

Kaminski, D.A.: 15A.2e

Kemp, W.G.: 8.5a, 10.15b, 13.13, 25.21d

Kiehn, F.A.: 21.1a, 21.1b

Kushalappa, A.C.: 6.9c

Lacey, M.L.: 4.6b

Laing, D.R.: 12.15b, 12.15c, 22.32c

Lamb, R.J.: 15A.14

Lemieux, C.: 2.3i, 2.3j, 2.3k

Letal, J.R.: 16.11c

Lim, K.P.: 16.49T2

Liptay, A.: 27.2T1

Louws, F.J.: 4.2b, 4.2d, 4.2e, 4.6T1, 8.11b, 18.14a

Lowery, D.T.: 8.12

Lyon, H.: 16.3b, 16.35, 16.36

MacDonald, L.S.: 7.1b, 7.6b, 7.12b, 8.1b, 10.5, 10.6b, 10.10b, 11.19b, 13.9a, 16.34f, 18.22b, 20.6, 20.9b, 22.24b, 22.25b, 24.2c, 24.5a, 24.5b, 24.8a, 24.8c, 25.5, 25.18a, 25.18b, 25.22a, 25.22c

Mauza, B.E.: 22.9a, 22.18b, 22.22, 25.8

McDonald, M.R.: 5.8a, 5.8b, 6.3, 6.8, 6.9b, 6.16, 7.3a, 7.8a, 7.8b, 11.7c, 11.8a, 13.8a, 13.8b, 13.11a, 13.15a, 13.15b, 13.15c, 13.17, 13.19, 13.20, 13.21, 18.1b

McKeen, C.D.: 9.3a, 9.3c, 9.6a, 9.6b, 11.5, 12.2b, 16.34e, 16.34i, 18.18d, 18.18e, 22.13, 25.21c

Menzies, J.G.: 22.7a, 22.15T1, 25.10c, 25.10d

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Mohyuddin, M.: 22.26f

Morrall, R.A.A.: 11.9a, 15A.4b, 15A.5a, 15A.7, 18.8f, 18.8g, 22.15a, 25.1 la

Morris, R.F.: 8.46a, 8.46b, 8.46c, 8.46d, 8.46e, 8.46f, 8.46g

Northover, J.: 5.9

Nuttall, W.V.: 9.17b

Odermatt, W.J.: 11.17a, 11.20

Olthof, T.H.A.: 5.14b, 16.38, 18.30

Ontario Ministry of Agriculture and Food: 4.1a, 4.1b, 4.2c, 4.5a, 4.6a, 4.6b

Ormrod, D.J.: 7.12a, 8.5b, 8.7, 8.13c, 8.23b, 9.5, 9.8a, 10.6a, 11.6a, 11.9b, 11.9d, 11.10a, 11.10b, 11.19a, 12.6a, 13.2a, 13.2b, 13.4, 13.5a, 13.6c, 13.7a, 13.11c, 13.12a, 14.2a, 16.6a, 17.6a, 17.6b, 17.9, 18.11a

Parr, M.: 9.22a, 9.22b

Parrot, M.: 16.42a

Pepin, H.S.: 7.10b, 15A.9a

Peterson, J.F.: 13.14

Philip, H.G.: 8.41a, 8.45a, 8.47a, 11.26, 12.21a, 13.26a, 13.26e, 16.49e, 18.35b, 22.32d

Pitblado, R.E.: 12.5, 12.6b, 12.16e, 18.1a, 18.1c, 18.4b, 18.4d, 18.8b, 18.8c, 18.13b, 18.21d, 18.35a, 18.36a, 18.36b

Platford, R.G.: 10.10a, 15B.8b

Platt, H.W.: 16.3c, 16.4a, 16.6b, 16.7a, 16.7b, 16.8c, 16.9, 16.10, 16.11b, 16.11d, 16.13, 16.14, 16.15d, 16.16, 16.17b, 16.18a, 16.19, 16.20a, 16.20c, 16.26a, 16.32, 16.34j

Proudfoot, K.G.: 16.21a

Pucat, A.M.: 3.14T1, 5.17f, 15B.19a, 18.43

Punja, Z.K.: 6.6a, 25.10c, 25.10d

Ragan, P.R.: 2.3g, 2.3p

Read, D.C.: 8.4a, 8.13c

Reeleder, R.D.: 20.1b

Reyes, A.A.: 8.11a, 9.10, 18.12c

Rinker, D.L.: 26.1, 26.2, 26.3, 26.4a, 26.4b, 26.5, 26.6, 26.7, 26.8, 26.9, 26.11, 26.12, 26.13, 26.16, 26.18, 26.19, 26.20

Sackston, W.E.: 21.3, 21.4, 21.6

Saettler, A.W.: 15B.1c, 15B.1f

Saskatchewan Agriculture: 16.49b

Schwartz, H.F.: 15B.1h, 15B.2a, 15B.2d, 15B.3a, 15B.12a

Scopes, N.: 22.36T1

Scott, D.: 24.2a, 24.2b

Seaman, C.B.: 10.15c

Seaman, W.L.: 2.3a, 2.3q

Sears, M.K.: 16.46a, 16.46b

Shattuck, V.I.: 8.20

Shaw, B.R.: 2.3T1

Sheppard, J.W.: 8.2f

Shipp, J.L.: 3.7j, 3.7q, 3.7t, 3.10f, 18.42i, 22.34c, 22.34e, 22.34f, 22.34g, 22.34h, 22.36a, 22.36e, 24.12d, 24.12e, 24.14a, 24.14b, 24.14d, 25.27b, 25.27c, 25.27d, 25.27e, 25.27f, 25.28e, 25.31, 25.32

Shurtleff, M.C.: 5.2, 5.3, 5.4a, 5.4b, 5.10, 6.7, 6.10, 7.2, 7.4

Skotland, C.B.: 10.9b

Soroka, J.J.: 8.44a, 8.44e
Stavely, J.R.: 15B.1e
Stephens, C.T.: 4.5b, 4.5c
Stevenson, A.B.: 7.20, 7.21c
Stewart, J.G.: 16.45b
Stobbs, L.W.: 8.16b
Sutton, J.C.: 6.12, 9.18b, 12.8c, 13.6a, 13.6b, 13.6d
Sweeney, M.E.: 8.1a, 8.10a, 8.10d, 8.24, 8.39a, 12.7a
Tarder, L.M.: 7.7b, 7.9a, 7.9c, 7.13, 13.1, 13.9b, 18.2, 18.4c, 18.4e, 18.4f, 18.6a, 18.6b, 18.6c, 18.8a, 18.8d, 18.8e, 18.11b, 18.11c, 18.12a, 18.12d, 18.13a, 18.13c, 18.14b, 18.17, 18.18b, 18.21a, 18.21b, 18.21c, 18.22a, 18.25, 18.28, 18.29a, 18.29b, 18.40a, 18.40b, 25.14, 25.16b
Tellier, A.J.: 3.7d
Thistlewood, H.M.A.: 22.36f
Thomas, D.: 3.7h
Thompson, C.N.: 8.23a, 8.25b, 8.26 Tu, J.C.: 15B.2b
University of California, Davis: 3.10c, 3.10h
University of Guelph: 6.23d, 6.23e, 6.24a, 6.24b, 6.24c, 6.24d, 6.26, 8.2d, 8.4b, 8.6d, 8.8c, 8.10e, 8.44b, 8.44c, 10.14a, 10.14b, 12.16d, 12.19, 12.20b, 12.20c, 18.37a, 18.39, 25.29
University of Wisconsin: 6.11a, 6.11b, 6.11c, 6.13a, 6.13b, 8.2a, 8.2c, 8.6a, 8.6b, 16.37
Uyenaka, J.: 8.15
Vanterpool, T.C.: 17.1
Vernon, R.S.: 6.23a, 6.23c, 11.24T1, T2
von Aderkas, P.: 19.1
Vrain, T.C.: 3.10a, 3.10b, 5.14b, 13.23, 13.24, 16.38T1
Warren, H.L.: 12.8a, 12.8d
Watson, M.C.: 3.11a, 3.11b, 3.11c
West, R.J.: 3.7u, 16.47a, 16.47b
Wuest, P.J.: 26.1, 26.2, 26.3, 26.4a, 26.4b, 26.5, 26.6, 26.7, 26.8, 26.9, 26.11, 26.12, 26.13, 26.16, 26.18, 26.19, 26.20
Wukasch, R.T.: 11.3a, 11.3b, 11.3c, 11.3d, 11.4, 11.6b, 11.7a, 11.7b, 11.8b, 11.10c, 11.10d, 11.10e, 11.10f, 11.15b
Zimmer, R.C.: 15A.2f, 15A.8, 15A.9f
Zitter, T.A.: 9.8b, 12.10a, 12.10b

Introduction

Diseases and Pests of Vegetable Crops in Canada is a practical guide to the diagnosis and management of the more important diseases and pests of vegetable crops grown in Canada. Pest management recommendations emphasize sustainable approaches to crop protection.

Part 1 Chapter 1 provides an overview of vegetable crops and their commercial importance in Canada. Chapter 2 includes a discussion of the effects of diseases and pests on vegetable production and a description of the major groups of causal agents and physiological factors that limit crop productivity or affect the quality of produce. Chapter 3 provides an outline of management strategies that will prevent crop losses or limit damage from diseases and pests to an acceptable level. This chapter also includes information on recommended cultural control practices, the availability of resistant cultivars, and the current status of monitoring techniques, biological controls, including parasites and predators, and the role of chemicals in management strategies. A special section on management by exclusion deals with pathogens and pests that are subject to import restrictions or quarantine regulations limiting or prohibiting the movement of seeds, plants and soil into or within Canada. Other major sections in Chapter 3 include discussions on the management of weeds and of nematode pests, and a special section on problems likely to be encountered in the home vegetable garden, where pest problems and management strategies often differ from those found in commercial production.

Parts 2 to 5 provide detailed descriptions of the most important diseases and pests that affect specific vegetable crops. For convenience, crops are grouped according to the method of production and are listed alphabetically within each group. The sequence of chapters and illustrations is the same in both the English and French editions of the book. This harmonization was achieved by the use of some unusual crop headings, such as Maize (sweet corn) [Mai's sucré] and Pea and bean [Pois et haricot]. Part 2, chapters 4 to 18, deals with disease and pest problems of the major field-grown vegetable crops. Part 3, chapters 19 to 21, includes plant species that are native to North America. The fiddlehead, or ostrich fern, is not cultivated in the normal sense; rather, it is collected from natural sites in eastern Canada. The Jerusalem artichoke, which is considered a weedy plant in some areas, is grown commercially on a very small scale as a vegetable and for other uses. Ginseng, although field-grown, is protected by lathing. Part 4, chapters 22 to 25, describes the disease and pest problems of the major greenhouse vegetable crops, including cucumber, lettuce, pepper and tomato. Vegetables grown in the greenhouse share many of the same disease and pest problems that are encountered on their counterparts in the field, but there also are important differences in epidemiology and management; in some cases, the reader will be referred to one or another section of the book for further information or for color illustrations. Part 5, chapters 26 and 27, deals with other protected crops, namely, the button mushroom and vegetable sprouts.

Disease and pest descriptions To aid in finding descriptions of diseases and pests and their color illustrations, which are grouped near the end of the book, the major text entries are numbered sequentially by chapter and section; the color illustrations appear in the same order and have the same number as the corresponding text. Halftones and line drawings in the text also are identified by section number and the letter T. For example, 4.6 is the section describing rust of asparagus and is also the figure number of the corresponding illustrations (4.6a,b) and text figure (4.6T1). Tables also are identified by the corresponding section number. The running head for a left-hand page includes the crop name and section number of the first entry beginning on that page; the running head for a right-hand page contains the section number of the last entry on that page.

The presentation of diseases and pests for each crop follows the same general order, beginning with diseases of bacterial, fungal, viral or physiological origin, followed by problems caused by nematodes, insects, other arthropods, and molluscs. Within these sections, diseases and pests are listed alphabetically by the most widely used common name. Included for some diseases and pests are alternative, often regional, names or names that are associated with distinctive symptoms, such as root rot, seedling blight or damping-off, all of which describe phases of the same disease.

The common name of a disease or pest is followed by the italicized scientific name or names of the causal organism and the name, usually abbreviated, of the taxonomic specialist who described the organism. Many fungi have distinct asexual (anamorph) and sexual (teleomorph) states, and each has a different scientific name. To add to the possible confusion, scientific names change from time to time as the result of research; therefore, synonyms or earlier names of organisms may be included for continuity and reference to earlier literature. Scientific names will be of interest chiefly to specialists but are essential in clearly identifying diseases and pests, which is a prerequisite to prescribing effective management practices.

The description of each disease or pest begins with an introduction to its importance and distribution in Canada, followed by a discussion of symptoms or damage that will assist in the diagnosis of the problem in the field or greenhouse. Sections headed Causal agent or Identification include detailed descriptions of causal organisms, including microscopic features and measurements of reproductive organs, or information on specialized media on which these organisms can be grown in the laboratory for identification. Because this type of information is of interest mainly to diagnosticians and other specialists, these sections are set in smaller type. Other sections describe the disease cycle or the life history of the pest, the epidemiology of the disease, or factors influencing epidemics and fluctuations in pest populations.

The Management section includes currently recommended strategies for limiting economic pest damage to vegetable crops; these include monitoring, cultural practices, resistant cultivars, biological control and chemical control. In this publication,

pesticides and resistant cultivars usually are discussed only in general terms because specific recommendations should be based on local conditions and current information.

Many descriptions include selected references to scientific articles and books containing more detailed information on diagnosis, epidemiology or management that will be of special interest to disease and pest specialists. Guides to further reading are found in additional references at the end of the crop chapters and in the Bibliography.

Each disease or pest description is followed by the name of the contributing author(s). In many cases, the original description has been modified following review and editing.

Color photographs For many users of the book, the color illustrations will provide the initial clues to diagnosing a problem. Illustrations include symptoms of most of the major infectious diseases and disorders described in the text, as well as many of the arthropod (insects and mites), nematode and mollusc pests of each of the crops. To aid in searching for the appropriate descriptive text for a disease or pest, the color illustrations are arranged by crop in the same sequence as in the text chapters, and the figure number for each illustration is the same as the section number of the corresponding text. Multiple illustrations of a disease or pest are identified by letters appended to the number; for example, the figure numbers of the two illustrations of downy mildew of beet are 5.4*a* and 5.4*b*.

Sources of information In addition to the references specific to pest sections and crop chapters, a list of general references for further reading is included in the Bibliography. Most of the technical terms used in the text are explained in the Glossary.

Advice Vegetable growers are encouraged to consult qualified extension specialists or crop consultants for advice on management strategies appropriate to a given crop and location. In most areas of Canada, expert advice is available at provincial diagnostic clinics and extension offices, at Agriculture Canada research stations, and at some universities and privately operated pest clinics. A guide to the location of such clinics or sources of advice may be found in the Appendix.

Collecting and submitting specimens for diagnosis For many diseases and pests, accurate diagnosis or identification will require microscopic examination of affected tissues for signs of a causal agent. In some cases, the isolation and characterization of a pathogen requires specialized techniques or resources found in diagnostic laboratories.

Plants or pests collected for diagnosis must be as complete and as fresh as possible. It is best to collect several specimens that show the various stages of a problem. Where possible, whole plants should be submitted. To keep root systems intact, plants should be dug rather than pulled from the soil. Soil samples should be submitted along with plants if a soil-borne insect or nematode problem is suspected. To avoid deterioration during shipment, foliage should be free of soil and excessive moisture. It is also important that plants not be mailed in plastic bags as this will hasten spoilage. Intact plants often may be shipped successfully in a cardboard container if a small amount of moist soil is retained around the roots and the root ball is enclosed in plastic wrap or a snugly fitted plastic bag tied off around the stem to prevent soil from escaping.

Hard-shelled insects should be placed in cotton wool or another soft material, placed in a sturdy vial, then securely packed in a cardboard mailing container. Dead insects are very fragile and shatter easily, making identification almost impossible. Mites and insects, especially caterpillars and grubs, should be collected live because they often must be reared through to the adult stage before an accurate identification can be made. Such specimens should be provided with adequate food, usually host material, to minimize mortality during shipment.

As much information as possible should be provided with specimens to aid the specialist in making an accurate diagnosis and in recommending appropriate control measures. This should include such details as host and cultivar names, habitat, cropping practices, type and extent of damage, and recent history of weather conditions and crop rotation.

Inquiries about this book General inquiries or comments about *Diseases and Pests of Vegetable Crops in Canada* should be addressed to the editors. We would appreciate receiving constructive criticism of the contents and would welcome new or additional information and photographs that could be used to improve a subsequent edition.

This book is also available in French under the title *Maladies et Ravageurs des Cultures Légumières au Canada*.

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