2018 Cornell Pest Management Guidelines for Commercial Tree Fruit Production

Cornell Cooperative Extension

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These guidelines are not a substitute for pesticide labeling. Always read and understand the product label before using any pesticide.

ORGANIZATION OF THIS PUBLICATION VIII

1 INTEGRATED CROP AND PEST MANAGEMENT 1
1.1 Background 1
1.2 Practicing IPM 1
1.3 IPM Components 1
1.4 IPM Tactics 2

2 ORGANIC TREE FRUIT PRODUCTION IN NEW YORK STATE 3
2.1 Introduction 3
2.2 Fungicide Options in Organic Tree Fruit Production 3
2.3 Arthropod Management Options in Organic Tree Fruit Production 4
2.4 Site Management Considerations 4
2.5 Summary 4
2.6 References 4

3 PESTICIDE INFORMATION 6
3.1 Pesticide Classification and Certification 6
3.2 Use Pesticides Safely 6
3.3 Pollinator Protection 7
3.4 New York State Pesticide Use Restrictions 7
3.5 Verifying Pesticide Registration and Restricted-Use Status 8
3.6 Check Label for Site and Pest 8
3.7 Pesticide Recordkeeping/Reporting 8
3.8 EPA Worker Protection Standard (WPS) for Agricultural Pesticides 9
3.9 Reduced-risk Pesticides, Minimum-risk Pesticides, and Biopesticides 9
3.10 FIFRA 2(ee) Recommendations 10

4 SPRAYER INFORMATION 11
4.1 Solutions For Safer Spraying 11
4.1.1 Reducing Risk of Pesticide Exposure Through Use Of Engineering Controls 11
4.1.2 Areas of Potential Contamination 11
4.2 Minimizing Pesticide Drift in Orchards Part I 12
4.2.1 Drift Factors 12
4.3 Minimizing Pesticide Drift in Orchards Part II 14
4.3.1 Before Spraying: 14
4.3.2 During Spraying: 14
4.3.3 A Case Study 14
4.3.4 Conclusion 15
4.4 Preparing the Air Blast Sprayer for Work 16
4.4.1 Checking the Sprayer 16
4.4.2 Fitting the Sprayer to the Tractor 16
4.4.3 Checking the Operation of the Sprayer 16
4.4.4 Pre-Season Maintenance 16
4.4.5 Sprayer Calibration 17
4.4.6 Dilute Spraying 17
4.4.7 Concentrate Spraying 17
4.5 Rate of Output (GPM) 18
4.6 Tree Row Volume 19
4.6.1 Dilute Applications 19
4.6.2 Concentrate Applications (Low Volume Application) 19
4.7 Nozzles on the Net 19
4.8 Selecting Nozzles from the Nozzle Catalogue – Airblast sprayers 20
4.9 Calibrating Airblast Sprayers 22
4.9.1 Air Blast Sprayer Calibration (Use Clean Water) 22
4.9.2 Calibrating a Kinkelder Sprayer 23
4.9.3 Calibrating an Agtec Sprayer (Use Clean Water) 23
4.10 Selecting Nozzles from the Nozzle Catalogue – Boom Sprayers 23
4.11 Boom Sprayer Calibration (Use Clean Water) 25
4.12 Going Spraying! 26

4 **SPRAYER INFORMATION** *(continued)*

4.13 Equipment for Weed Control in Orchards 29
4.13.1 Boom Applicators 29
4.13.2 Conventional Flat Fan Nozzles 29
4.13.3 Pre-orifice Flat Fan Nozzles 29
4.13.4 Turbo-Teejet 29
4.13.5 Air Induction Nozzles 29
4.16.6 Sensor-Controlled Applicators 29
4.13.7 Controlled Droplet Applicators (CDA) 30
4.13.8 Flame Applicators 30
4.13.9 Where to Look/Buy Equipment and Nozzles 30
4.14 Decontaminating and Storing Crop Sprayers 31
4.14.1 Reducing Cleaning Problems 32
4.14.2 Sprayer Cleansers 32
4.14.3 Tank Rinse Systems (Low-Volume Tank Rinsing) 32
4.14.4 Cleaning the Sprayer 32
4.14.5 Tank Rinse Nozzle Suppliers 34
4.14.6 Disposal of Pesticide Waste 34
4.14.7 Mechanical Maintenance 34
4.14.8 Storage of Sprayers 34
4.14.9 References 34
4.15 Distance Learning 35

5 CHARACTERISTICS OF CROP PROTECTANTS USED ON TREE FRUITS 36
5.1 Cross Reference of Chemical vs. Trade Names of Pesticides 36
5.1.1 By Common Name 36
5.1.2 By Trade Name 37
5.2 Fungicides 39
5.3 Bactericides 44
5.4 Other Materials 45
5.5 Insecticides 46
5.5.1 Organophosphates 46
5.5.2 Carbamates 47
5.5.3 Pyrethroids 47
5.5.4 Neonicotinoids 48
5.5.5 Pre-Mixes 48
5.5.6 Other Materials 50
5.6 Acaricides 52
5.7 Fumigants and Nematicides for Tree Fruits 55

6 DISEASE MANAGEMENT 57
6.1 Apple Scab Fungicides 57
6.2 Notes on Apple Scab Management 61
6.2.1 Implications of Inoculum Dose 61
6.2.2 Orchard Sanitation for High-inoculum Orchards. 61
6.2.3 Options for Low-inoculum Orchards 61
6.2.4 Determining Scab Infection Periods. 61
6.2.5 Day vs. Night Release of Ascospores. 61
6.2.6 Seasonal Ascospore Maturity and Discharge. 62
6.3 Cedar Apple Rust Management 62
6.3.1 Determining Cedar Apple Rust Infection Periods. 62
6.4 Stone Fruit Fungicides 63
6.4.1 Characteristics of Stone Fruit Fungicides 63
6.5. Cherry Leaf Spot 63
6.5.1 Determining Cherry Leaf Spot Infection Periods. 63

7 INSECT AND MITE MANAGEMENT 65
Table 7.1.1. Activity spectrum of pome fruit insecticides and acaricides. 65
Table 7.1.2. Relative toxicity of pome fruit insecticides and acaricides to beneficials. 67
Table 7.1.3. Activity spectrum of stone fruit insecticides. 68

7 INSECT AND MITE MANAGEMENT *(continued)*

Table 7.1.4. Degree-day accumulations (from Jan. 1) corresponding to selected fruit phenology and arthropod pest events. 70
Figure 7.1.1. STLM Pink Sampling Form 72
Figure 7.1.2. Obliquebanded Leafroller Sampling Form 73
Figure 7.1.3. STLM Petal Fall Sampling Form 74
Figure 7.1.4. Mite Sampling Chart – Threshold = 2.5 mites/leaf (June 1-30) 75
Figure 7.1.5. Mite Sampling Chart – Threshold = 5.0 mites/leaf (July 1-31) 76
Figure 7.1.6. Mite Sampling Chart – Threshold = 7.5 Mites/leaf (August 1-15) 77
Figure 7.1.7. STLM Summer Sampling Form 78
Figure 7.1.8. Apple Maggot Monitoring Form 79
Figure 7.1.9. Apple Events Calendar for the Lake Plains Area of New York 80
Figure 7.1.10. Pear Events Calendar for the Lake Plains Area of New York 81
Figure 7.1.11. Cherry Events Calendar for the Lake Plains Area of New York 82
Figure 7.1.12. Peach Events Calendar for the Lake Plains Area of New York 83
Figure 7.1.13. Prune and Plum Events Calendar for the Lake Plains Area of New York 84

8 WEED MANAGEMENT 85
8.1 Calibration to Ensure Correct Herbicide Rate 85
8.2 Groundcover Management 86
8.3 Herbicides and Their Use 87
8.4 Herbicides for Tree Fruits 90
Table 8.4.1. Minimum time between planting and herbicide use. 94
Table 8.4.2. Effectiveness of herbicides in tree fruit crops. 94
Table 8.4.3. Weed control guidelines for tree fruit. 95

9 WILDLIFE DAMAGE MANAGEMENT 102
9.1 Deer and Rabbits 102
9.2 Meadow and Pine Voles 102
9.3 Woodchucks 103
9.4 Beavers 104

10 NUTRIENT MANAGEMENT OF APPLE ORCHARDS 105
10.1 Introduction 105
10.2 Nitrogen 105
10.3 Soil Analysis 105
10.4 Preplant Soil Preparation 105
10.5 Fertilization Program for Young Trees 108
10.6 Fertilization Program for Established Orchards 108
10.6.1. Maintenance Program 109
10.6.2 Corrective Program 109
10.6.3 Special Considerations in Foliar Application of Nutrients 110
10.6.4 Characteristics of Commonly Available Fertilizers 110

11 APPLES 113
11.1 Insecticides and Fungicides for Apples 113
Table 11.1.1 Pesticide Spray Table – Apples 113
11.2 Apple Disease Notes 146
11.2.1 Apple Scab 146
11.2.2 Black Rot & White Rot 147
11.2.3 Blister Spot 148
11.2.4 Blossom End Rot 148
11.2.5 Cedar Apple Rust 148
11.2.6 Crown Rot (Collar Rot) 148
11.2.7 Fire Blight 149
11.2.8 Phytophthora Rots 151
11.2.9 Powdery Mildew 151
11.2.10 Sooty Blotch And Fly Speck 152

11 APPLES *(continued)*

11.3 Apple Insect and Mite Notes....152
11.3.1 American Plum Borer....152
11.3.2 Apple Aphid, Spirea Aphid....152
11.3.3 Apple Maggot....153
11.3.4 Apple Rust Mite....153
11.3.5 Black Stem Borer....153
11.3.6 Climbing Cutworms: Darksided, Dingy, Mottled, Spotted, Variegated....154
11.3.7 Codling Moth....154
11.3.8 Comstock Mealybug....155
11.3.9 Dogwood Borer....155
11.3.10 European Apple Sawfly....155
11.3.11 European Corn Borer....156
11.3.12 European Fruit Lecanium....156
11.3.13 European Red Mite....156
11.3.14 Green Fruitworms....157
11.3.15 Japanese Beetle....157
11.3.16 Lesser Appleworm....157
11.3.17 Mullein Plant Bug....158
11.3.18 Obliquebanded Leafroller....158
11.3.19 Oriental Fruit Moth....159
11.3.20 Oystershell Scale....159
11.3.21 Plum Curculio....160
11.3.22 Redbanded Leafroller....160
11.3.23 Rosy Apple Aphid....161
11.3.24 San Jose Scale....161
11.3.25 Spotted Tentiform Leafminer, Apple Blotch Leafminer....161
11.3.26 Spotted Wing Drosophila....162
11.3.27 Stink Bugs (including Brown Marmorated Stink Bug)....162
11.3.28 Tarnished Plant Bug....163
11.3.29 Twospotted spider mite....163
11.3.29 Twospotted spider mite....163
11.3.30 Variegated Leafroller, Sparganothis Fruitworm....163
11.3.31 White Apple Leafhopper, Potato Leafhopper....163
11.3.32 White "Peach" (Prunicola) Scale....164
11.3.33 Woolly Apple Aphid....164
11.4 Storage Disorders....164
11.4.1 Storage Rots....164
11.4.2 Storage Scald....165
11.4.3 Senescent Breakdown (McIntosh)....165
11.5 Notes on Scald Control....165
11.5.1 Materials....165
11.5.2 Application Equipment....165
11.5.3 Variety Requirements....165
11.6 Growth Regulator Use In Apples....166
11.6.1 Chemical Thinning....166
11.6.2 Weather Factors That Affect Thinning Response....166
11.6.3 Tree Factors That Affect Thinning Response....167
11.6.4 Chemicals Registered for Thinning in New York....167
11.6.5 Chemicals Not Registered for Thinning that Influence Cropload....168
11.6.6 Spray Timings....168
11.6.7 Suggested Strategies for New York Growers....169
11.6.8 Summary....169
11.7 Other Growth Regulator Uses In Apples....175
11.7.1 Growth Regulator Chemicals Registered in New York....175

12 PEARS ... 180
12.1 Insecticides and Fungicides for Pears ... 180
Table 12.1.1 Pesticide Spray Table – Pears. ... 180
12.2 Pear Disease Notes ... 194
12.2.1 Crown Rot ... 194
12.2.2 Fabraea Leaf Spot ... 194
12.2.3 Fire Blight ... 194
12.2.4 Pear Scab ... 195
12.2.5 Phytophthora Rots ... 196
12.3 Pear Insect and Mite Notes ... 196
12.3.1 Apple Aphid, Spirea Aphid ... 196
12.3.2 Codling Moth ... 196
12.3.3 Comstock Mealybug ... 197
12.3.4 European Red Mite ... 197
12.3.5 Green Fruitworms ... 197
12.3.6 Obliquebanded Leafroller ... 198
12.3.7 Pear Midge ... 198
12.3.8 Pear Psylla ... 198
12.3.9 Pear Rust Mite ... 199
12.3.10 Pearleaf Blister Mite ... 199
12.3.11 Plum Curculio ... 199
12.3.12 Redbanded Leafroller ... 200
12.3.13 San Jose scale ... 200
12.3.14 Spotted Wing Drosophila ... 200
12.3.15 Stink Bugs (incl. Brown Marmorated Stink Bug) ... 200
12.3.16 Tarnished Plant Bug, Pear Plant Bug ... 201
12.3.17 Twospotted spider mite ... 201
12.3.18 White "Peach" (Prunicola) Scale ... 201
12.4 Growth Regulation of Pears ... 202
Table 12.4.1. Growth Regulator Uses in Pears. ... 202

13 CHERRIES ... 205
13.1 Insecticides and Fungicides for Cherries ... 205
Table 13.1.1 Pesticide Spray Table – Cherries ... 205
13.2 Cherry Disease Notes ... 217
13.2.1 Bacterial Canker (*Pseudomonas syringae*) ... 217
13.2.2 Black Knot ... 217
13.2.3 Brown Rot (Blossom & Shoot Blight) ... 218
13.2.4 Leaf Spot ... 218
13.2.5 Phytophthora Rots ... 218
13.2.6 Powdery Mildew ... 219
13.3 Cherry Insect and Mite Notes ... 219
13.3.1 American Plum Borer ... 219
13.3.2 Black Cherry Aphid ... 219
13.3.3 Black Cherry Fruit Fly/Cherry Fruit Fly ... 219
13.3.4 European Fruit Lecanium ... 220
13.3.5 European Red Mite ... 220
13.3.6 Japanese Beetle ... 220
13.3.7 Lesser Peachtree Borer ... 220
13.3.8 Obliquebanded Leafroller ... 221
13.3.9 Plum Curculio ... 221
13.3.10 San Jose Scale ... 221
13.3.11 Spotted Wing Drosophila ... 222
13.3.12 Stink Bugs (incl Brown Marmorated Stink Bug) ... 222
13.3.13 Twospotted spider mite ... 222
13.3.14 White "Peach" (Prunicola) Scale ... 223
13.4 Storage Rot Notes ... 223
13.5 Growth Regulation of Cherries ... 223

14 PEACHES AND NECTARINES ... 226
14.1 Insecticides and Fungicides for Peaches and Nectarines ... 226
Table 14.1.1 Pesticide Spray Table – Peaches and Nectarines. ... 226
14.2 Peach and Nectarine Disease Notes ... 239
14.2.1 Bacterial Spot ... 239
14.2.2 Blossom Rot ... 239
14.2.3 Brown Rot ... 240
14.2.4 Peach Leaf Curl ... 240
14.2.5 Peach Scab ... 240
14.2.6 Phytophthora Rots ... 241
14.3 Peach and Nectarine Insect and Mite Notes ... 241
14.3.1 American Plum Borer ... 241
14.3.2 European Fruit Lecanium ... 241
14.3.3 European Red Mite ... 241
14.3.4 Green Peach Aphid ... 242
14.3.5 Japanese Beetle ... 242
14.3.6 Lesser Peachtree Borer ... 242
14.3.7 Oriental Fruit Moth ... 243
14.3.8 Peachtree Borer ... 243
14.3.9 Plum Curculio ... 243
14.3.10 San Jose Scale ... 244
14.3.11 Spotted Wing Drosophila ... 244
14.3.12 Stink bugs, incl. Brown Marmorated Stink Bug ... 244
14.3.13 Tarnished plant bug ... 245
14.3.14 Twospotted Spider Mite ... 245
14.3.15 Western Flower Thrips ... 245
14.3.16 White "Peach" (Prunicola) Scale ... 246
14.4 Storage Rots ... 246
14.5 Growth Regulation of Peaches and Nectarines ... 246

15 APRICOTS ... 247
15.1 Insecticides and Fungicides for Apricots ... 247
Table 15.1.1 Pesticide Spray Table – Apricots. ... 247
15.2 Apricot Disease Notes ... 254
15.2.1 Bacterial Canker ... 254
15.2.2 Brown Rot ... 255
15.2.3 Peach Scab ... 255
15.2.4 Phytophthora Rots ... 255
15.3 Apricot Insect and Mite Notes ... 256
15.3.1 European Fruit Lecanium ... 256
15.3.2 European Red Mite ... 256
15.3.3 Japanese Beetle ... 256
15.3.4 Lesser Peachtree Borer ... 256
15.3.5 Oriental Fruit Moth ... 256
15.3.6 Peachtree Borer ... 257
15.3.7 Plum Curculio ... 257
15.3.8 San Jose Scale ... 258
15.3.9 Spotted Wing Drosophila ... 258
15.3.10 Stink Bugs, incl. Brown Marmorated Stink Bug ... 258
15.3.11 Tarnished Plant Bug ... 258
15.3.12 Twospotted Spider Mite ... 259
15.3.13 Western Flower Thrips ... 259
15.3.14 White "Peach" (Prunicola) Scale ... 259
15.4 Storage Rot Notes ... 259
15.5 Growth Regulation of Apricots ... 260

16 PLUMS AND PRUNES **262**
16.1 Plum and Prune Spray Table 262
Table 16.1.1 Pesticide Spray Table – Plums and Prunes. 262
16.2 Plum and Prune Disease Notes 268
16.2.1 Black Knot 268
16.2.2 Brown Rot 268
16.2.3 Peach Scab 269
16.2.4 Phytophthora Rots 269
16.3 Plum and Prune Insect and Mite Notes 269
16.3.1 American Plum Borer 269
16.3.2 Apple Maggot 269
16.3.3 European Fruit Lecanium 270
16.3.4 European Red Mite 270
16.3.5 Japanese Beetle 270
16.3.6 Lesser Peachtree Borer 270
16.3.7 Oriental Fruit Moth 270
16.3.8 Peachtree Borer 271
16.3.9 Plum Curculio 271
16.3.10 Redbanded Leafroller 271
16.3.11 San Jose Scale 272
16.3.12 Spotted Wing Drosophila 272
16.3.13 Stink Bugs, incl. Brown Marmorated Stink Bug 272
16.3.14 Twospotted Spider Mite 273
16.3.15 White "Peach" (Prunicola) Scale 273
16.4 Storage Rots 273
16.5 Growth Regulation of Plums and Prunes 273

17 APPENDICES **274**
17.1 Pesticide Data 274
17.2 EPA numbers and worker protection standard re-entry and personal protective equipment (PPE) guidelines. 279
17.3 Spray Mixture Compatibility Notes 284
17.3.1 Suggested Mixing Sequence 284
17.4. Tree Fruit Reference Materials 284
17.4.1 Tree Fruit IPM Fact Sheets 285
17.4.2 Other References 285
17.4.3 Websites 287
17.5 Cornell Diagnostic and Analytical Services 288
17.6 County and Regional Extension Tree Fruit Specialists In New York 289
17.7 Campus-Based Extension Faculty and Staff 290
17.8 Abbreviations and Symbols Used in This Publication 292

1 Integrated Crop and Pest Management

1.1 Background

Cornell University and Cornell Cooperative Extension actively promote the use of Integrated Crop and Pest Management (IPM) by New York growers in order to address agricultural concerns. In many areas of New York State, there are horticultural, economic, social, and political pressures to reduce the environmental impact and use of pesticides in crop production. Public concerns with nutrient and sediment movement into ground and surface water and pressure against pesticide applications is growing. In other regions, agricultural producers are being asked to submit nutrient and soil management plans to address the offsite impacts of their practices. In addition, the development of pesticide resistance in key pests; registration of fewer and more expensive new chemicals for pest control; loss of existing products; and increased competition from other regions continue to push New York agriculture to look for nonchemical alternatives.

IPM requires a combination of long and short term production strategies to maximize net profit while minimizing risks of undesirable environmental impacts of practices. Some of these practices include site selection, crop-specific production strategies, nutrient management, and cover cropping. IPM is a pest control strategy that promotes the use of a variety of tactics including pest-resistant cultivars and biological, cultural, and physical controls. Pesticides are a control tactic employed in IPM, but they are used preferably only when needed. Pesticide use is thus minimized without jeopardizing crop quality or yield. Applying multiple control tactics minimizes the chance that pests will adapt to any one tactic and allows growers to choose the most environmentally sound, efficacious, and economically efficient pest management program for their situation.

This manual provides information and references that will allow New York fruit growers to practice IPM for many of their crops. While information for the proper use of pesticides is a main component of this manual, other information is contained that can help growers reduce their reliance on pesticides and take advantage of alternatives to pesticides that may be less expensive, less environmentally harmful, and more acceptable to the non-agricultural community.

1.2 Practicing IPM

In an IPM program, it is important to accurately identify the pests (vertebrates, diseases, insects, and weeds) and assess pest abundance. See the listing (at the end of this publication) of laboratories at Cornell that do pest and disease diagnosis and soil and tissue analysis for assistance in maintaining crop health and nutrition. It is important to have knowledge of the biology and ecology of the pest(s) attacking the crop and the factors that can influence pest infestations. An understanding of the influence of factors such as weather and natural enemies on pest abundance will aid the choice of management tactics. IPM programs stress suppression of insect and disease populations to levels that do not cause economic damage, rather than total eradication of a pest. In the case of insect pests, it may be important to have at least some pests present to ensure that natural enemies will remain in the crop to suppress subsequent infestations.

1.3 IPM Components

1.3.1 Monitoring (Scouting)

Scouting includes detecting, identifying, and determining the level of pest populations on a timely basis. Insect traps can often be used to detect pests and identify times when scouting should be intensified or control measures should be taken. Monitoring individual orchard blocks throughout the season is the most effective way of assessing the insect, disease, and weed situation and, therefore, the need for chemical treatment in that block. Scientifically based, accurate, and efficient monitoring methods are available for many pests on fruit crops in New York. Brief descriptions of the recommended techniques are given in this manual.

1.3.2 Forecasting

Weather data and other information helps predict when specific pests will most likely occur. Weather-based pest forecast models for diseases and insects of many crops have been developed in New York. This information will be referred to for the pests that have such models available. Weather forecasts are available through the NYS IPM Program's Network for Environment and Weather Awareness (NEWA) on a daily basis.

Access to a computer network to obtain weather, regional insect, and disease forecasts is useful but not essential. NEWA provides automated local weather information and the results of pest forecasts on a daily basis. Access NEWA online at newa.nysaes.cornell.edu. Simple weather recording equipment such as thermometers, hygrometers, and rain gauges placed in orchards will assist the prediction of pest outbreaks. Information on the potential for pest outbreaks generally can also be obtained from local Cooperative Extension offices, newsletters, and regional crop advisors.

1.3.3 Thresholds

Use thresholds to determine when pest populations have reached a level that could cause economic damage. Thresholds have been scientifically determined by Cornell researchers. Following the thresholds indicated in this manual has reduced pesticide use by as much as 50%, saving significant money for growers. The term ***suggested***

2 Organic Tree Fruit Production in New York State

2.1 Introduction

A large number of both native and introduced pest species attack apples and other tree fruits grown in commercial orchards. Control of this pest complex is particularly challenging in N.Y., because unlike more arid production regions in the country, fruit orchards in N.Y. are commonly in close proximity to semi-wooded areas with an abundance of naturalized and wild host species that can harbor populations of certain tree fruit pests. Traditionally, conventional fruit orchards in N.Y. have been treated heavily with pesticides to control this extensive pest complex.

In the past, very few growers in the northeast have attempted to produce apples and other tree fruits organically because of the practical difficulties involved in controlling pests in this region without using conventional, broad-spectrum pesticides. However, during the last 10-15 years, studies have been conducted to develop management programs that may be able to replace current strategies that rely primarily on these pesticide applications. For example, recent studies have shown that the predaceous mite, *Typhlodromus pyri*, which is native to apple production regions in western N.Y., can successfully control populations of the key mite pest, European red mite, in commercial apple orchards so that no applications of miticides are required for seasonal control. Recent research in N.Y. and elsewhere has also shown that pheromones can be deployed in orchards to disrupt mating of key lepidopteran species such as oriental fruit moth, and borer species, and substantially reduce fruit damage from this complex of pests. In addition to some of these newer types of organically compatible pest control technologies, traditional control methods such as selective fruit thinning, pruning, sanitation (frequent removal of dropped fruit infested or infected with pests), removal of wild hosts near commercial plantings, and exclusion of pests with biological or physical barriers near or around trees, have also been shown to reduce populations of many types of pests in fruit plantings in this region.

Ideally, organic fruit production is the synthesis of an entire suite of practices intended to take advantage of natural ecosystem interactions and minimize synthetic inputs. Such a system might start with the selection of disease-resistant cultivars, to circumvent the need for the majority of normal disease sprays. This one tactic could eliminate or substantially reduce the need to manage apple scab, powdery mildew, cedar apple rust, and fire blight (Ellis et al., 1998). In lieu of resistance, a combined strategy of orchard sanitation and frequent applications of elemental sulfur and copper throughout most of the season would be the next practical alternative.

2.2 Fungicide Options in Organic Tree Fruit Production

Organic approved fungicides and bactericides are often not as effective and the convention fungicides and antibiotics in temperate apple production regions such as NY and New England. In recent years, organic copper and sulfur products, and biopesticide products have greatly improved in terms of formulation and efficacy. In drier seasons and against lower disease pressure situations (e.g. low level of inoculum & less susceptible cultures), organic-approved products can provide a level of control comparable to conventional products. That being said, organic-approved products may need to be applied at higher rates and frequencies to match the activity of convention products. In field trials conducted at Cornell and other regional institutions, applied plant pathologists are achieving greater success in managing fire blight and summer diseases with biopesticides based on *Bacillus subtilis*, *B. amyloliquefaciens*, *B. mycoides*, and *Reynoutria sachalinensis*, and new low MCE copper products formulated to reduce risk of phytoxicity. In many instances, biopesticides and organic copper and sulfur products are being used in conventional production as means of resistance management or to avoid exceeding seasonal tolerances for key conventional fungicides. Biopesticides based on natural oils, such as white mineral oil or oil of thyme have similar potential for controlling fungal and bacteria diseases, but the use of oils complicates the use of other agrichemicals as oils act as intensifiers and could lead to problems with phytoxicity in tank mixes. Biopesticides based on potassium bicarbonate and peroxides have utility against fungal diseases, particularly, powdery mildew and sooty blotch fly speck. However, these would be need to be applied every 3-5 days or at each wetting event for maximum efficacy. Phosphorous acid fungicides are biopesticides and can be fairly effective against fire blight, powdery mildew, and flyspeck sooty blotch when applied at model recommendations and short intervals (e.g. 3-7 days). However, these products are not approved for organic agriculture. Additional biopesticides and organically approved copper and sulfur products are being developed and improved every year. While some of these products have been evaluated, many are either not commercially available or have yet to be thoroughly evaluated by multiple experts in the region. Products designated with the section symbol "§" indicate that they are suitable for organic production. A provisional program for managing the major diseases of apples covering might resemble:

- **Apple scab** [silver tip through midsummer] – copper [silver tip & green tip]; sulfur, *Bacillus sp,* potassium bicarbonate, and peroxides [tight cluster to midsummer]

3 Pesticide Information

3.1 Pesticide Classification and Certification

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) created two classifications of pesticides – general-use and restricted-use. **General-use pesticides** may be purchased and used by anyone. **Restricted-use pesticides can** only be purchased by a certified applicator. Restricted-use pesticides must also be used by a certified applicator or someone under their supervision.

The same federal law that classifies pesticides divided applicators into two groups: private and commercial. **Private applicators** use or supervise the use of pesticides to produce agricultural commodities or forest crops on land owned or rented by the private applicator or their employer. A farmer must be certified as a private applicator in order to purchase and use restricted-use pesticides on agricultural commodities. (No certification is needed if a farmer does not use restricted-use pesticides.)

A **commercial applicator** uses or supervises the use of pesticides for any purpose or on any property not covered by the private applicator classification. In New York, a commercial applicator must be certified to purchase or use any pesticide whether it is general- or restricted-use.

Information about pesticide certification and classification is available from your Cornell Cooperative Extension office (cce.cornell.edu/localoffices), regional NYSDEC pesticide specialist (www.dec.ny.gov/about/ 558.html), the Pesticide Applicator Training Manuals (store.cornell.edu/c-876-manuals.aspx), or the Pesticide Management Education Program (PMEP) at Cornell University (psep.cce.cornell.edu).

3.2 Use Pesticides Safely

Using pesticides imparts a great responsibility on the user to protect their health and that of others and to protect the environment. Keep in mind there is more to “pesticide use” than the application. Pesticide use includes mixing, loading, transporting, storing, or handling pesticides after the manufacturer’s seal is broken; cleaning pesticide application equipment; and preparing a container for disposal. These activities require thoughtful planning and preparation. They are also regulated by state and federal laws and regulations intended to protect the user, the community, and the environment from any adverse effects pesticides may cause.

3.2.1 Plan Ahead

Many safety precautions should be taken *before* you actually begin using pesticides. Too many pesticide applicators are dangerously and needlessly exposed to pesticides while they are preparing to apply them. Most pesticide accidents can be prevented with informed and careful practices. **Always read the label on the pesticide container before you begin to use the pesticide.** Make sure you understand and can follow all directions and precautions on the label. Be prepared to handle an emergency exposure or spill. Know the first aid procedures for the pesticides you use.

3.2.2 Move Pesticides Safely

Carelessness in transporting pesticides can result in broken containers, spills, and contamination of people and the environment. Once pesticides are in your possession, you are responsible for safely transporting them. Accidents can occur even when transporting materials a short distance. You are responsible for a pesticide accident so take every effort to transport pesticides safely. Be prepared for an emergency.

3.2.3 Personal Protective Equipment and Engineering Controls

Personal protective equipment needs depend on the pesticide being handled. ***Required personal protective equipment (PPE) are listed on pesticide labels.*** The required PPE are based on the pesticide’s toxicity, route(s) of exposure, and formulation. Label required PPE are the minimum that must be worn during the pesticide’s use. Pesticide users can always wear more protection than the label requires.

The type of protective equipment used depends on the type and duration of the activity, where pesticides are being used, and exposure of the handler. Mixing/loading procedures often require extra precautions. Studies show you are at a greater risk of accidental poisoning when handling pesticide concentrates. Pouring pesticide concentrates from one container to another is the most hazardous activity. More information on personal protective equipment can be found online at umes.edu/NC170/Default.aspx?id= 7184.

Engineering controls are devices that help prevent accidents and reduce a pesticide user’s exposure. One example is a closed mixing/loading system that reduces the risk of exposure when dispensing concentrated pesticides. More information on engineering controls can be found online at umes.edu/NC170/Default.aspx?id=7196.

3.2.4 Avoid Drift, Runoff, and Spills

Pesticides that move out of the target area can injure people, damage crops, and harm the environment. Choose weather conditions, pesticides, application equipment, pressure, droplet size, formulations, and adjuvants that minimize drift and runoff hazards. See product labels for specific application and equipment requirements.

4 Sprayer Information

4.1 Solutions For Safer Spraying

4.1.1 Reducing Risk of Pesticide Exposure Through Use Of Engineering Controls

Because handling and applying pesticides is risky business, keeping pesticide exposure to a minimum should be a chief concern of any pesticide applicator. To reduce the risks associated with handling and applying pesticides, devices known as engineering controls can be used that help to reduce or practically eliminate exposure to toxic chemicals. This section describes various engineering controls that can help reduce applicator exposure to pesticides in five areas of potential contamination.

4.1.2 Areas of Potential Contamination

1. Loading the Sprayer

Closed Transfer Systems – Closed transfer systems allow concentrated pesticide to be moved from the original shipping container to the sprayer mix tank with minimal or no applicator contact. Many systems provide a method to measure the concentrated pesticide. Some systems also include a container rinsing system. Currently available closed transfer systems use a probe inserted into the pesticide container, a connector on the container that mates to a similar connector on the application equipment, or a vacuum-type (venturi) system that uses flowing water to transfer the chemical from the container.

Induction Bowls – Induction bowls are metal, plastic or fiberglass hoppers attached to the side of the sprayer or nurse tank that allow pesticides to be added to the mix tank without the applicator climbing onto the spray rig. Pesticides are poured into the bowl and water is added to flush out the bowl and carry the pesticide to the spray tank. Often a rinse nozzle is mounted inside the bowl for rinsing out empty pesticide containers. Typically induction bowls are raised out of the way during spraying and lowered to about 3 feet above ground when loading the sprayer.

Direct Pesticide Injection System – Direct pesticide injection systems allow pesticides to be mixed directly with water in the sprayer plumbing system rather than in the main spray tank. The pesticide is pumped from its container and mixed with the water either in a manifold or at the main water pump. Only clean water is held in the main tank of the sprayer. An electronic controller and up to four pumps adjust the amount of concentrated pesticide that is injected into the water stream, allowing for variable application rates.

Container Rinse System – Container rinse systems consist of a rinse nozzle and a catch bowl that traps the container washings (rinsate). The empty container is placed over the rinse nozzle and a jet of water cleans the inside of the container. The rinsate caught in the bowl is pumped into the spray tank to be used along with the spray mixture. Often rinse nozzles are installed in chemical induction bowls. Most closed transfer systems also provide a way of rinsing containers and piping the rinse water into the spray tank.

2. Reducing Contamination at the Boom

Boom Folding/Extending – Manually folding booms can be a major source of operator contamination because the boom can be covered with pesticide from drift or dripping nozzles. Consider the use of hydraulic or mechanical folding methods.

Diaphragm Check Valves – Typically, when a sprayer is shut off and as the system pressure drops, any liquid remaining in the boom piping drips from the nozzles, possibly dripping onto the boom or even the operator. Diaphragm check valves installed at each nozzle prevent this by using a spring-loaded rubber diaphragm to close off the flow of liquid once the system pressure drops below about 10 pounds per square inch. When the sprayer is switched on and system pressure builds up, the valve opens and allows the liquid to flow through the nozzles.

Multiple Nozzle Bodies – Contamination can occur when operators change or unclog nozzles during an application. Multiple nozzle bodies (or turret nozzles) allow operators to switch between nozzles with a turn of the nozzle body rather than having to unscrew or undo a threaded or a bayonet fitting.

Hand Wash Water Supply – Providing adequate wash water is essential (and often required). A simple container with a hand-operated valve can be mounted on the side of the sprayer to provide clean water for hand washing and personal hygiene.

3. Protecting from Drift and Contaminated Clothing in Cabs

Cab Filtration Using Carbon Filters – Carbon filtration systems are used to remove pesticide odor and pesticide-laden mist from fresh air used in a tractor or self-propelled sprayer cab. Carbon filtration systems are often a standard feature on self-propelled sprayers. Now many factory installed tractor cabs offer optional filtration systems. In 1998, the American Society of Agricultural Engineers (ASAE) adopted testing standards for operator cabs used in pesticide application. Cabs certified under this standard meet the requirements for enclosed cabs contained in the Worker Protection Standard.

Protective Clothing Lockers – To prevent contamination of the tractor or sprayer cab interior, entering the cab. A few sprayer companies offer a simple compartment (or pressure gauge, replace it or refer the problem to the manufacturer or supplier.

Nozzles
check…

- ☐ all nozzles are the same
- ☐ all nozzles are in good condition, with no leaks around the body
- ☐ all nozzles are clean and free from obstruction (note: clean with a soft brush or airline – don't damage nozzles by using wires or pins)
- ☐ all nozzles deliver to within + or - 5% of the manufacturer's chart value

Using water only, set to 'spray' at the specified pressure and collect the output from each nozzle in turn for a period of 60 seconds. Record each output and replace those outside the 5% tolerance stated in the manufacturer's chart.

Calibration
Where your sprayer has automatic controllers to monitor the speed of the sprayer and the flow, pressure and area sprayed:
check…

- ☐ they are in good condition and properly maintained
- ☐ they are frequently calibrated for accuracy, leaks, blockages, variations in pressure or any minor damage during spraying

Routine Maintenance
The following checks should be carried out routinely:

- ☐ All hoses are tightly connected and free from sharp bends; cracked or damaged hoses must be replaced.
- ☐ All controls move freely and are fully adjustable.
- ☐ Pressure gauge reads zero.
- ☐ Pump can be turned over by hand.
- ☐ Fan turns freely and is not obstructed; bearings are sound and lubricated.
- ☐ Air pressure in pump accumulator (if fitted) is correctly adjusted.
- ☐ Drain plugs and clean filters are in position.
- ☐ Tires on trailed machines are sound and correctly inflated; wheel nuts are tight.

4.4.5 Sprayer Calibration

Accurate calibration of orchard spray equipment is important for efficient use of pesticides. The selection of the right chemical and timing of its application are equally important. Tree spraying requires a sprayer with adequate capacity to distribute the spray evenly throughout the trees. Individual sprayers can be designed to operate most effectively over a range of gallonages per acre. The best spray coverage and deposit are obtained within the manufacturer's recommended operating range. Sprayer performance will be limited by pump output, maximum pressure, fan capacity, and travel speed.

4.4.6 Dilute Spraying

The amount of dilute spray required to adequately cover trees varies with the size, density of canopy, and stage of growth of the trees. Unless adjustments are made in the spray delivery, spray pattern, and fan output required by differences in tree size, difficulties such as inadequate pest control or excessive application of material will result. Approximate dilute gallonages required in different orchard situations are indicated in Table 4.4.1.

4.4.7 Concentrate Spraying

Table 4.4.1 shows how the amount of dilute spray required to cover an acre of orchard will vary according to tree size. This table also can be used to adjust the per-acre rate of pesticides for orchards of different tree sizes when concentrate sprays are applied. For instance, in an orchard with rows 30 ft apart and trees 20 ft wide x 15 ft tall, the minimum dilute spray per acre is shown to be 300 gallons. Thus, if you are applying a pesticide recommended at a rate of 2 lb/100 gal dilute basis, the appropriate per acre rate in such an orchard would be 6 lb, which could be applied in 75 gal of water at a 4X concentration or in 50 gal of water at a 6X concentration.

However, in a more compact orchard with 22 ft between rows and trees 14 ft wide x 10 ft tall, the minimum dilute spray per acre is shown to be 200 gal. Thus, the same pesticide would be applied at a rate of only 4 lb per acre in this orchard (2 lb/100 gal dilute basis x 200 gal dilute coverage). If concentrate spraying, the 4 lb of pesticide would be applied in 50 gal of water per acre at a 4X concentration or in 33 gal of water at a 6X concentration.

Concentrate spraying must be considered in terms of reducing the gallons of water per acre for the row-spacing and tree-size combination being sprayed. As the gallonage of water is reduced, errors become more critical. Concentrate sprays reduce or eliminate run-off, depending upon the degree of concentration. From a practical viewpoint, the acceptable concentrate level depends on several factors including the pest being controlled, density of foliage, weather conditions, and material being applied. Dilute sprays are generally more effective and are preferred for applying growth regulators, nutrient sprays, acaricides, and insecticides for control of pests such as scales and woolly aphid. In most other instances, concentrate sprays in the range of 6X to 8X usually provide satisfactory results.

Additional savings in cost of application above this level of concentration are minimal, and frequency of poor spray performance increases.

5 Characteristics of Crop Protectants Used on Tree Fruits

5.1 Cross Reference of Chemical vs. Trade Names of Pesticides

Key to pesticide type: (**A**) = Acaricide; (**B**) = Bactericide; (**F**) = Fungicide; (**I**)= Insecticide.

NOTE: See Chapter 8 for a discussion of herbicides used in tree fruit.

5.1.1 By Common Name

abamectin/avermectin – (*†Agri-Flex, *Agri-Mek) Syngenta; (*Abba) Makhteshim; (*Gladiator) FMC **(A,I)**
acequinocyl – (Kanemite) Arysta LifeScience **(A)**
acetamiprid – (Assail) United Phosphorus **(I)**
azadirachtin – (§Aza-Direct) Gowan; (§Neemix 4.5) Certis **(I)**

Bacillus subtilis – (§Serenade products) Bayer **(B, F)**
Bacillus amyloliquefaciens – (§DoubleNickel prodcucts) Certis **(B, F)**
Bacillus mycoides isolate J– (§LifeGuard) Certis **(B, F)**
bifenazate – (Acramite) Chemtura **(A)**
bifenthrin – (*Brigade) FMC (**I, A**)
boscalid + pyraclostrobin – (Pristine) BASF (**F**)
Bacillus thuringiensis (B.t.) – (§Agree) Certis; (§Dipel) Valent BioSciences; (§Deliver) Certis; (§Javelin) Certis **(I)**
buprofezin – (*†Centaur) Nichino **(I)**
Burkholderia spp. strain A396 – (§Venerate XC) Marrone Bio Innovations **(I)**

captan – (Captan) Micro Flo, Drexel, Makhteshim Agan; (Captec) Micro Flo **(F)**
carbaryl – (Carbaryl) Drexel; (Sevin) TKI (**I**)
chlorantraniliprole – (*†Altacor) DuPont; (*†Voliam Flexi, *†Voliam Xpress, *†Beseige) Syngenta **(I)**
chlorpyrifos – (Lorsban) Dow AgroSciences, Gowan **(I)**
chlorothalonil – (Bravo) Syngenta; (Echo) Sipcam Agro; (Equus) Makhteshim Agan **(F)**
Chromobacterium subtsugae **–** (§Grandevo) Marrone Bio Innovations **(I)**
clofentezine – (Apollo) Makhteshim Agan **(A)**
copper hydroxide – (Kocide, Champ) DuPont, Nufarm Americas **(B, F)**
copper oxychloride/copper sulfate – (C-O-C-S) Loveland **(B, F)**
copper oxychloride/ copper hydroxide – (Badge SC, §Badge X2) Gowan **(B, F)**
copper octanoate – (Cueva) Certis **(B, F)**
copper sulfate – (Cuprofix Ultra Disperss) United Phosphorus **(B, F)**
cyantraniliprole – (*†Exirel) DuPont **(I)**
cyantraniliprole/abamectin – (*†Minecto Pro) Syngenta **(I)**
cyflumetofen – (Nealta) BASF **(A)**
cyfluthrin – (*Baythroid, *Leverage) Bayer **(I)**
cyprodinil – (Vangard) Syngenta **(F)**

diazinon – (*Diazinon) Makhteshim **(I)**
difenoconazole + cyprodinil– (Inspire Super) Syngenta **(F)**
difenoconazole + fludioxonil– (Academy) Syngenta **(F)**
dimethoate – (*Dimethoate) Loveland (*Dimethoate) Drexel **(I)**
dodine – (Syllit FL) Agriphar **(F)**

emamectin benzoate – (*Proclaim) Syngenta **(I)**
esfenvalerate – (*Asana) DuPont **(I)**
etoxazole – (Zeal) Valent **(A)**

fenazaquin – (Magister) Gowan **(A)**
fenbuconazole – (Indar) Dow AgroSciences **(F)**
fenbutatin-oxide – (*Vendex) United Phosphorus **(A)**
fenhexamid – (Elevate) Arvesta **(F)**
fenpropathrin – (*Danitol) Valent BioSciences **(I)**
fenpyroximate – (Portal) Nichino America **(A,I)**
flonicamid – (Beleaf) FMC **(I)**
flutriafol – (†Topguard) Cheminova **(F)**
fluopyram + pyrimethanil (*†Luna Tranquility) Bayer (**F**)
fluopyram + trifloxystrobin (*†Luna Sensation) Bayer (**F**)
fluopyram + tebuconazole (*†Luna Experience) Bayer (**F**)
fluxapyroxad (*†Sercadis) BASF (**F**)
fluxapyroxad + pyraclostrobin) (*†Merivon) BASF (**F**)
ferbam – (Ferbam Granuflo) Taminco **(F)**
fludioxonil – (Scholar) Syngenta **(F)**
fosetyl-Al – (Aliette) Bayer **(F)**

hexakis – (*Vendex) United Phosphorus **(I)**
hexythiazox – (Savey, Onager) Gowan **(A)**
hydrogen dioxide – (OxiDate, StorOx) Biosafe Systems **(B, F)**

imidacloprid – (*Admire Pro, *Leverage) Bayer **(I)**
indoxacarb – (Avaunt) DuPont **(I)**
insecticidal virus – (§Cyd-X, §Madex) Certis; (§Carpovirusine) Arysta LifeScience **(I)**
iprodione – (Rovral) Bayer; (Iprodione) MicroFlo **(F)**

kaolin – (§Surround) TKI (**A,F,I**)
kasugamycin – (Kasumin 2L) Arysta LifeScience **(B)**
kresoxim-methyl – (Sovran) BASF **(F)**

lambda-cyhalothrin – (*Lambda-Cy) United Phosphorus; (*Warrior; *†Voliam Xpress; *†Endigo) Syngenta **(I)**

malathion – (Clean Crop Malathion) Loveland; (Malathion) Drexel; (*Prentox Malathion) Prentiss **(I)**
mancozeb – (Dithane) Dow AgroSciences; (Manzate) DuPont; (Penncozeb) United Phosphorus **(F)**
maneb – (Manex) Griffin **(F)**
mefanoxam – (Ridomil Gold) Syngenta **(F)**
metconazole – (Quash) Valent (**F**)
methomyl – (*Lannate) DuPont **(I)**
methoxyfenozide – (*†Intrepid) Dow AgroSciences **(I)**
metiram – (Polyram) BASF **(F)**
metrafenone – (Vivando) BASF **(F)**
myclobutanil – (Rally) Dow AgroSciences **(F)**

common soil resident. The bacterium acts by releasing cell contents during growth in order to eliminate or reduce competitors in its immediate environment. Serenade Optimum may be less effective than conventional fungicide for controlling fungal diseases under the favorable climatic conditions that exist in New York. When used alone, Serenade Optimum provides only some control of fire blight. In alternation with streptomycin, it sometimes provides control approaching that of a full streptomycin program. Serenade Optimum should be applied as a preventive and can be applied up to and including the day of harvest.

5.5 Insecticides

The insecticides and acaricides used to control fruit pests can be divided into several categories according to their chemical composition, mode of action, persistence, and other properties. To plan and carry out an effective spray program, it is important to understand these characteristics. A simplified classification of most of the insecticides and acaricides recommended in this bulletin is given, along with some of their general properties and uses.

Notes on Materials

The hazard of a material poisoning honey bees is given as follows: High = hazardous to bees at any time; 1 day to 2 wk residual toxicity. Moderate = not hazardous if applied in either evening or early morning when bees are not foraging, except during periods of high temperature; 3 hr to 1 day residual toxicity. Low = not hazardous to bees at any time; 1 hr to 1 day residual toxicity.

5.5.1 Organophosphates

Most organophosphate insecticides are highly toxic to warm-blooded animals when inhaled, swallowed, or absorbed through the skin. Persons handling or applying these materials should take every precaution for their own safety and for that of others. Although the organophosphates in general are less persistent than the chlorinated hydrocarbons, their toxicity often prohibits their use close to harvest (see following materials). Organophosphates are contact insecticides as well as stomach poisons. Therefore, they are useful for a quick kill of all insect forms present at the time of application, as well as for reasonable residual protection. When used alone or in combination with other materials, some organophosphates cause phytotoxicity on fruit varieties. Check this reference under the pest, the crop, and the product for more details about this situation.

Chlorpyrifos (Lorsban) is registered for control of San Jose scale during the prebloom period on apples, pears, peaches, and plums. Application during this period will also control rosy apple aphid. This material can be used alone or in combination with oil. It is also registered for use on peaches and cherries to control peachtree borers and in apples as a trunk spray to control a variety of borers. A 75 WG (water dispersible granule) formulation is available for all tree fruits except apricots, and exhibits better efficacy, rainfastness, and fewer phytotoxicity problems than the *3.76EC or *4EC formulations. This label also lists postbloom trunk sprays for many borer species in apple. All formulations can also be used in tart cherries to control borers, as well as other pests including leafrollers, plant bugs, and scales. The material has a high bee-poisoning hazard.

Diazinon has caused russeting or related finish problems on R.I. Greening, Golden Delicious, and Baldwin. No injury has been reported on McIntosh or closely related varieties. Observations on other varieties are limited. The material should not be used in combination with copper. It is principally used prebloom for control of San Jose scale or postbloom for broad-spectrum control of major pests. It is generally less persistent than other standard phosphates and has a high bee-poisoning hazard.

Dimethoate is a broad-spectrum systemic material registered on pears that is still effective against certain organophosphate-resistant aphids and leafhoppers. It will also suppress tarnished plant bug when used prebloom. It has a high bee-poisoning hazard.

[Note: These products have been voluntarily withdrawn from use on apples. Pears are still a registered use.]

Malathion is a mild phosphate that is used where a high degree of safety to people or animals is desired. It is no longer labeled for apples. It is registered for use on cherry, peach, nectarine and apricot for a variety of pests including aphids, scales, codling moth, oriental fruit moth, plum curculio and Japanese beetle. It has a very short PHI, is compatible with most other insecticides and fungicides and has a high bee-poisoning hazard.

Phosmet (*Imidan) is a broad-spectrum material with a lower toxicity to mammals than many other commonly used organophosphates. It is compatible with most commonly used insecticides and fungicides, but is incompatible with alkaline materials such as Bordeaux mixture and lime. It may cause severe leaf injury to sweet cherries, particularly those of Emperor Francis parentage. It can be used in summer sprays in integrated mite-control programs because of its low toxicity to predator mites. In some seasons in which rainfall has been negligible during the late summer, the fruit occasionally shows a buildup of the carrier used in the wettable powder. *Imidan is effective in controlling codling moth, apple maggot, redbanded leafroller, plum curculio, peach twig borer, and oriental fruit moth on apple, pear, peach, apricot, nectarine, and plums to be used for prunes. It has been ineffective against phosphate-resistant populations of pear psylla. It has a high bee-poisoning hazard.

6 Disease Management

6.1 Apple Scab Fungicides

Apple scab fungicides can control disease through four different types of activity: protection, post-infection activity, presymptom activity, and postsymptom activity. Understanding these activities and knowing which fungicides exhibit them can help a grower determine the materials that are likely to give the best results under a certain set of conditions.

Protection. Protection refers to the ability of fungicide residues to kill or inactivate scab spores (and thereby prevent infection) when the residue is already on or in the leaf or fruit before the infection takes place. A good protective fungicide must exhibit satisfactory retention, that is, the fungicide residue must stick to the leaf surface or be retained within to resist excessive washing away of the deposits by rain. On the other hand, a good protective fungicide should also have good redistribution properties, that is, fungicide residues should have a tendency to be washed by rain and redeposited on previously unprotected tissue. Ideally, a fungicide should stick well enough not to be washed off the tree, but should be redistributed well enough during rains to protect new growth.

Post-infection activity. Post-infection activity refers to the ability of a fungicide to kill or stop the growth of the fungus and thereby prevent the establishment of scab lesions, if applied within a given period after the start of a wetting period. It is expressed as the period of time from the beginning of a wetting period within which the fungicide must be applied to stop infection. The data given in Table 6.1.3 are accurate at average temperatures of 50-60°F. At lower temperatures, the periods of after-infection activity for contact fungicides are longer than those listed.

Presymptom activity. Presymptom activity can be thought of as an extension of after-infection activity. When applied following an infection period, but beyond the time limits of its after-infection activity listed in Table 6.1.3, a fungicide with significant presymptom activity will allow small chlorotic lesions to develop; however, it will inhibit or greatly reduce the production of secondary spores from those lesions. Thus, if applied too late to completely stop infection, it will still greatly reduce the amount of inoculum available for secondary spread.

Postsymptom activity. Postsymptom activity refers to the ability of a fungicide, when applied to an actively sporulating scab lesion, to prevent or greatly inhibit the further production of secondary scab spores from that lesion. Because such applications do not kill the fungus, but merely arrest its development, they must be repeated to maintain this suppression. As with presymptom activity, this has the obvious benefit of reducing the pressure for the spread of secondary scab.

Table 6.1.1. Activity spectrum of apple fungicides.

			Ratings for the Control of						
Active Ingredient (Trade Name)	**Fungicide Family**	**FRAC code‡**	*Scab*	*Powdery Mildew*	*Cedar Apple Rust*	*Black/ White Rot*	*Sooty Blotch/ Fly speck*	*Bitter Rot*	*Mite Suppres-sion(a)*
captan[g]	Phthalimide	M4	4	0		2	3	2[e]	3[e]
cyprodinil (Vangard)	Anilinopyrimidine	9	2(f)[i]	1		0	0	0	0
dodine (Syllit)	Guanidine	M7	4[i]	0	1	1	1	0	0
difenoconazole + cyprodinil (Inspire Super MP)[f]	DMI (SI) and Anilinopyrimidine	3	4[c]	3	4	2	4	2	
fenarimol (Rubigan)[f]	DMI (SI)	3	4[c]	4	4	0	0	0	
ferbam (Ferbam)	Dithiocarbamate	M3	2	0	2	1	2	1	0
fenbuconazole (Indar 2F)[f]	DMI (SI)	3	4[c]	3	4	2	2	2	
flutriafol (†Topguard)	DMI (SI)	3	4[c]	4	4	2	2	2	—
kresoxim-methyl (Sovran)	Strobilurin (QoI)	11	4[c]	4	2	3	4	2	0
mancozeb (Dithane, Manzate, Penncozeb)	Dithiocarbamate	M3	3[d]	0	4	3	4	4	0
maneb (Manex, Maneb)	Dithiocarbamate	M3	3[d]	0	4	3	4	4	0
metiram (Polyram)	Dithiocarbamate	M3	3[d]	0	4	3	4	1	0
myclobutanil (Rally)[f]	DMI (SI)	3	4[c]	4	4	2	2	2	—
metrafenone (Vivando)[f]	aryl-phenyl-ketone	U8	0	4	0	0	0	0	

Table continues on next page.

7 Insect and Mite Management

Table 7.1.1. Activity spectrum of pome fruit insecticides and acaricides.

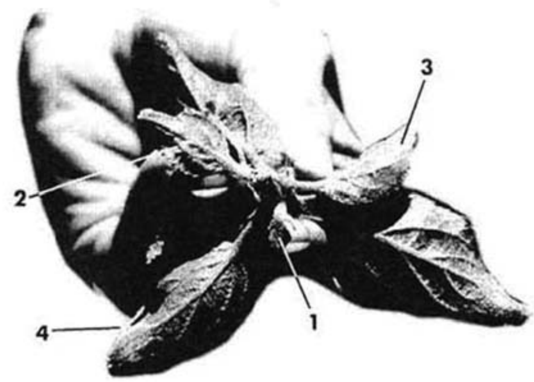
		Ratings for the Control of														
Trade Name (Active Ingredient)	**IRAC‡**	**AM**	**Aph**	**EAS**	**Int**	**GFW**	**LH**	**OBLR**	**PC**	**PPs**	**RAA**	**RBLR**	**SJS**	**STLM**	**TPB**	**WAA**
*†Actara (thiamethoxam)	4A	1	3	3	1	—	3	0	3	3	3	0	0	2	2	—
*Admire Pro (imidacloprid)	4A	—	3	—	—	—	3	—	—	2	3	—	2	3	—	2
*†Agri-Flex (abamectin/ thiamethoxam	6/4A	1	3	3	1	—	3	0	3	3	3	0	0	3	1	—
*Agri-Mek (abamectin)	6	—	—	—	—	—	3	—	—	3	—	—	—	3	—	—
*†Altacor (chlorantraniliprole)	28	2	1	3	3	3	—	3	2	—	—	3	2	—	1	—
*Pounce (permethrin)	3A	3	2	2	—	3	3	2-3	2	2	2	3	1	3	3	—
*Asana XL (esfenvalerate)	3A	3	2	2	2-3	3	3	2-3	2	2	2	3	1	3	3	—
Assail (acetamiprid)	4A	3	3	2	3	—	3	0	2	2	3	0	2	3	2	2
Avaunt (indoxacarb)	22	2	1	2	2	—	3	0	3	—	0	—	0	2	2	—
§Aza-Direct, §Neemix	18B	—	2	1	2	—	2	—	0	—	2	—	—	3	—	—
§B.t, (§Agree, §Biobit, §Deliver, §Dipel, §Javelin)	11A	0	0	—	2	3	0	3	0	0	0	3	—	0	0	—
*Baythroid (cyfluthrin)	3A	3	2	2	2-3	3	3	2-3	2	—	—	3	—	3	3	—
Beleaf (flonicamid)	9C	—	3	—	—	—	—	—	—	—	—	—	—	—	3	2
*†Centaur (buprofezin)	16	—	—	—	—	—	2	—	—	3	—	—	3	—	—	—
*Danitol (fenpropathrin)	3A	3	2	2	2-3	3	3	2-3	2	2	2	3	1	3	3	—
Delegate (spinetoram)	5	2	0	—	3	3	—	3	2	3	—	3	—	3	—	—
*diazinon	1B	3	1	—	2	2	1	0	2	0	3	0	2	1	1	3
*dimethoate	1B	3	2	—	3	2	3	0	2	0	2	0	2	1	2	—
*†Endigo (thiamethoxam/ lambda-cyhalothrin)	3A/4A	3	2	2	2-3	3	3	2-3	2	2	2	3	2	3	3	—
§Entrust (spinosad)	5	2	0	—	2	3	0	3	0	–	0	3	—	2	0	—
Esteem (pyriproxyfen)	7C	0	0	—	2	0	0	0	0	3	3	0	3	2	0	—
*†Exirel (cyantraniliprole)	28	2	1	3	3	3	3	3	3	3	3	3	0	3	0	0
§Grandevo (*Chromobac-terium subtsugae*)	—	—	—	—	2	—	—	2	—	—	—	—	—	—	—	—
*Imidan (phosmet)	1B	3	1	3	3	1	1	1	3	0	1	3	2	1	1	—
*†Intrepid (methoxyfen-ozide)	18A	0	0	—	2	—	0	3	0	—	0	3	0	2	0	—
*Lannate (methomyl)	1A	2	2	1	3	3	3	2-3	2	0	1	3	2	3	1	—
*Leverage (cyfluthrin/ imidacloprid)	3A/4A	3	3	2	3	3	3	2-3	3	2	3	3	2	3	3	—
Lorsban (chlorpyrifos)	1B	—	—	—	—	—	—	—	—	—	2	2	3	1	1	—
§M-Pede, Des-X (insecticidal soap)	—	0	2-3	0	0	0	1	0	0	2	1	0	1	0	0	—
Malathion	1B	2	2	2	2	1	1	1	2	0	1	2	—	1	1	—
*†Minecto Pro (cyantraniliprole/abamectin)	28/6	2	0	0	3	3	3	3	3	3	3	3	0	3	0	0
Movento (spirotetramat)	23	—	3	—	—	—	—	—	—	3	—	—	3	—	—	3
†Nexter (pyridaben)	21	—	0	—	—	—	2	—	—	3	—	—	—	—	—	—
§oil (Stylet, Damoil, PureSpray)	—	—	—	—	1	—	—	—	—	2	—	—	3	1	—	1
*Proclaim (emamectin benzoate)	6	0	0	—	2	3	0	3	1	2	0	3	0	3	0	—

Table continues on next page.

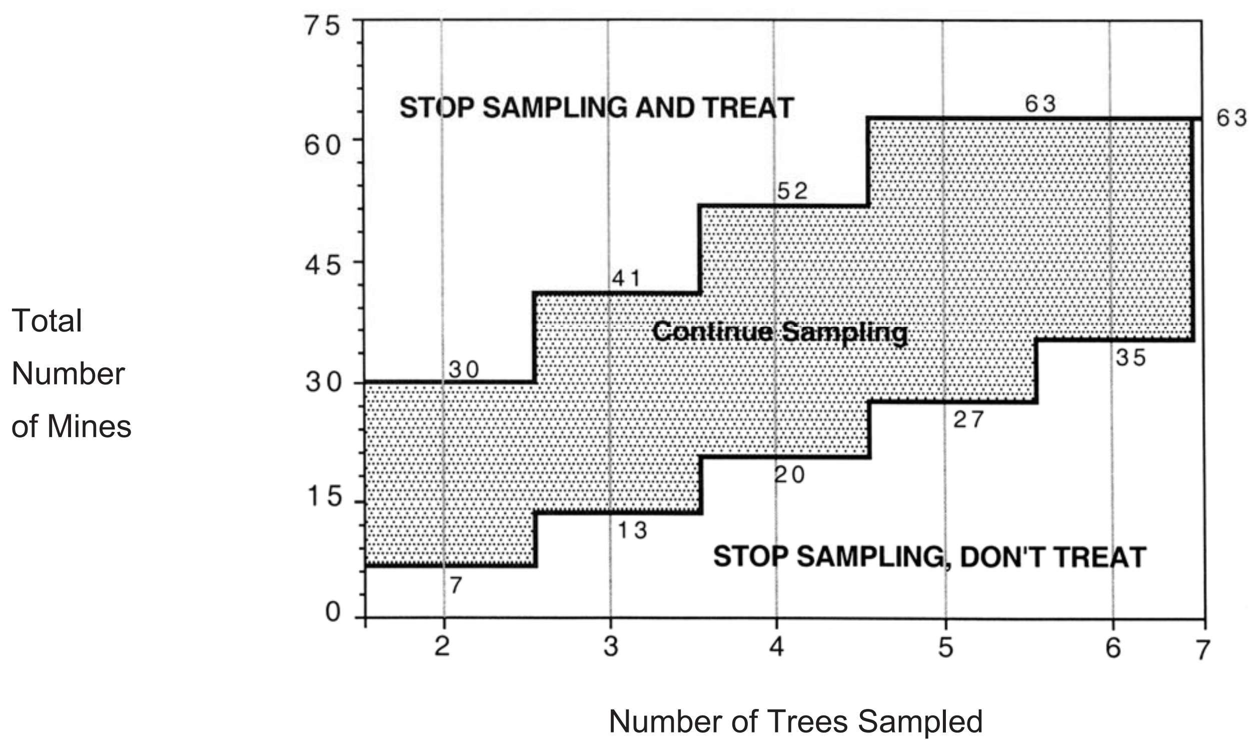
Figure 7.1.3. STLM Petal Fall Sampling Form

- If STLM eggs were not sampled during the pink or early bloom stage, a decision on 1st generation control can still be made by sampling sap-feeding mines at petal fall. After all the blossoms have fallen, start near one corner of the block, and go to every other tree until you have sampled enough trees to reach a decision. Select 3 fruit clusters from around the canopy of each tree sampled.

- Using a magnifier, count the mines on the undersides of the 2nd, 3rd, and 4th leaves in each cluster, counting leaves in the order they unfolded (see diagram at right).



- After 2 trees have been sampled, begin comparing the accumulated total number of mines found with the decision lines shown in the chart below for that number of trees.



- If the number of mines falls in the "Continue Sampling" zone, sample another tree. If the total is in the "Stop Sampling, Don't Treat" zone, sampling is stopped and no treatment is recommended. If the total is in the "Stop Sampling and Treat" zone, sampling is stopped and a treatment is recommended at petal fall. If 7 trees are sampled and the total number of mines equals 63, the population is below threshold.

Refer to the Apple Pesticide Spray Table for a choice of pesticide materials.

8 Weed Management

8.1 Calibration to Ensure Correct Herbicide Rate

Herbicide labels indicate rate of application as amount of product per acre; that is, per acre actually treated. Only if you broadcast herbicide over the entire orchard floor will the treated acreage equal the orchard acreage. Follow the instructions below to assure application of the correct herbicide rate.

8.1.1 Calculating Nozzle Flow Rate

Travel Speed:
For most situations, 2-2.5 mph is best (176-220 ft. /min.).

Pressure:
Use low pressure (20-35 psi) to minimize formation of small droplets, because small droplets can drift off target.

Spray Volume per Treated Acre:
Generally, low rates (20-30 gals./acre or less) are more suitable for postemergence herbicides, where runoff from weeds would reduce effectiveness. Higher rates, 40-50 gals./acre, may provide better coverage and control when using preemergence herbicides.

Nozzles:
Avoid nozzles that produce fine mist. Generally, hollow cone nozzles produce the finest droplets, flat sprays are second, and full cone nozzles produce the coarsest spray.

A single boomless off-center flat spray nozzle, or a flooding nozzle, may be suitable for some orchards, but one or more regular flat spray nozzles on a boom may be better where branches are close to the ground.

Use the following formula to determine nozzle flow rate in gal./min., then consult a nozzle manufacturer's chart to select the proper nozzle.

Shields:
By adding a shield over the spray boom, thin, young bark of fruit trees may be protected when using glyphosate or other herbicides that can injure fruit tree bark. If weeds are tall when treated and spring back into the tree banches after application under a shield, glyphosate can still be picked up through the leaves of the trees.

8.1.2 Definition of Terms

1. **Gallons per Treated Acre (G/TA)** = Amount of herbicide spray you want to apply per treated acre.
2. **Swath (S)** = Width of the sprayed area in feet.
3. **Travel Speed (TS)** = Feet traveled per minute.
4. **Nozzle flow rate** (gallons per minute) = (Gallons per Acre x Swath x Travel Speed) divided by 43,560

Nozzle Flow Rate = (G/TA x S x TS) / 43,560

Example:
What nozzle flow rate do you need to apply 25 gallons of herbicide spray mix per treated acre, using a 3-foot-wide swath and a travel speed of 220 feet per minute (=2.5 miles per hour)?

Nozzle flow rate
= (25 x 3 x 220) divided by 43,560
= (16,500) divided by 43,560
= 0.38 gallons per minute.

If using 2 nozzles, select 2 that will give 0.19 gallon per minute each at the selected pressure.

8.1.3 Checking Herbicide Sprayer Output

Spray Pattern:
Check uniformity of spray pattern, using corrugated fiberglass roofing panels as a spraying surface. Spray from the same height as will be used in the orchard. Compare liquid volume collected in each trough.

Actual Spray Volume:
With proper nozzles installed, travel a measured distance at the selected speed and pump pressure. Use this formula to determine the actual spray volume in gallons per treated acre.

Gallons per Treated Acre:
= (Gallons sprayed during trial run x 43,560) divided by (Feet traveled during trial run x Swath width in feet).

Example:
You emptied a tank containing exactly 3 gallons in a distance of 1,200 feet. The treated swath was 3 feet wide. How many gallons of spray are you applying per treated acre?

Gallons per Treated Acre
= (3 x 43,560) divided by (1,200 x 3)
= (130,680) / (3,600)
= 36.3 gallons

If you want to apply 4 lbs. of herbicide per acre, then in this case you would add 4 lbs. of herbicide to each 36 gallons of water in the tank.

Agitation:
If herbicides are allowed to settle or separate in the sprayer tank, distribution in the orchard will not be uniform. Provide constant agitation when using wettable powders, or any other insoluble formulation (emulsions, emulsifiable concentrates, dry flowables, liquid flowables, and suspensions). Use defoaming adjuvant when needed to control excessive foam.

Table 8.4.3. Weed control guidelines for tree fruit.

Refer to back of book for key to abbreviations and footnotes.

Crop						Tree Age				
Apples	Pears	Cherries	Peaches	Apricots	Plum/Prune	Planting Year	1 year plus	2 years plus	3 years plus	**PRODUCT NAME** (*active ingredient, weight of active per unit of herbicide*) *Notes:*
X	X	X	X		X		X	X		***UNISON or other labeled formulation** (*2,4-D, 1.74 lb/gal*) *Weeds Controlled:* broadleaves *Rate (per acre):* 3 pt. *AI per acre (lbs/acre):* 0.6525 *Days to harvest:* Apples and pears: 14; cherries, peaches, plums: 40 *REI (hours):* 48 *Comments:* To control dandelions and other broadleaf weeds in sod cover under cherry trees, apply in the fall (best) or early spring BEFORE TREES OR DANDELIONS BEGIN TO BLOOM. Yearly application is needed to control dandelions. Avoid contact with fruit, foliage, stems, or limbs of trees.
X	X	X	X	X	X	X	X	X		**AIM EC** (*carfentrzone-ethyl, 2 lb/gal*) *Weeds Controlled:* annual grasses and broadleaves *Rate (per acre):* 1-2 oz, 2 oz. for green rootsucker control. *AI per acre (lbs/acre):* 0.03 *Days to harvest:* All tree fruits: 3 *REI (hours):* 12 *Comments:* Apply in tank mix with paraquat or glyphosate for broadleaf and grass control, but avoid contact with green bark and foliage in new to 2 year old trees.
X	X	X	X	X	X				X	***†ALION** (*indaziflam, 1.67 lb./gallon*) *Weeds Controlled:* annual broadleaves and grasses *Rate (per acre):* 5-6.5 oz. *AI per acre (lbs/acre):* 0.065-0.085 *Days to harvest:* 14 *REI (hours):* 12 *Comments:* Use on trees established for at least 3 years that show normal growth and good vigor.Best control when applied in strip free of weed residue, No post-emergence activity. Note that rate varies depending on soil texture and organic matter content; see label.
X	X	X					X	X		**CASORON 1.4CS** (*dichlobenil, 1.4 lb/gal*) *Weeds Controlled:* annual grasses and broadleaves, and perennial seedlings *Rate (per acre):* 1.4-2.8 gals. *AI per acre (lbs/acre):* 2.9-4.3 *Days to harvest:* None listed *REI (hours):* 12 *Comments:* Apply late fall to early spring. Controls many annual and perennial grasses and weeds in trees established for 1 year.
X	X	X					X	X		**CASORON 4G** (*dichlobenil, 0.04 lb/lb*) *Weeds Controlled:* annual grasses and broadleaves, and perennials at high rates *Rate (per acre):* 100-150 lb *AI per acre (lbs/acre):* 4.0-6.0 *Days to harvest:* none listed *REI (hours):* 12 *Comments:* November 15 to March 15 when soil temp is below 45˚. Allowed 4 weeks after transplanting

10 Nutrient Management of Apple Orchards

10.1 Introduction

When developing mineral nutrient management programs for tree fruits, it is important to consider the nutrient demand-supply relationship throughout the season.

10.2 Nitrogen

Early season canopy development and fruit growth require large amounts of nitrogen (N), while fruit quality development and the acquisition of adequate cold hardiness by the tree later in the season require only a minimum supply of N. Thus, an ideal seasonal pattern of tree nitrogen status should be to start the season with relatively high nitrogen status to promote rapid leaf development and early fruit growth. As the season progresses, nitrogen status should decline gradually to guarantee fruit quality development and wood maturity before the onset of winter. There are three sources of nitrogen supply tree fruits can use. First is reserve nitrogen that has accumulated in the tree from the previous growing season. This source of nitrogen is readily available for initial growth during the spring. In fact, spur leaf development and early fruit growth are mainly supported by the reserve N. The second source is the natural N supply from the soil mineralization process. This process provides substantial amounts of nitrogen for trees growing on soils with high organic matter. The third is nitrogen fertilizers applied to the soil or to the foliage. To determine the amount of fertilizer nitrogen needed, we need to know the total tree demand and the amounts the other two nitrogen sources can provide. However, there is not enough information currently available on this demand-supply relationship to make this approach practical. Instead, soil and leaf analyses have been developed over the years to help growers diagnose tree nutrient status and soil nutrient availability and make adjustments on their fertilization programs accordingly.

10.3 Soil Analysis

Soil analysis is very useful for determining lime requirement and mineral availability in the soil before orchard establishment. For existing orchards, it provides information necessary for interpreting leaf analysis results and modifying fertilization programs.

A soil nutrient analysis should be performed before planting a new orchard and every 2 to 3 years after orchard establishment. The soil sample taken should be representative of the soil type and conditions within the orchard. Generally, the area included in any one-sample collection should not exceed 10 acres. Scrape away the surface 1-inch of soil, then collect samples from the 1 to 8 inch depth, and separate samples from 8 to 16 inches. In a 10 acre orchard, a minimum of 10 to 20 subsamples is suggested. Thoroughly mix the 1-8 inch subsamples together to provide a representative sample for the topsoil, and treat the 8 to 16 inch subsamples similarly to get a representative sample for subsoil. Soil samples can be sent to Agro-One, 730 Warren Road, Ithaca, NY 14850.

10.4 Preplant Soil Preparation

New York soils are classified into 5 management groups on the basis of texture and parental materials (Table 10.4.1). Percentage of clay, buffering capacity, and potassium supply power decrease from group I to V.

10.4.1. Liming

The pH values of orchard soils should be maintained in the range of 6.0 to 6.5 throughout the soil profile to optimize plant growth and nutrient availability. For preplant soil preparation, we recommend the pH of topsoil (0-8 inch depth) be adjusted to 7.0 and that of subsoil to 6.5. Most soils in New York have pH values lower than optimum and need liming to raise the pH prior to planting a new orchard. This also ensures adequate calcium and magnesium supplies in the soil.

The amount of lime required to adjust topsoil pH to 7.0 and subsoil pH to 6.5 is determined by the current pH values of the topsoil and subsoil (determined from a soil analysis) and the buffering capacity of the soil, i.e. exchange acidity or cation exchange capacity, (CEC), of topsoil and subsoil (also determined from a soil analysis). Using these values, the lime requirement can be determined from Table 10.4.2 for topsoil and from Table 10.4.3 for subsoil. The amount of lime to be added is the sum of topsoil plus subsoil requirement. When complete soil tests are not available, Table 10.4.4 may be used to estimate lime requirement.

Table 10.4.1. Soil management groups

Soil group	Texture	Examples
I	Clayey soils, fine-textured soils.	Vergennes, Kingsbury, Hudson, Rhinebeck, Schoharie, Odessa.
II	Silty loam soils with medium to moderately fine texture.	Cazenovia, Hilton, Honeoye, Lima, Ontario, Lansing, Mohawk, Chagrin, Teel.
III	Silty loam soils with moderately coarse texture.	Barbour, Chenango, Palmyra, Tioga, Mardin, Langfor, Tunkhannock.
IV	Loamy soils, coarse- to medium-textured soils.	Bombay, Broadalbin, Copake, Empeyville, Madrid, Sodus, Worth.
V	Sandy soils, very coarse-textured soils.	Alton, Colton, Windsor, Colonie, Elmwood, Junius, Suncook


FIGURE 11.1.1
GROWTH STAGES IN APPLE
1 Dormant
2 Silver tip
3 Green tip
4 Half-inch green
5 Tight Cluster
6 Pink
7 Bloom
8 Petal Fall
9 Fruit set

11 Apples

11.1 Insecticides and Fungicides for Apples

See Sections 11.2, 11.3, 11.4, and 11.5 for comments related to this table.

Table 11.1.1 Pesticide Spray Table – Apples.

(Refer to Section 17.8 for key to abbreviations and footnotes.)

Pest	IRAC & FRAC	Product	Rates	PHI (days)	REI (hrs)	Efficacy	Comments (see text)
Silver Tip							
Apple scab	9 + 7	*†Luna Tranquility	11.2-16 fl oz/acre	72	12	High	
	M1	Badge SC	3.5-7.0 pts/acre	0	48		[8.4]
	M1	Badge X2	3.5-7.0 lb/acre	0	48		[8.4]
Blister Spot	33	Phostrol	2.5-5.0 pts/acre	0	4	High	[5.1]
Crown rot	04	Ridomil Gold SL	2 qt/acre 0.5 pt/100 gal water		48		[7.2]
	33	Aliette WDG	2.5-5 lb/acre 0.5-1 pt/100 gal water	14	12		
	33	Phostrol	2.5-5.0 pts/acre	0	4	High	
	33	Prophyt	2-4 pt/100 gal water	0	4	High	[7.3]
European Fruit Lecanium		oil	2-3 gal/100 gal water			High	[20.2]
European Red Mite		oil	2-3 gal/100 gal water			High	[20.2]
Fire blight		Agri-mycin		50	12		[8.5]
	M1	Badge SC	3.5-7.0 pts/acre	0	48		[8.4]
	M1	Badge X2	3.5-7.0 lb/acre	0	48		[8.4]
Phytophthora Rots	33	Phostrol	2.5-5.0 pts/acre	0	4	High	[7.3]
	33	Prophyt	2-4 pt/100 gal water	0	4	High	[7.3]
Green Tip							
Apple scab		*†Luna Sensation	4.0 to 5.8 fl oz/acre	14	12	High	
		*†Sercadis	4.5 fl oz/acre	0	12	High	
	M1	Badge SC	3.5-7.0 pts/acre	0	48		[8.4]
	M1	Badge X2	3.5-7.0 lb/acre	0	48		[8.4]
	M3	Manzate ProStik	3.0-6.0 lb/acre 1.0-2.0 lb/100 gal water	BL, 77(A)	24		[1.3,2.2]
	M3	Penncozeb 75DF	3.0-6.0 lb/acre 1.0-2.0 lb/100 gal water	BL, 77(A)	24		[1.3,2.2,2.8]
	M3	Polyram 80DF	3.0-4.5 lb/acre	BL, 77(A)	24		[1.3,2.2]
	M4	Captan 50WP	8.0 lb/acre 1.0-2.0 lb/100 gal water	0	24		[2.1,2.2]
	M4	Captan 80WDG	5.0 lb/acre 0.65-1.25 lb/100 gal water	0	24		[2.1,2.2]
	M4	Captec 4L	0.5-1.0 qt/100 gal water	UDH	24		[2.1,2.2]
	U12	Syllit FL	2.0 pts/acre				[2.15]
	M4	Captan 4L	1.0 pt/100 gal water	Up to day	24		
	9	Scala	7.0-10.0 fl oz/acre	72	12		
	9	Vangard WG	3.0-5.0 oz/acre	0	12		
	9 + 7	*†Luna Tranquility	11.2-16 fl oz/acre	72	12	High	
	11 + 7	*†Merivon	4-5.5 fl oz/acre	0	12	High	
Bitter Rot		*†Luna Sensation	4.0 to 5.8 fl oz/acre	14	12	High	
Black Rot & White Rot		*†Luna Sensation	4.0 to 5.8 fl oz/acre	14	12	High	
Blister Spot	33	Phostrol	2.5-5.0 pts/acre	0	4	High	[5.1]
Cedar Apple Rust	11 + 7	*†Merivon	4-5.5 fl oz/acre	0	12	Moderate	

11.2 Apple Disease Notes

11.2.1 Apple Scab

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[1.3] The EBDC fungicides (mancozeb, maneb, Polyram) are labeled for use on apples in one of two different ways: (i) at a rate of 1.5-2 lb/100 gal (maximum 6 lb/A, no more than 24 lb/A per year), not to be applied after bloom; OR (ii) at a reduced rate of 3 lb/A (maximum 21 lb/A per year), which may be applied to within 77 days of harvest. The latter rate is adequate for control of rust diseases, and the extended timing is necessary to control rust infections on terminal leaves. It is illegal to combine or integrate the two treatment regimes.

[2.1] See discussion of inoculum reduction in the disease management section. Scab fungicide sprays beginning at green tip are absolutely essential in orchards with high carry-over inoculum or orchards where scab control with SI fungicides was less than satisfactory in previous years. If early season infections are allowed to become established, even the best fungicide programs will not prevent development of fruit scab in orchards where the scab fungus has developed resistance to all three of the fungicide groups (dodine, benzimidazoles, SI's) that previously provided presymptom and postinfection activity against apple scab.

[2.2] Fungicide rates per acre should never be reduced below either (i) 50% of the per-acre rate listed on the label or (ii) 1.5 multiplied by the Amt/100 gal listed on the label. This applies even when spraying small trees. Although tree-row volume calculations may suggest that lower rates are appropriate, applying less than 50% of the per-acre rate has frequently resulted in unsatisfactory scab control and/or more rapid development of fungicide resistance. In orchards with SI-resistant scab, a combination of a mancozeb fungicide at 3 lb/A plus a captan formulation that supplies 1.5 lb of active ingredient/A has provided excellent scab control when used in prebloom and bloom sprays. (A captan rate of 1.5 lb active ingredient/A translates to 3 lb/A of Captan 50W, 30 oz/A of 80W, or 1.5 qt/A for the 4L formulations.) This combination provides a better residual activity through heavy rains than would be available from either product used alone and it preserves the option of using mancozeb sprays after petal fall. The mancozeb-captan combination cannot be used close to prebloom oil sprays because of captan-oil incompatibilities. For reasons of economy and resistance management, it is recommended that SI and strobilurin fungicides not be used until pink, even when fungicidal protection is needed earlier; in such cases, make a single application of an alternative fungicide (captan, copper, EBDC) at green tip and half-inch green, then begin the SI/strobilurin program at pink. Do not apply captan or sulfur within 10 days of an oil spray. Do not apply liquid captan formulations with sulfur on sulfur-sensitive varieties. A further discussion of apple scab fungicide characteristics is presented in the section "Apple Scab Fungicides" and in Table 6.1.3.

[2.4] Sovran and Flint are excellent protectants, but they have only 48-72 hours of post-infection activity compared with 72-96 hr for the SI fungicides. Sovran and Flint also lack the presymptom activity that makes the SI fungicides so effective (in the absence of SI resistance) for arresting scab epidemics after primary scab lesions become visible in trees. Sovran and Flint have proven very effective against apple scab when applied at 7-9-day intervals to control primary scab, but they have not performed as well when used to control secondary scab in trees where scab lesions are already visible. Sovran and Flint control rust diseases fairly well when used as protectants, but they have little or no post-infection activity against rust diseases. CAUTION: Sovran has caused moderate to severe phytotoxicity (leaf burning) on several sweet cherry varieties when sprayed directly onto them at high labeled rates. The most sensitive varieties were: Somerset, Sweetheart, Valera, Van, and Vandalay; these varieties might also be injured by spray drift containing Sovran. Minor to moderate injury occurred on Cavalier, Coral Champagne, Emperor Francis, Royalton, Schmidt, Summit, and Viva; there is less danger of injury due to spray drift on these varieties. Many other sweet and sour cherry varieties (including Bing, Brooks, Cashmere, Gold, Hardy Giant, Hartland, Hedelfingen, Hudson, Kristin, Lapins, Lambert, Montmorency, Napoleon, Nelson Black Sweet, Rainier, Royal Ann, Sam, Stark Crimson, Stella, Sue, Tehranivee, Tulare, Ulster, Vega, Vic, Viscount, and Windsor) showed no injury when sprayed directly with high labeled rates. The Sovran manufacturer recommends: (i) Do not apply Sovran near or allow drift onto cherries in the highly sensitive group (Somerset, etc.); and (ii) thoroughly rinse spray equipment (tanks, hoses, nozzles) after spraying Sovran and before using this equipment on sensitive cherry varieties.

[2.6] Primary inoculum pressure is generally at a peak from pink through bloom—this is a critical time to maintain full coverage with proper fungicide rates.

[2.7] Serious losses from apple scab are usually the result of secondary spread to developing fruits. Therefore, it is important to carefully check blocks for the presence of primary scab lesions from petal fall through the early cover spray period. This is particularly important because fruit are most susceptible to infection during the first few weeks of their development. If scab is detected, the management strategy should be to (i) thoroughly protect the sensitive young fruitlets from fungal spores that are present, AND (ii) limit the number of new spores that can be produced. To protect fruitlets, use (a) the full rate of captan (e.g., 2 lb/100 gal of the 50WP formulation), or (b) the reduced rate of an EBDC fungicide (if allowable) supplemented with a half rate of captan, or (c) a strobilurin fungicide combined with a contact fungicide. To limit new spore production, use (a) an DMIfungicide through 2nd cover (to prevent new leaf lesions), or (b) a registered QoIfungicide (to prevent new leaf lesions and suppress spore production from existing lesions),. SI's should be used only in orchards where there

11.6 Growth Regulator Use In Apples

11.6.1 Chemical Thinning

Fruit thinning is a management practice that reduces yield in the current season but results in increased fruit size and also increased return bloom and yield in the next season. Large fruit size is best obtained with consistent cropload reductions each year through chemical thinning. The use of growth regulating chemicals to thin apple trees is not an exact science and each grower must weigh and evaluate the many factors that affect chemical thinning response in deciding on a thinning program. Although the recommendations in this section are based on research and experience, growers are cautioned that their success with chemical thinning depends on many factors and they should use these recommendations only as a guide.

11.6.2 Weather Factors That Affect Thinning Response

Frost. Frost before application of thinners can greatly increase the amount of thinning obtained from chemical thinners. Frost at bloom can damage fruitlets and reduce seed set, which can result in increased natural drop and greater chemical thinning response. Frost can also damage spur leaves, resulting in greater chemical uptake and thus greater thinning response. Wherever flowers and leaves have been damaged by frost, extreme caution should be used with chemical thinners. Typically, lower rates would be used in such cases. Surfactants and oil additives should be avoided following a frost and may cause overthinning.

Sunlight Levels before Application. The amount of sunlight for the 3-5 days preceding application of chemical thinners has an important effect on chemical uptake and response. Intense cloudy weather before application of thinners can result in increased chemical uptake and greater thinning response, due to greater succulence of the leaves and a thin wax cuticle. In addition, intense cloudy weather results in reduced carbohydrate supply for fruit growth and reduced fruit growth rate. This results in increased natural drop.

Temperature at Time of Application. The uptake of chemical thinners is greater at higher temperatures than at lower temperatures. The optimum is between 70-80°F. Above 80°F, uptake is substantially greater than below 80°F. The time of day applications are made appears to be unimportant. Applications made in the morning or evening when it is cool have a longer drying time on the leaf, resulting in a slow but sustained uptake of chemical, while at higher temperatures during mid-day, drying times are shorter, resulting in a short but rapid uptake of chemical. Thus, the total amount of chemical taken into the plant appears to be very similar regardless of the time of day. Recent research results also indicate that similar thinning is achieved regardless of the time of day applications are made.

Weather After Application. Temperature and sunlight levels for the 5-day period after application of thinners are the predominant weather factors affecting chemical thinning response. The interaction of temperature and sunlight affect the production and demand for carbohydrates within the tree. Warmer temperatures increase carbohydrate production (photosynthesis) up to about 80F but higher temperatures reduce photosynthesis.

The demand for carbohydrate to support fruit growth and shoot growth increases linearly with increasing temperature. Increasing sunlight level increases photosynthesis. The combined effects of sunlight and temperature on chemical thinning are complex but a simplification is presented in Fig. 11.6.1. A more sophisticated estimate of the effects of light intensity and temperature on thinning is given by the Cornell Carbohdyrate thinning model available on the web at www.newa.cornell.edu.

Night temperatures are also an important factor to consider. Warm night temperatures greater than 60°F give greater thinning response. With high night temperatures, fruits use up the carbohydrates that were produced during the day at a fast rate, resulting in a deficit of resources for fruit growth and causing the weakest fruits to drop. The greatest thinning can result if warm night temperatures are combined with intense cloudy/warm daytime weather. Under these conditions, the tree produces little reserves during the day and at night the fruits use up all of the reserves produced during the day, making the fruits very susceptible to the stress caused by chemical thinners. Under these conditions, excessive fruit drop can result. The least effective thinning is achieved when bright, warm daytime weather is accompanied by low night temperatures. Under these conditions, the tree produces large amounts of carbohydrates during the day and the fruits use them up at a slow rate during the night. With a large surplus of carbohydrates there is little stress created by chemical thinners and the thinning response is poor. At the time of

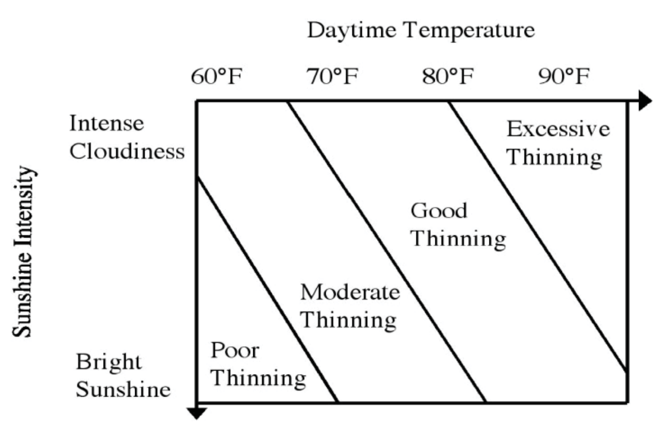


Figure 11.6.1. The interaction of temperature and sunlight intensity on thinner action.

17 Appendices

17.1 Pesticide Data

Table 17.1.1 Common names, product names, formulations, and days-to-harvest for insecticides, acaricides, fungicides, and bactericides used on tree fruits.

Common Names/ Products Formulations	DAYS TO HARVEST (A)					
	Apples	*Apricots*	*Cherries*	*Peaches*	*Pears*	*Plums*
Insecticides and Acaricides						
abamectin/avermectin						
*Agri-Mek 8SC	28	21	21	21	28	21
*Abba 0.15EC	28	21	21	21	28	21
*†Agri-Flex SC	35	—	—	—	35	—
*Gladiator EC	28	21	21	21	28	21
acequinocyl						
Kanemite 15SC	14	—	—	—	14	—
acetamiprid						
Assail 30SG	7	7	7	7	7	7
azadirachtin						
§Neemix 4.5L, §Aza-Direct 1.2L, §Azatin XL 0.27EC	0	0	0	0	0	0
bifenazate						
Acramite 50WS	7	3	3	3	7	3
bifenthrin						
*Brigade 10WS, 2 EC *Fanfare 2EC	—	—	—	—	14	—
Bt (*Bacillus thuringiensis*)						
§Deliver 18WG	0	0	0	0	0	0
§Dipel 10.3 DF	0	0	0	0	0	0
§Biobit 2.IFC	0	0	0	0	0	0
§Javelin 7.5WDG	0	0	0	0	0	0
§Agree 3.8 WS	0	—	0	0	0	0
buprofezin						
*†Centaur 0.7WDG	14	14	14	14	14	14
Burkholderia spp. strain A396						
§Venerate XC	0	0	0	0	0	0
carbaryl						
Sevin 4F, 4EC, 80S	3	3	3	3	3	3
chlorantraniliprole						
*†Altacor 35WDG	5	10	10	10	5	10
*†Voliam Flexi WDG	35	14	14	14	35	14
*†Voliam Xpress EC	21	14	14	14	21	14
*†Besiege CS-SC	21	14	14	14	21	14
chlorpyrifos						
*Lorsban 4EC, *Lorsban Advanced 3.76EC	PB/28(A)	—	21	14	PB	PB
Lorsban 75WG	PB/28(A)	—	14 or 21(C)	PB	PB	PB
Chromobacterium subtsugae						
§Grandevo	0	0	0	0	0	0
clofentezine						
Apollo 4SC	45	21	21	21	21	—
cyantraniliprole/cyazypyr						
*†Exirel	3	3	3	3	3	3
cyantraniliprole/abamectin						
*†Minecto Pro	28	21	21	21	28	21
cyflumetofen						
Nealta	7	—	—	—	7	—
cyfluthrin						
*Baythroid XL 1E, 2EC, *Leverage 360	7	7	7	7	7	7

Table 17.2.1 Insecticides and acaricides

NOTE: *Always read product label to confirm required PPE.*

Product	EPA Reg. No.	Common Name	REI (hrs)	Applicator PPE	Early Entry PPE
*Imidan 70W	10163-169	phosmet	3-7 days(E)	abcjl	bcjk
§Grandevo	84059-17	*Chromobacterium subtsugae*	4	abch	bchk
*†Intrepid 2F	62719-442	methoxyfenozide	4	abc	fgk
§Isomate-CM/OFM TT	53575-30	pheromone	0	b	—
§Isomate-PTB Dual	53575-34	pheromone	0	b	—
§Isomate OFM TT	53575-29	pheromone	0	b	—
§Isomate CM/OFM Mist	53575-44	pheromone	0	b	—
§Isomate DWB	53575-40	pheromone	0	b	—
§Javelin 7.5WDG	70051-66	Bt	4	abcl	bck
JMS Stylet-Oil	65564-1	parrafinic oil	4	acf	cfk
Kanemite 15SC	66330-38	acequinocyl	12	acf	cfk
§Kumulus 80DF	51036-352-2935	sulfur	24	acfh	cfhk
*Lambda-Cy 1EC	70506-121	lambda-cyhalothrin	24	acfh	acf
*Lannate 90SP	352-342	methomyl	48-96 (E)	acfhl	cfhk
*Lannate LV 2.4L	352-384	methomyl	48-96 (E)	acfk	cfhk
*Leverage 360	264-1104	imidacloprid/beta-cyfluthrin	12	acf	cfk
*Lorsban 4EC	62719-220	chlorpyrifos	96	adfgijl	dfgj
Lorsban 75WG	62719-301-10163	chlorpyrifos	96	acefgij	dfgj
*Lorsban Advanced 3.76EC	62719-591	chlorpyrifos	96	acgfijl	dfgj
§Madex HP	69553-1	insecticidal virus	4	abc	bck
Magister SC	10163-322	fenazaquin	12	acf	bck
Malathion 57EC	34704-108	malathion	12	acfh	cfhk
*†Minecto Pro SC	100-1592	cyantraniliprole/abamectin	12	acf	cfk
Movento 240SC	264-1050	spirotetramat	24	acfh	acfh
§M-Pede 49L	10163-324	insecticidal soap	12	ac	bck
Nealta	7969-336	cyflumetofen	12	acf	cfk
§Neemix	70051-9	azadirachtin	4	acfh	cfhk
†Nexter 75WS	81880-4-10163	pyridaben	12	abchjl	bchjkl
Onager 1EC	10163-277	hexythiazox	12	acf	cfk
Portal 0.4EC	71711-19	fenpyroximate	12	acfhj	dfgh
Portal XLO 0.4EC	71711-40	fenpyroximate	12	acfh	dfgh
*Pounce 25 WP	279-3051	permethrin	12	abc	cfk
*Proclaim 5SG	100-904	emamectin benzoate	12	acef	cfhk
§PyGanic 1.4EC	1021-1771	pyrethrins	12	acf	cfk
§Pyrenone 6L	432-1033	pyrethrins/PBO	12	acf	cfk
*Rimon 0.83EC	66222-35-400 (NY SLN 10-0001)	novaluron	12	acfh	cefh
Savey 50DF	10163-250	hexythiazox	12	abc	abc
§Seduce Insect Bait	67702-25-70051	spinosad	4	ac	bck
Sevin XLR Plus	61842-37	carbaryl	12	acfj	cfjk
Sevin 4F	61842-38	carbaryl	12	acfj	cfjk
SPLAT OFM 30M-1	80286-1	pheromone	4	acfh	afhk
§Surround 95WP	61842-18	kaolin	4	acl	ac
*Vendex 50WP	70506-211	hexakis	48	dfghijl	cfhk
§Venerate XC	84059-14	*Burkholderia* spp. strain A396	4	abch	cfhk
*†Voliam Flexi WDG	100-1319	thiamethoxam, chlorantraniliprole	12	acf	cfk