So, You Want to Grow Apples?

Site Selection, Prep, and Pest Management Basics

Mike Basedow- Cornell Cooperative Extension ENYCHP

Site Selection and Preparation

Where should I plant?

Trees Need Adequate:

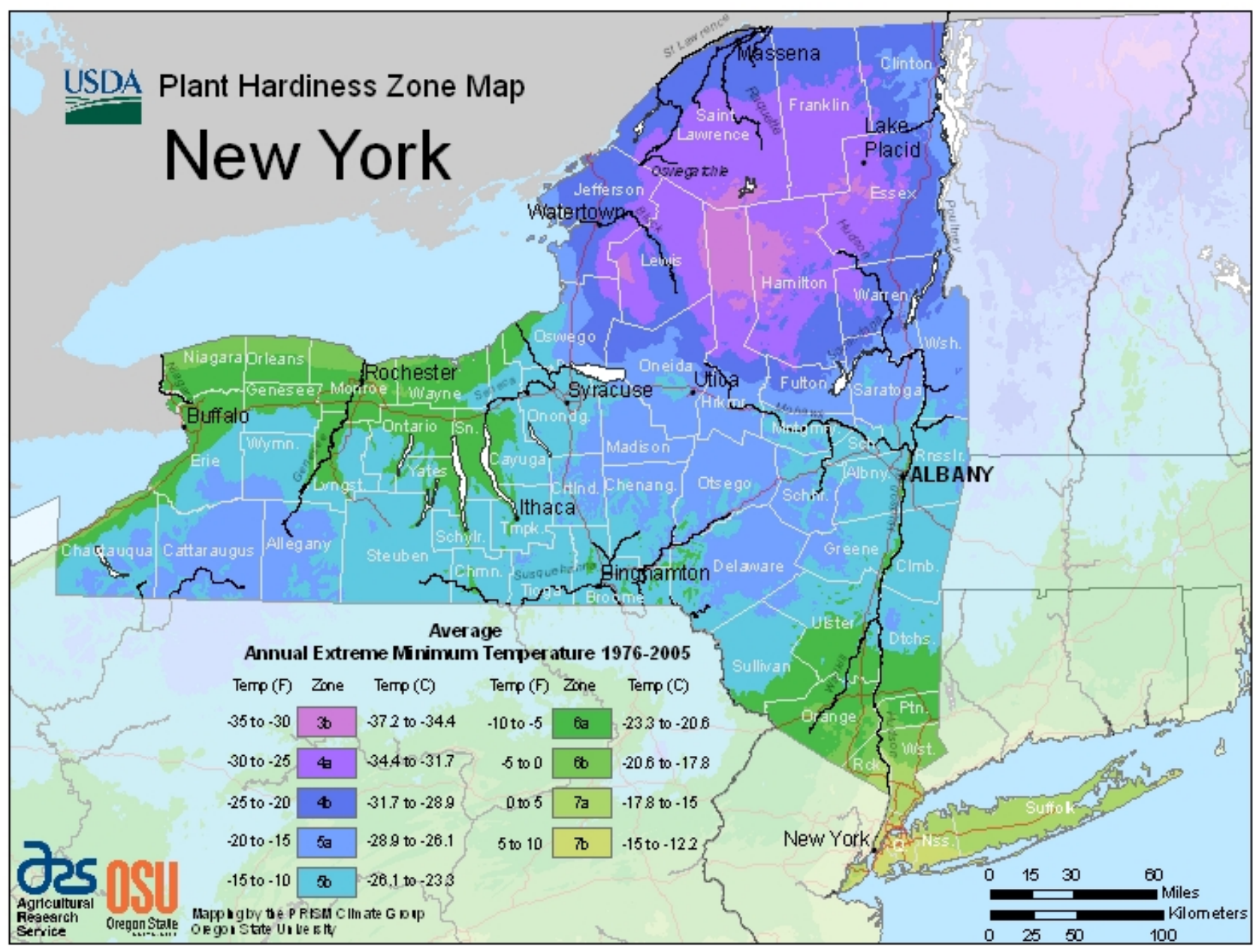
- Nutrients
- Sunlight
- Growing season length
- Temperature range
- Water
- Air Movement

Climate

Topography

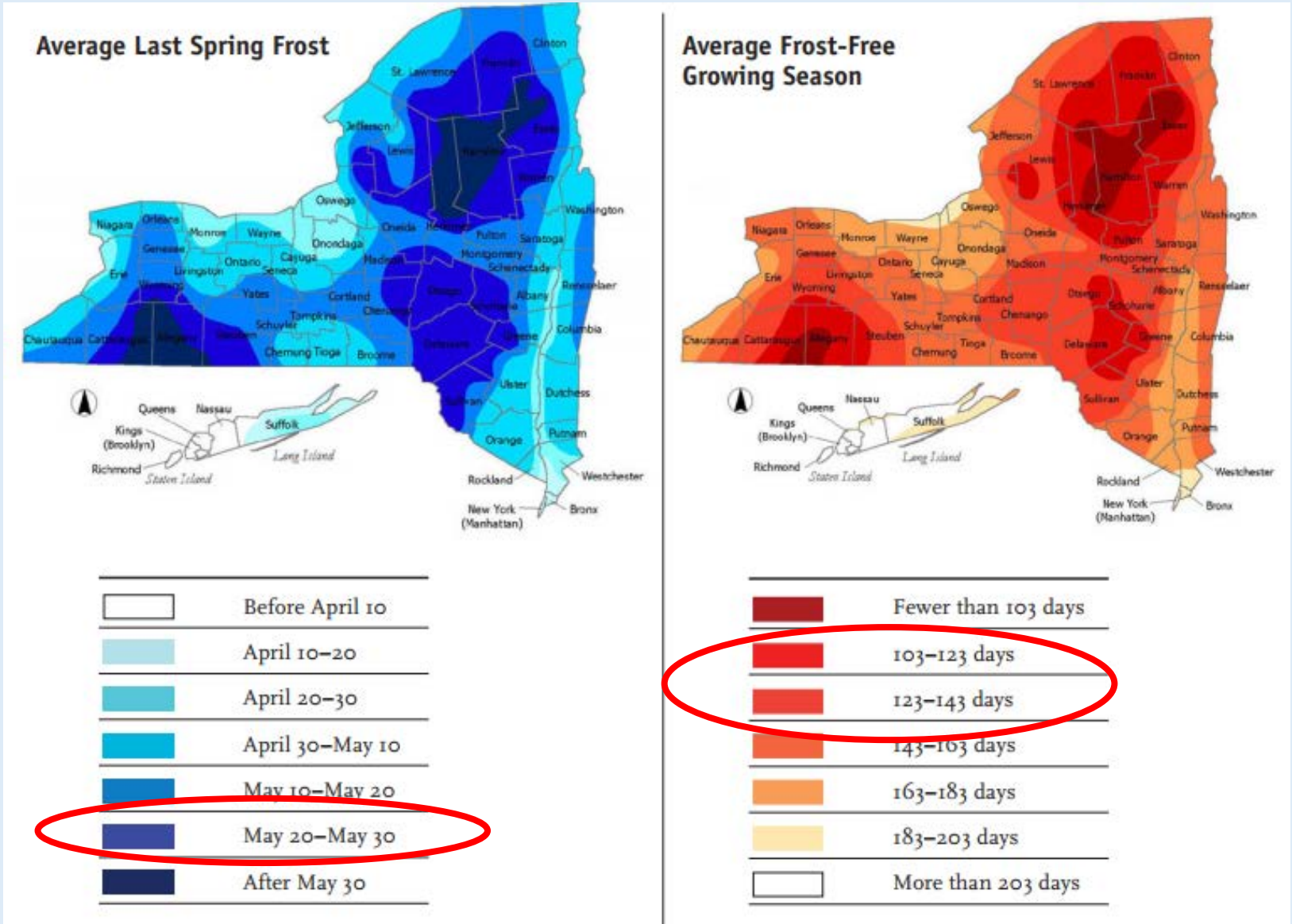
Soils

Winter Low Temps



Frost Free Days

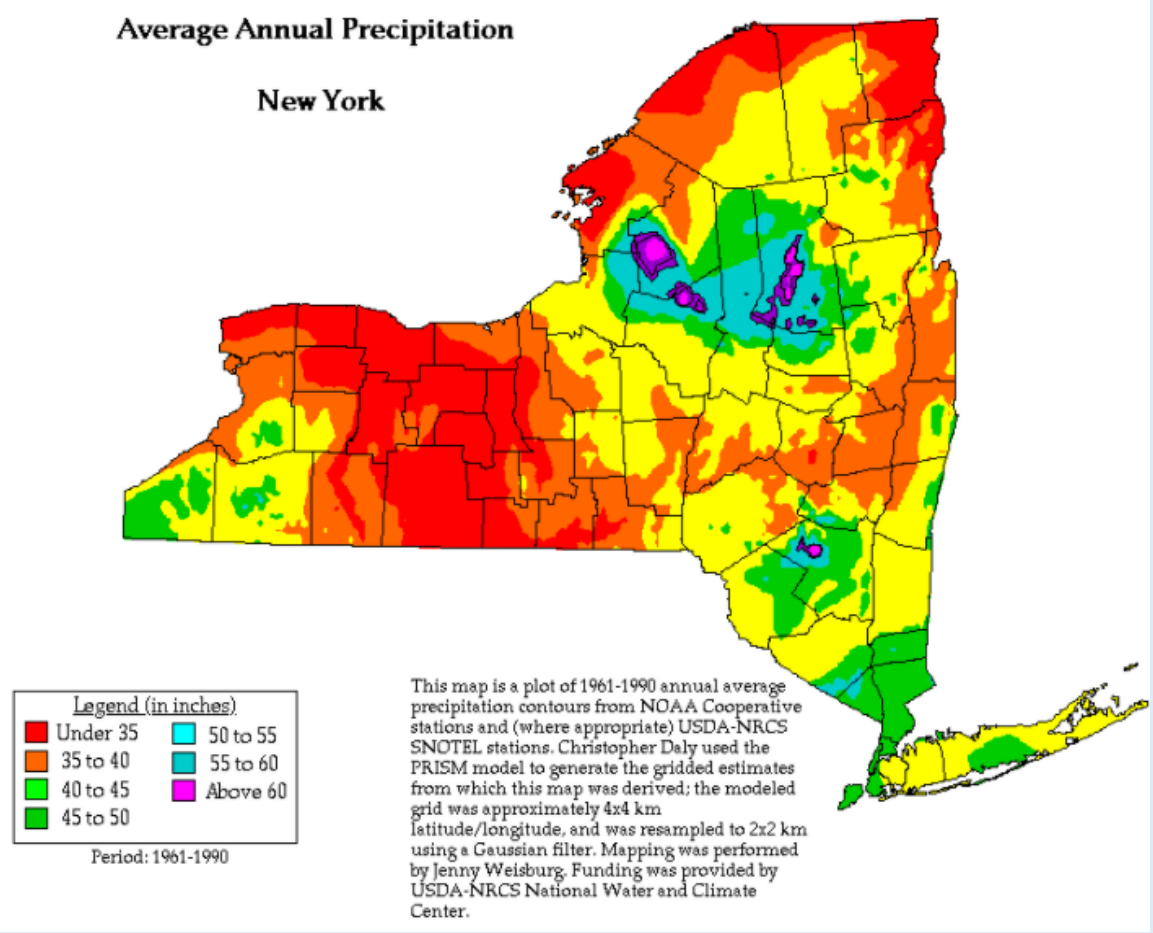
Most commercial orchards have growing seasons of 150 days or more



Precipitation:
Orchards need between 20 and 30 inches of water annually

Supplemental irrigation is recommended:

- In dry years, particularly when trees are young and establishing
- High Density
- Fruit Size



Topography

The arrangement of the natural and artificial physical features of an area.

Air Drainage

f

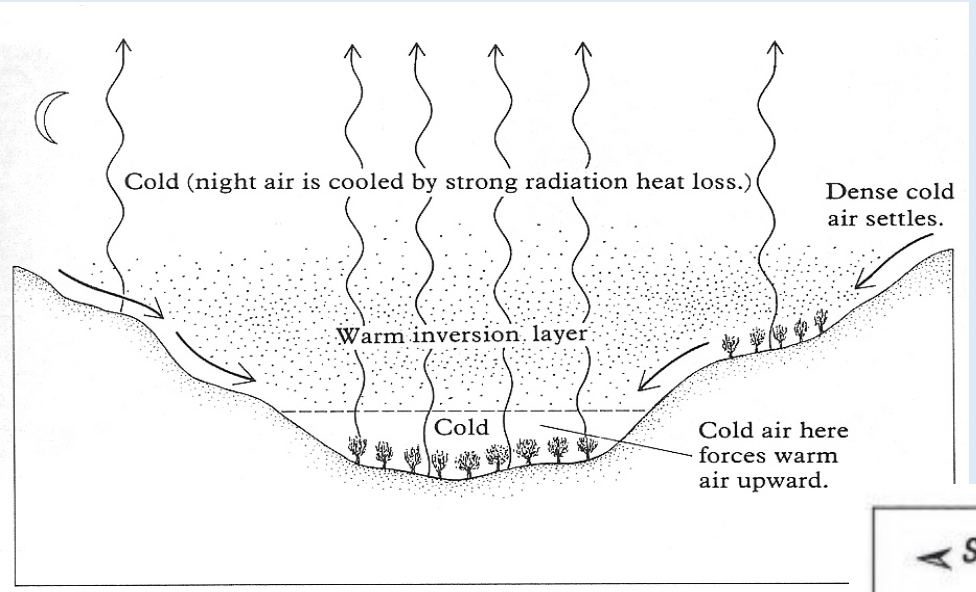


Figure 15-17 A schematic view of a valley with trees planted on the floor and up a slope. On clear, still nights, strong radiation heat loss at the earth's surface cools the air. The dense cold air that is formed settles at the bottom of the valley, forcing warmer air up to a higher level—thus producing a temperature inversion, which is advantageous to the trees on the slope on frosty nights.

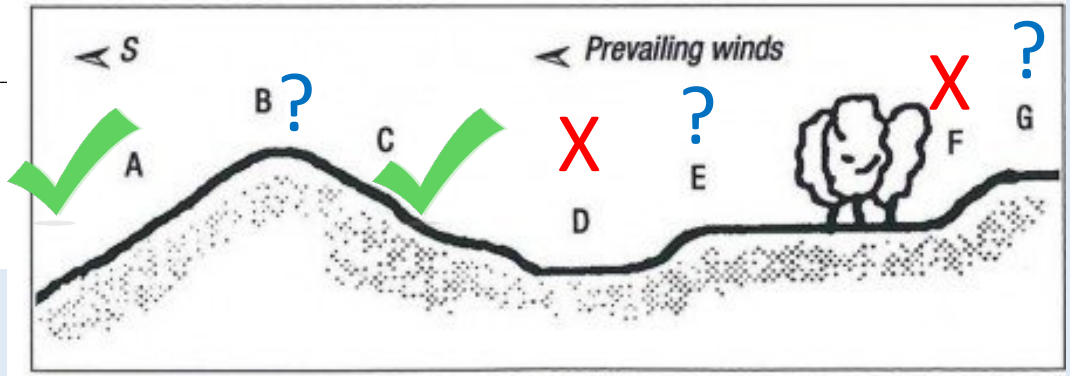
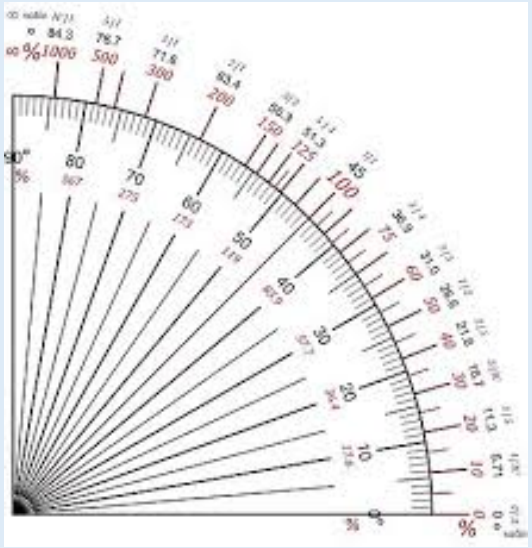


Figure 1-1. Considerations for orchard sites.

Typical site arrangements. A, C - warm locations; B, G - top may be too cold in winter; D, F - susceptible to spring frosts; E - can still be frosty, but the woods act as a windbreak.

Slopes: Degree and Direction

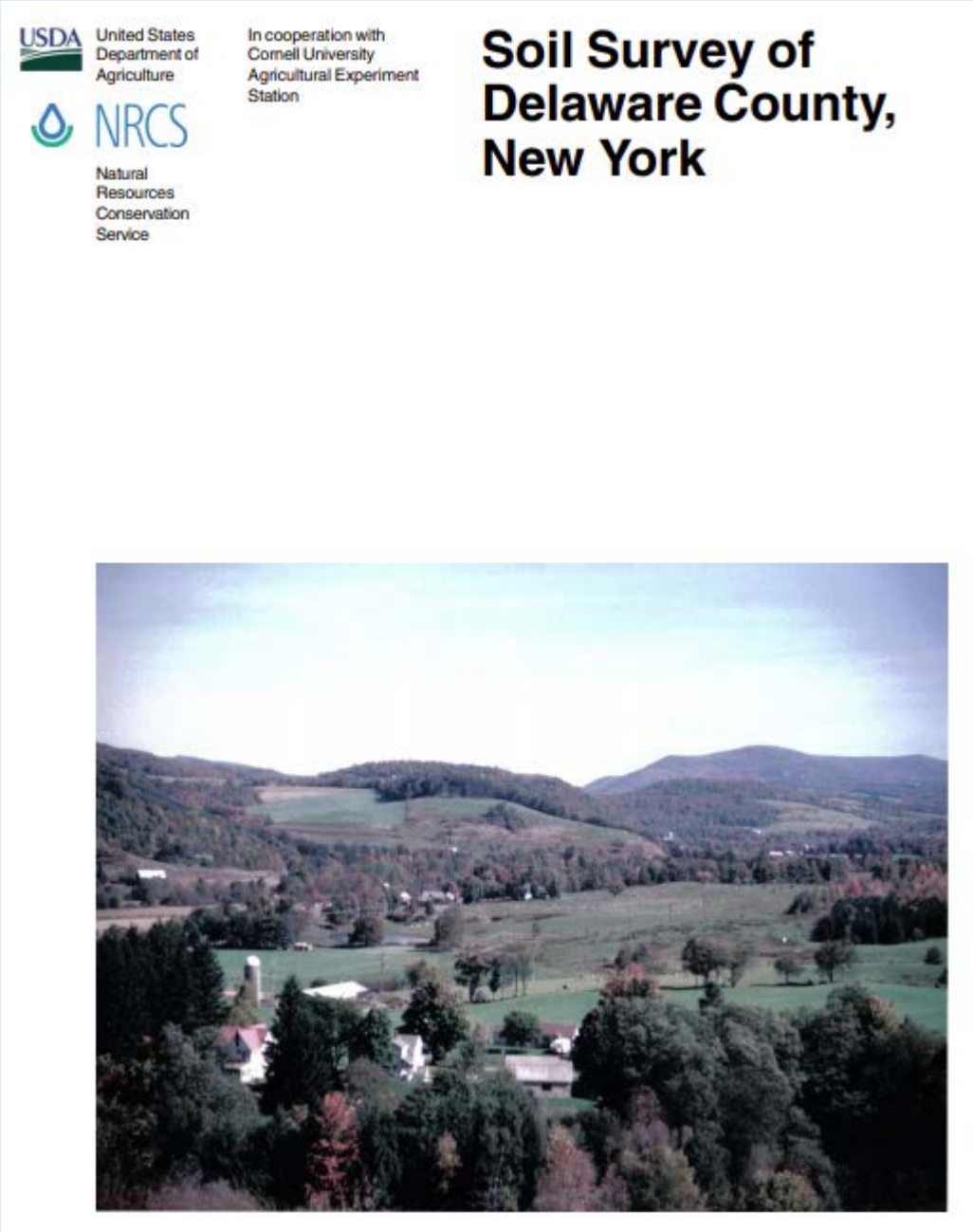
- + Air drainage for frost protection
- + Soil moisture (Infiltration & Surface runoff)
- - Soil erosion
- - Cultural practices – equipment!



Growing Condition	N	S	E	W
Available Sunlight	Lowest	Highest	Int. +	Int. -
Accumulation of Heat Units	Lowest	Highest	Int. -	Int. +
Need for Water	Lowest	Highest	Int. -	Int. +
Risk of a Spring Frost	Lowest	Highest	Int. -	Int. +
Fluctuating Winter Temperatures	Lowest	Highest	Int. -	Int. +

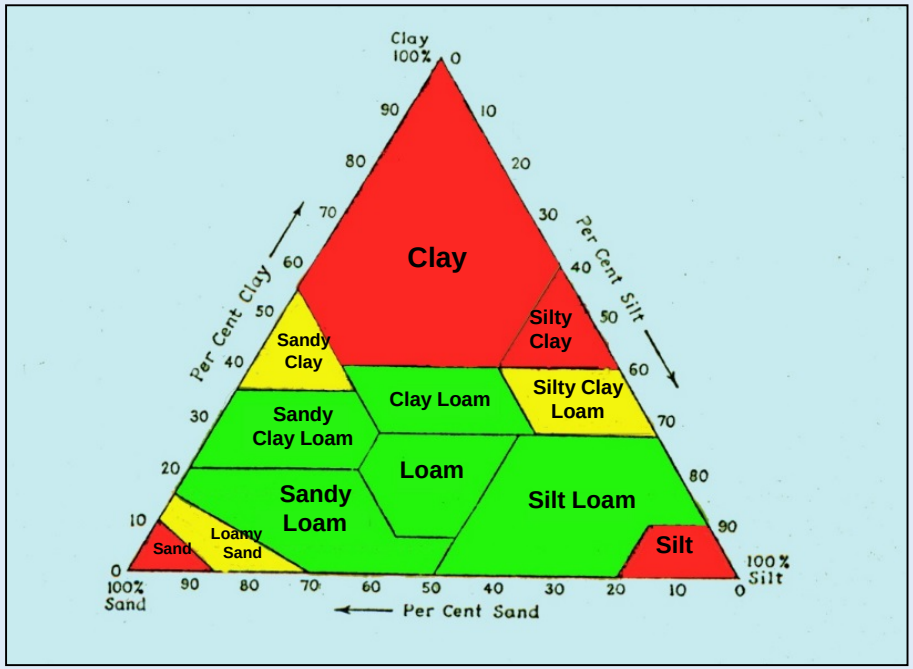
Soils

- Type and Texture
- Drainage
- Rooting Depth
- Water Holding Capacity
- Nutrients
- pH



Ideal Orchard Soils

- Preferably **well drained** loams and sandy loams, at least 3-4ft deep



Drainage is very important

Reasons for Poor Soil Drainage

Poor surface runoff
- Slope
- Depressions

Lateral seepage
- On slopes
- Textural change

Texture
- High clay content

Impervious layer in substrata
- Clay layer
- Compacted layer

High water table

Excessively drained?

Dig test holes if uncertain

Test Holes:

- 3 feet deep
- Fill with water
- Check after 72 hrs
- If water is still present:
  - Find another site
  - Take corrective measures

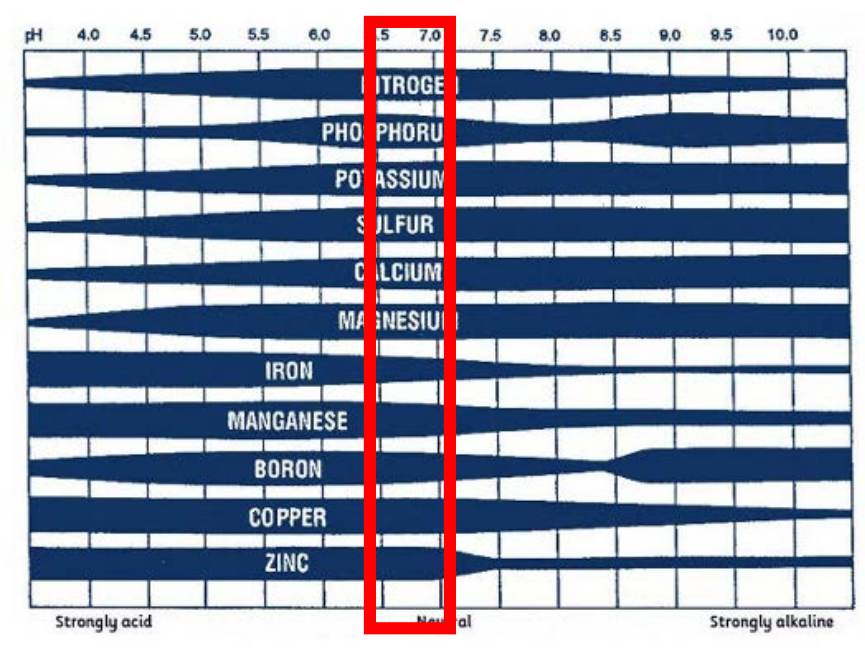
Soil Fertility & pH: Adjustable!

- **Pre-plant, Test for:**
  pH, P, K, Ca, Mg, OM

- Submit samples collected from 2 depths:
  - **0 to 8** inch depth.
  - **8 to 16** inch depth

Nutrient availability for given soil pH

Target: 6.5-7



Labs:

- Agro-One Soil Testing
  http://dairyone.com/analytical-services/agronomy-services/soil-testing/

Can you adjust your site?

Climate

Winter low Temperatures **No**

Spring/Fall Frosts **No**

Heat (Growing Degree-days) **No**

Topography (Air Drainage) **Maybe**

Soils

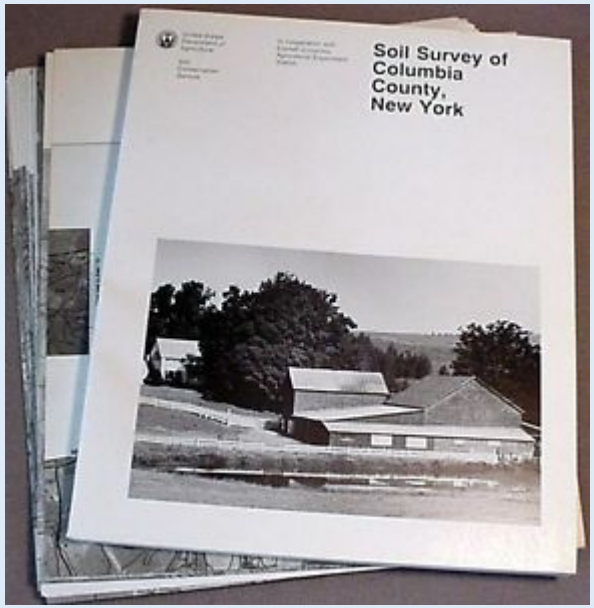
Rooting depth **Maybe – break up hardpan (subsoiling)**

Water Holding Capacity **Limited – but irrigation possible**

Drainage **Yes**

Soil pH and fertility **Yes**

County Soil Surveys



- **Soil Series Description:**

  Texture, Drainage, Fertility, Erosion
- **Soil Profile Classification:**

  Structure
- **Table of Engineering Index Properties:**

  Soil texture classification by depth
- **Table of Physical & Chemical Properties:**

  Permeability, available water holding capacity, organic matter content

How do you evaluate these things for your site?

Web Soil Survey Tool – NRCS
http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

More user friendly tool
https://casoilresource.lawr.ucdavis.edu/gmap/

Site Preparation: A Rough Timeline

2 to 1 seasons prior	Year prior	Year of Planting

- Evaluate Site
- Correct Drainage
- Remove Stumps & Vegetation
- Test soil
- Amend Soil
  - pH
  - Nutrients
  - OM
- Cover crops
- Order Trees
- Begin Planning Layout
  - Access roads
  - Irrigation
	Spring and Summer
	- Cover crops
	- Nutrition
	- Weed control
	
	Fall
	- Kill Perennial Weeds
	- Amend Soil
	- Cultivate, prepare seed bed
	- Seed field to prevent erosion
	
	Winter
	- Determine final layout
	- Order trellis supplies
	- Order irrigation supplies
		Plant
		- Lay out planting
		- Kill weeds
		- Mark field
		- Plant
		
		Follow up
		- Reset graft unions
		- Install trellis
		- Protect trees
		- Irrigate

1-2 Years Ahead: Big Infrastructure Changes

- Access roads
  - Keep enough room for the tractor to make turns (~40ft)
- Irrigation headers
- Fencing
- Drainage
  - Tiling
    - System of pipes to drain excess water from site
  - Swales/berms
- Soil tests and adjustments

Improving Soil Drainage

- **Sub-soil before planting**
  - Effective for compacted soils if there is good soil below.

- **Plant on raised beds**
  - Suitable on moderately well drained soils.
  - Maybe okay for somewhat poorly drained soils.

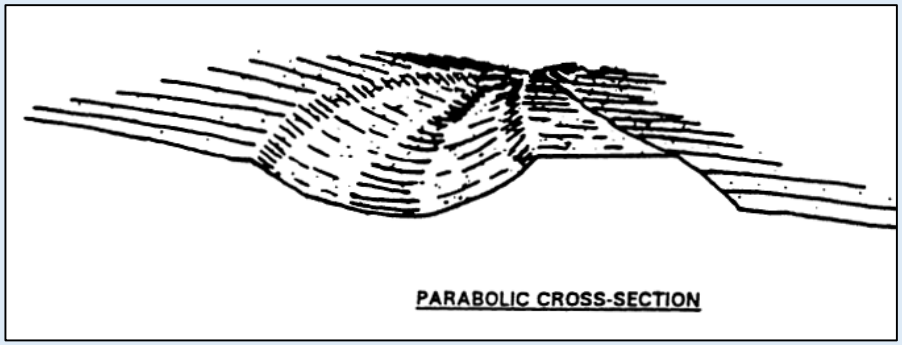
- **Install drainage tile**

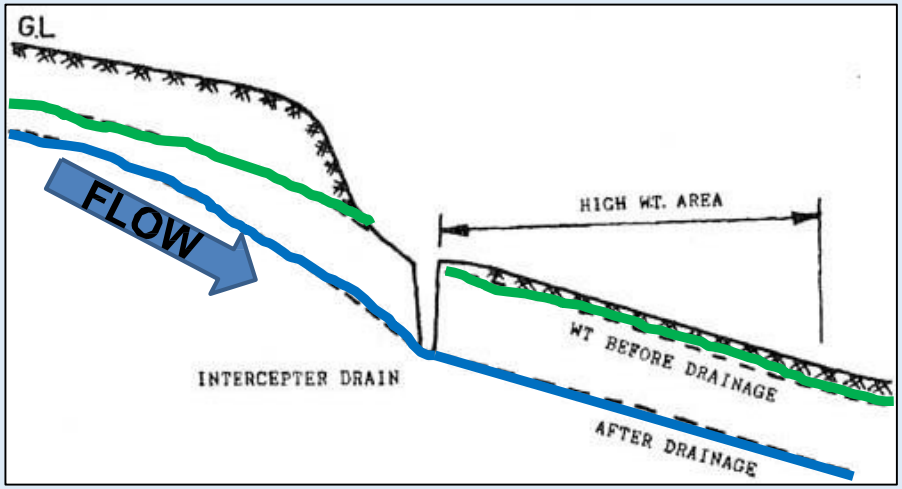
(most common in commercial orchards)

  - Suitable for somewhat poorly drained soils.
  - Maybe okay for poorly drained soils (distance between tile lines & cost become a factor).

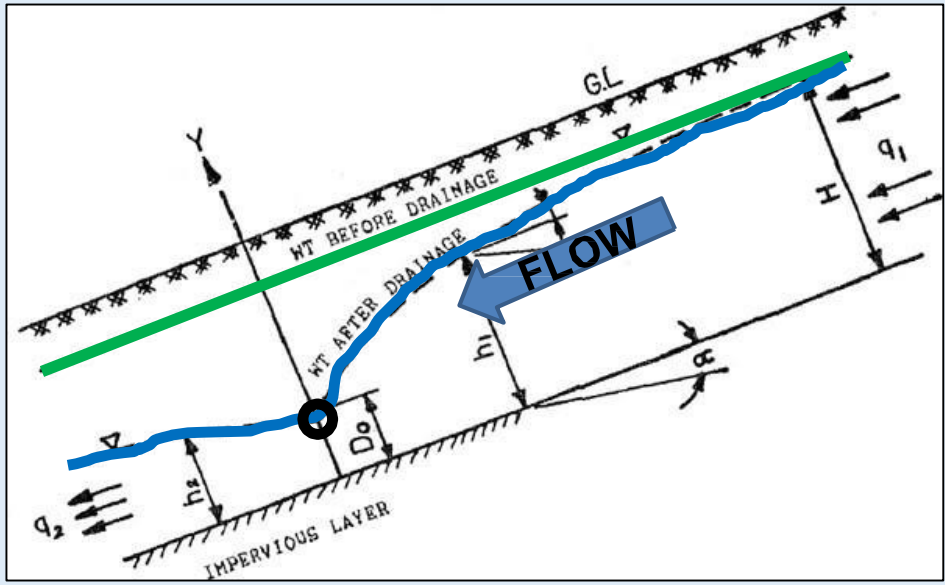
Ag Drainage: Interceptor

- Surface water or groundwater (a.k.a. diversion drains)
- Water originating off-site in sloping terrain



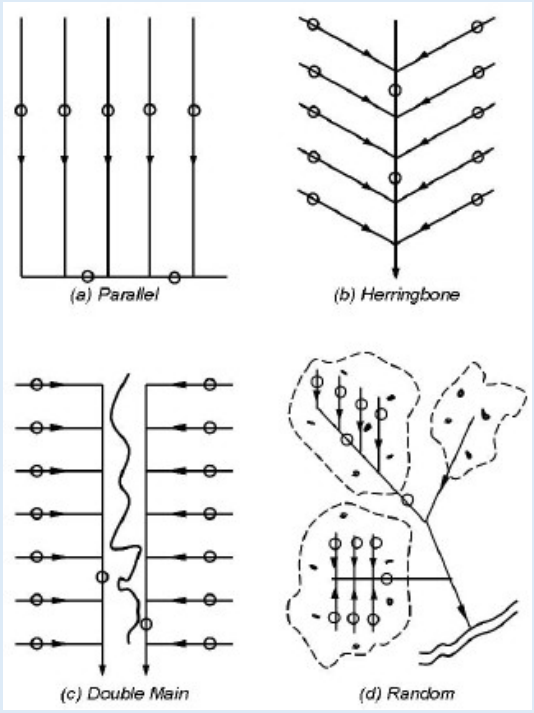


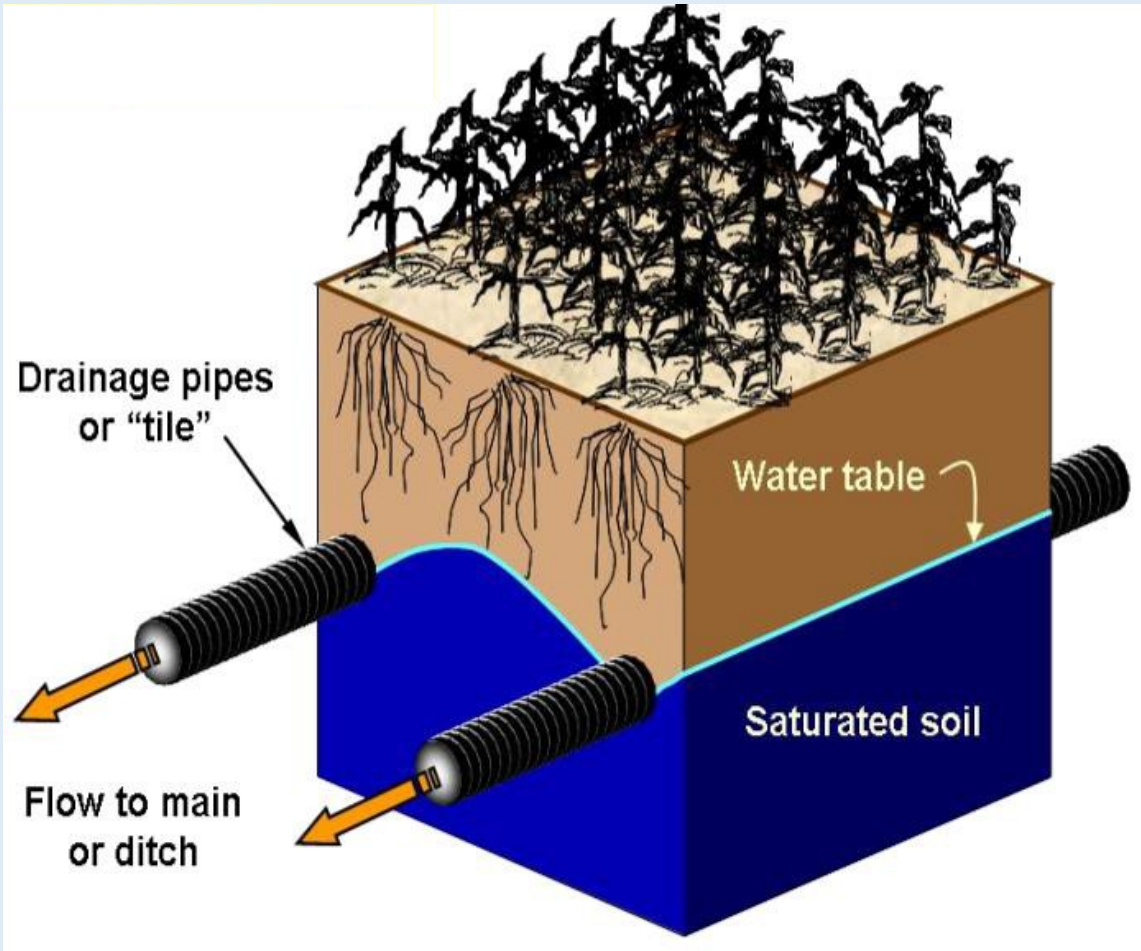
(Source: law.resource.org)



(Source: law.resource.org)

Ag Drainage: Subsurface, i.e. 'Tile'





(Source: G. Sands,UMN)

Ag Drainage: Subsurface – Misc.

- **Ensure adequate outlet!**
- Depth: at least 2.5’
- Pipe material: double/single wall
- Slope: at least 0.2%
- Rodent guard
- Main pipe size?
- Filter needed?
- Surface inlets?

Site Prep: Sample Cover Crop Regime

- Fall Y1- Clear vegetation if needed, remove stumps and rocks
  - Winter rye / vetch to ↑ soil N & OM, control erosion
- Spring Y2
  - Sudangrass ↑ soil OM, plow under, follow with
  - Canola, plow under, follow with
  - Buckwheat, plow under, follow with
  - Winter Rye
- Fall Y2
  - Permanent sod middles sown:
    - 40% proprietary perennial rye
    - 30% creeping red fescue
    - 30% chewing fescue
- Cornell Cover Crop tool
  http://covercrops.cals.cornell.edu/decision-tool.php

Soil Fertility: Pre-plant Amendments

Lime, organic matter, and mineral elements

- Adjust ahead, no chemical fertilizers in the planting hole!

Lime and OM can go a long way

- Use high mag lime if Mg is low

Cover crop year before planting to increase OM (buckwheat, rye, clovers)

- Add 40lbs N to establish cover crop, and ahead of sod establishment

Some fertilizers to apply if soil test shows need

- P, K, Ca, Mg, Zn, B

SAMPLE DESCRIPTION

planting: apple COMMERCIAL
to be planted
soil texture: sandy
soil drainage: good
size of area: < 1 acre

REPORT FOR:

Terry Bradshaw
121 Hills Bldg

SOIL TEST REPORT

AGRICULTURAL & ENVIRONMENTAL TESTING LABORATORY
AND UVM EXTENSION
UNIVERSITY OF VERMONT

LAB NUMBER L 20749
DATE 10/01/02

COUNTY UNKNOWN

FIELD NAME Calais - 1

SOIL TEST RESULTS

Avail.phosphate	(ppm P)	0.3
Potash	(ppm K)	15
Magnesium	(ppm Mg)	17
pH		5.1
Calc		
Effe		
Ca:M		
Alum		

Remember pH effect on nutrients: 5 Tons Lime-Ash + 25#
Buckwheat cover cropped!

Please refer to the back side for a more detailed description of the test

for target pH of 6.8 apply 5.5 tons/A of lime (or 275 lbs/1000 sq.ft.)

SOIL TEST RESULTS

Avail.phosphate	(ppm P)	3.3
Potash	(ppm K)	96
Magnesium	(ppm Mg)	106
pH		6.9
Calcium	(ppm Ca)	4131
Effective CEC	(meq/100g)	21.8
Ca:Mg:K ratio		84: 3.6:1
Aluminum	(ppm Al)	87

Please refer to the back side for a more detailed description of the test

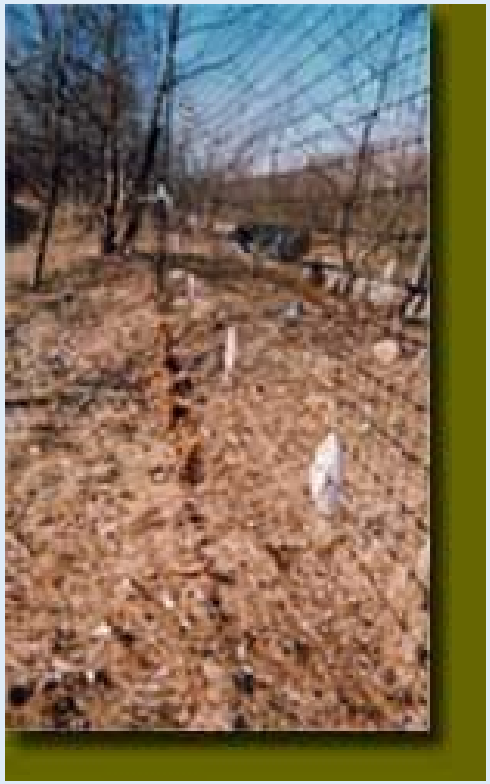
target pH is 6.8

Deer Protection

Fourth year, no deer fence

Third year, <u>with</u> deer fence

High tensile electric multi-strand



High tensile woven wire

Plastic mesh

Year Prior to Planting

Take care of your perennial weeds before trees are in the ground!

- Cultivation
- Cover crops to smother
- Systemic herbicides

Chop and plow down cover crops late summer prior

- Final soil test and add final amendments
- Final disking, leveling, prepare seedbed

Seed rows with your grass mix mid-August to mid-September

Orchard-vineyard-nursery mix

- 40% proprietary perennial rye
- 30% creeping red fescue
- 30% chewing fescue

Figure 4. A good stand of a grass mix when seeded early in the Spring (photo taken 30 days after seeding).

Figure 5. A better stand of an OVN-Mix @ 60 days after seeding in Alton, Wayne County.

Site Preparation and Planting

Spring of planting:

Lay out the planting.

- Square the field.
- Mark the location of the rows.

Kill out sod strips for the rows.

Mark the location for the trees.

Plant the trees.

Determining Trees Needed

- (Sq Feet/ Acre) / (Sq Feet/Tree)
- 43560 / (tree spacing * row spacing)
- 43560/ (6*15)
- 43560 / 90 = **484 trees/acre**

Orchard Layout

Row Spacing:

10 to 24 feet (depends on tree vigor and equipment size)

Tree Spacing within Rows:

2 to 12 feet (depends on tree vigor and training system)

Number of Trees per Acre:

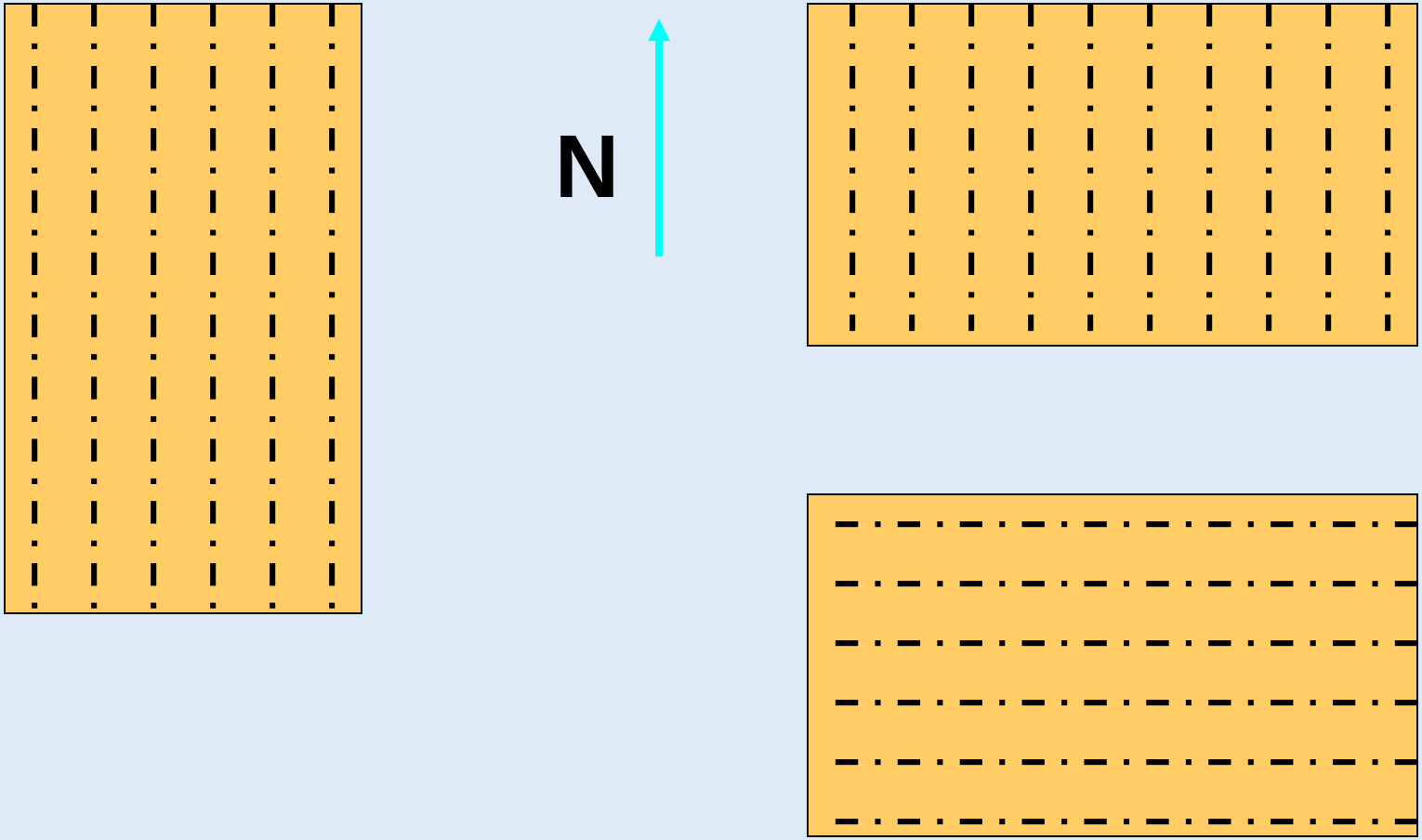
3x10=1452	**3x12=1210**
6x14=518	10x15=290
12x20=181	20x24=91

Direction of Rows

North / South Preferred

Across Slope or Contoured

Shape of the Field



Laying out the orchard

- 30-40-50
- Sight Lines
- Laser
- Survey Transit

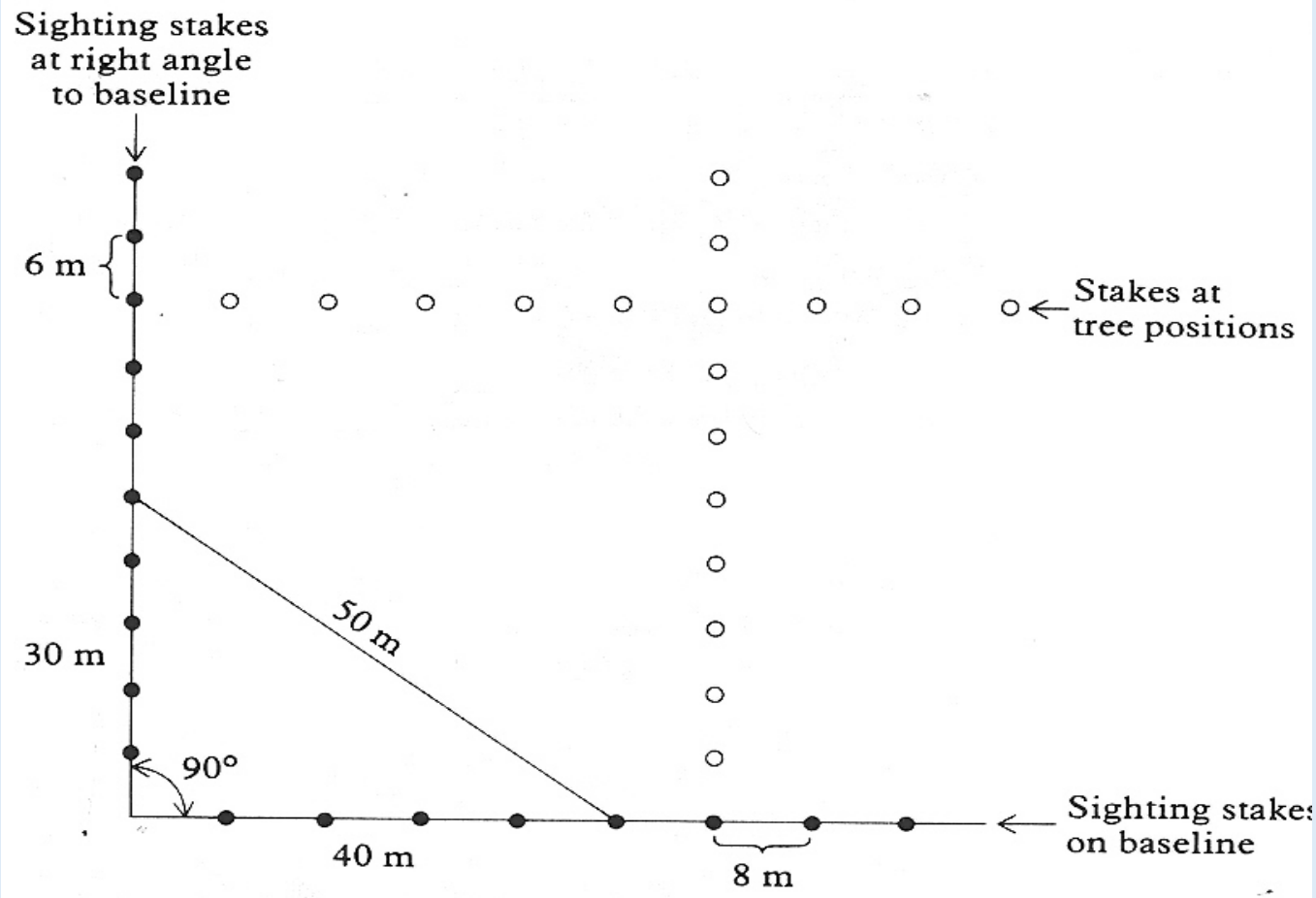


Figure 5-3 Diagram showing the use of 30:40:50 m ropes to establish a line at right angles to the base line. From these two lines a few measurements can be made to place sighting stakes from which the entire planting can be laid out.

3-4-5 Triangle

Mark out Rows and Tree Placement With Markers


NEW HOLLAND
S160


POLARIS

Immediate aftercare

- Reset graft unions
  - 2-6” from ground
  - More union showing =
    - More dwarfing
    - Fewer burr knots
  - Pack planting furrow
  - Water: Install drip irrigation ASAP
- Install trellis immediately if using one
  - Multiple kinds of training systems
  - At least ends, trunk wire

Immediate aftercare

- Begin pest management program immediately to protect young trees
- Focus in on:
  - Disease management
  - Foliar feeding insect pests
  - Borers
  - Mammals
- Apply copper immediately after planting
- Upon bloom, remove flower buds
  - Why? Fire Blight

Brief Intro to Apple Pest Management

Diseases

- Apple Scab
- Fire blight
- Cedar Apple Rust
- Powdery Mildew
- Summer Rots (bitter rot, brown rot, white rot)
- Marssonina leaf blotch

Mammals

- Deer
- Rabbits
- Mice/voles
- Groundhogs

Arthropods

- Plum curculio
- Apple maggot
- Internal feeding moths
- Leafrollers
- Plant bugs
- Stink bugs
- Mites, aphids, scales
- Borers
- Japanese beetles

Weeds

- Perennials
- Biennials
- Annuals

Growth Stages

Pest Management “Calendar”

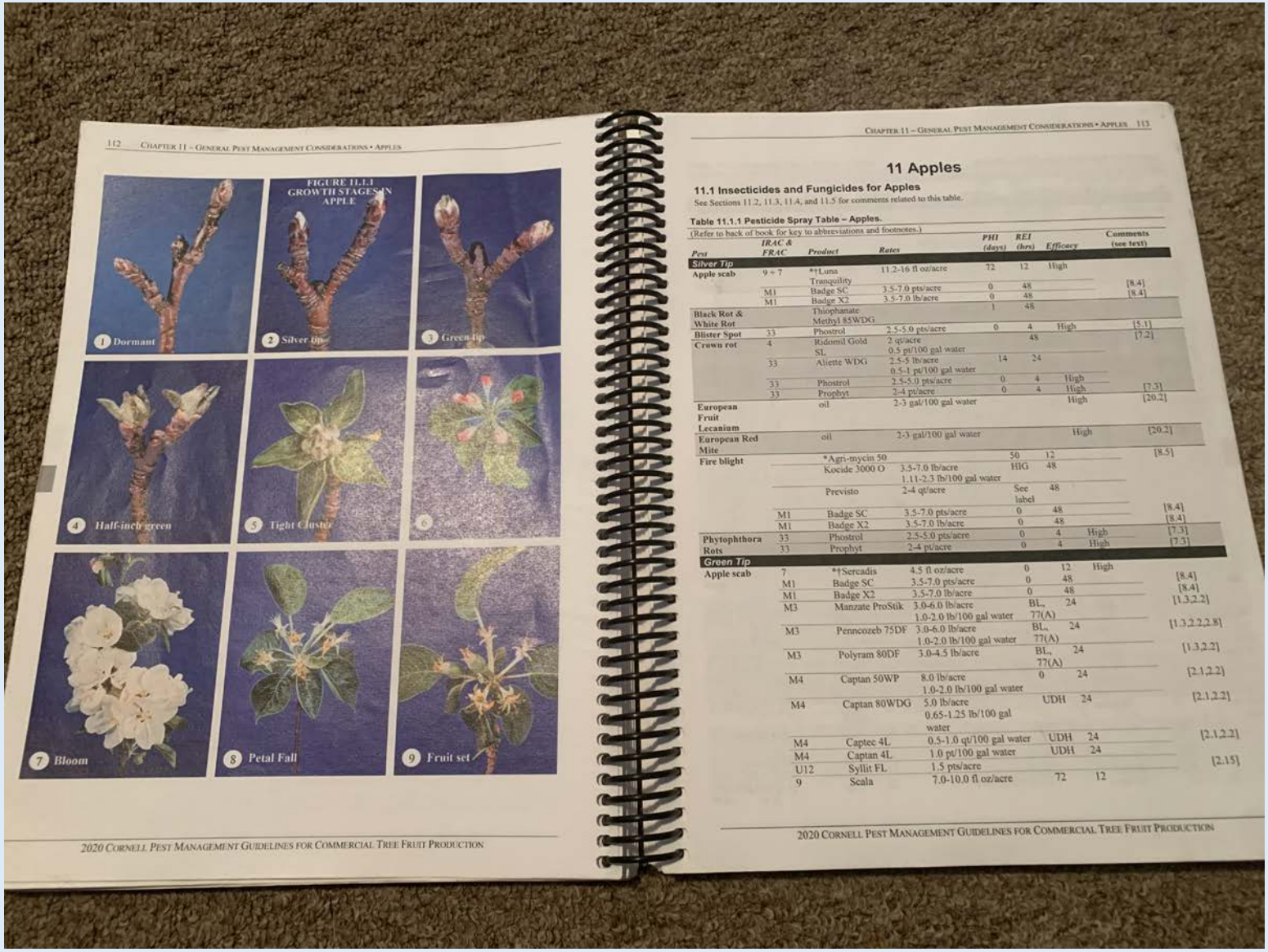


FIGURE 11.1.1 GROWTH STAGES IN APPLE

1 Dormant
2 Silver tip
3 Green tip
4 Half-inch green
5 Tight Cluster
6
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 back of book 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]
Black Rot & White Rot		Thiophanate Methyl 85WDG		1	48		
Blister Spot	33	Phostrol	2.5-5.0 pts/acre	0	4	High	[5.1]
Crown rot	4	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	24		
	33	Phostrol	2.5-5.0 pts/acre	0	4	High	
	33	Prophyt	2-4 pt/acre	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		50	12		[8.5]
		Kocide 3000 O	3.5-7.0 lb/acre 1.11-2.3 lb/100 gal water	HIG	48		
		Previsto	2-4 qt/acre	See label	48		
	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/acre	0	4	High	[7.3]
Green Tip							
Apple scab	7	*†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	UDH	24		[2.1.2.2]
	M4	Captec 4L	0.5-1.0 qt/100 gal water	UDH	24		[2.1.2.2]
	M4	Captan 4L	1.0 pt/100 gal water	UDH	24		[2.15]
	U12	Syllit FL	1.5 pts/acre				
	9	Scala	7.0-10.0 fl oz/acre	72	12		


KYX
HASTINGS TRIPLET
BAUSCH & LOMB

Degree Days

- Pest development is well timed to temperature
- We can track temperature accumulations to better predict pest events (and management tasks)
- Example: codling moth larvae hatch roughly 250DD (base 50°) following sustained flight

CODLING MOTH						
1st catch	18-May(±7)	22-May	475(±85)	350	249(±55)	15
1st flight peak	3-Jun(±12)	5-Jun	768(±206)	678	442(±134)	386
1st flight subsides	6-Jul(±12)	6-Jul	1557(±262)	1483	1011(±187)	976
2nd flight start	20-Jul(±13)	9-Jul	1887(±313)	1587	1251(±223)	1059
2nd flight peak	6-Aug(±13)	7-Aug	2327(±349)	2447	1585(±265)	1716

Codling Moth: Base 50

- DD Base 50 is an average unit of temperature above 50°F each day, which accumulates from a specified starting point (usually first trap catch)

- How to calculate?
  - On May 25, High was 75, low 65.
  - Average temp = 75 + 65, divided by 2 = 70 (daily average).
  - 70 (average) – 50 (the base temp) = 20. 20 degree days for this day.

- Add each day to the previous tally
  - May 25 – 20
  - May 26 – 7
  - May 27 – 3

On May 27, you would now have 30 DD's (Base 50) since May 25

Spray once you've accumulated 250 since your first capture

Lower Threshold: 50.0°F **Upper Threshold:** 88.0°F **Method:** Single Sine **Cutoff:** Horizontal

Max temps \ Minimum temperatures	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90
48	0	0	0	0	0	0	0	0																					
50	0	0	0	0	0	0	0	0	0																				
52	0	0	0	0	0	0	1	1	1	2																			
54	1	1	1	1	1	1	1	2	2	3	4																		
56	1	1	2	2	2	2	2	2	3	4	5	6																	
58	2	2	2	2	3	3	3	3	4	5	6	7	8																
60	3	3	3	3	3	4	4	4	5	6	7	8	9	10															
62	4	4	4	4	4	5	5	5	6	7	8	9	10	11	12														
64	4	4	5	5	5	5	6	6	7	8	9	10	11	12	13	14													
66	5	5	6	6	6	6	7	7	8	9	10	11	12	13	14	15	16												
68	6	6	6	7	7	7	8	8	9	10	11	12	13	14	15	16	17	18											
70	7	7	7	8	8	8	9	9	10	11	12	13	14	15	16	17	18	19	20										
72	8	8	8	8	9	9	10	10	11	12	13	14	15	16	17	18	19	20	21	22									
74	8	9	9	9	10	10	11	11	12	13	14	15	16	17	18	19	20	21	22	23	24								
76	9	10	10	10	11	11	12	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26							
78	10	11	11	11	12	12	13	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28						
80	11	11	12	12	13	13	14	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30					
82	12	12	13	13	14	14	15	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32				
84	13	13	14	14	15	15	16	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34			
86	14	14	15	15	15	16	17	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		
88	15	15	16	16	16	17	18	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	
90	16	16	16	17	17	18	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	36	37	38	38
92	16	17	17	17	18	18	19	20	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	37	38	38
94	17	17	18	18	18	19	20	20	21	22	23	24	25	26	27	28	29	30	31	32	33	33	34	35	36	37	38	38	38
96	17	18	18	19	19	20	20	21	22	23	23	24	25	26	27	28	29	30	31	32	33	34	35	35	36	37	38	38	38
98	18	18	19	19	19	20	21	21	22	23	24	25	26	27	28	29	30	30	31	32	33	34	35	36	36	37	38	38	38
100	18	19	19	19	20	20	21	22	22	23	24	25	26	27	28	29	30	31	32	32	33	34	35	36	36	37	38	38	38
102	19	19	19	20	20	21	21	22	23	24	25	26	27	27	28	29	30	31	32	33	34	34	35	36	37	37	38	38	38
104	19	19	20	20	21	21	22	22	23	24	25	26	27	28	29	30	30	31	32	33	34	34	35	36	37	37	38	38	38
106	19	20	20	21	21	22	22	23	24	24	25	26	27	28	29	30	31	31	32	33	34	35	35	36	37	37	38	38	38
108	20	20	20	21	21	22	22	23	24	25	26	27	27	28	29	30	31	32	32	33	34	35	35	36	37	37	38	38	38
110	20	20	21	21	22	22	23	23	24	25	26	27	28	28	29	30	31	32	33	33	34	35	36	36	37	37	38	38	38
112	20	21	21	22	22	22	23	24	24	25	26	27	28	29	30	30	31	32	33	34	34	35	36	36	37	37	38	38	38
114	21	21	21	22	22	23	23	24	25	26	26	27	28	29	30	31	31	32	33	34	34	35	36	36	37	37	38	38	38
116	21	21	22	22	23	23	24	24	25	26	27	27	28	29	30	31	31	32	33	34	34	35	36	36	37	37	38	38	38
118	21	21	22	22	23	23	24	24	25	26	27	28	28	29	30	31	32	32	33	34	35	35	36	36	37	37	38	38	38

Hours of Wetting for Primary Apple Scab Infection

Number of hours at different air temperatures are approximate.

Avg. Temp. (°F/°C)	Hours of wetting required for infection from primary inoculum		
	Light Infection	*Mod. Infection*	*Heavy Infection*
78°/25.5°	13	17	26
77°/25°	11	14	21
76°/24.5°	9.5	12	19
63–75°/ 17–24°	9	12	18
62°/17°	9	12	19
61°/16°	9	13	20
60°/15.5°	9.5	13	20
59°/15°	10	13	21
58°/14.5°	10	14	21
57°/14°	10	14	22
56°/13.5°	11	15	22
55°/13°	11	16	24
54°/12°	11.5	16	24
53°/11.5°	11.5	17	25
52°/11°	12	18	26
51°/10.5°	13	18	27
50°/10°	14	19	29
49°/9.5°	14.5	20	30

Avg. Temp. (°F/°C)	Hours of wetting required for infection from primary inoculum		
	Light Infection	*Mod. Infection*	*Heavy Infection*
48°/9°	15	20	30
47°/8.5°	15	23	35
46°/8°	16	24	37
45°/7°	17	26	40
44°/6.5°	19	28	43
43°/6°	21	30	47
42°/5.5°	23	33	50
41°/5°	26	37	53
40°/4.5°	29	41	56
39°/4°	33	45	60
38°/3.5°	37	50	64
37°/3°	41	55	68
33–36°/ 0.5–2°	48	72	96

Adapted from North Carolina State University and Michigan State University fruit publications and based on the original "Mills" chart developed by W. O. Mills of Cornell University and modified by A. L. Jones. The infection period starts with the beginning of rain.

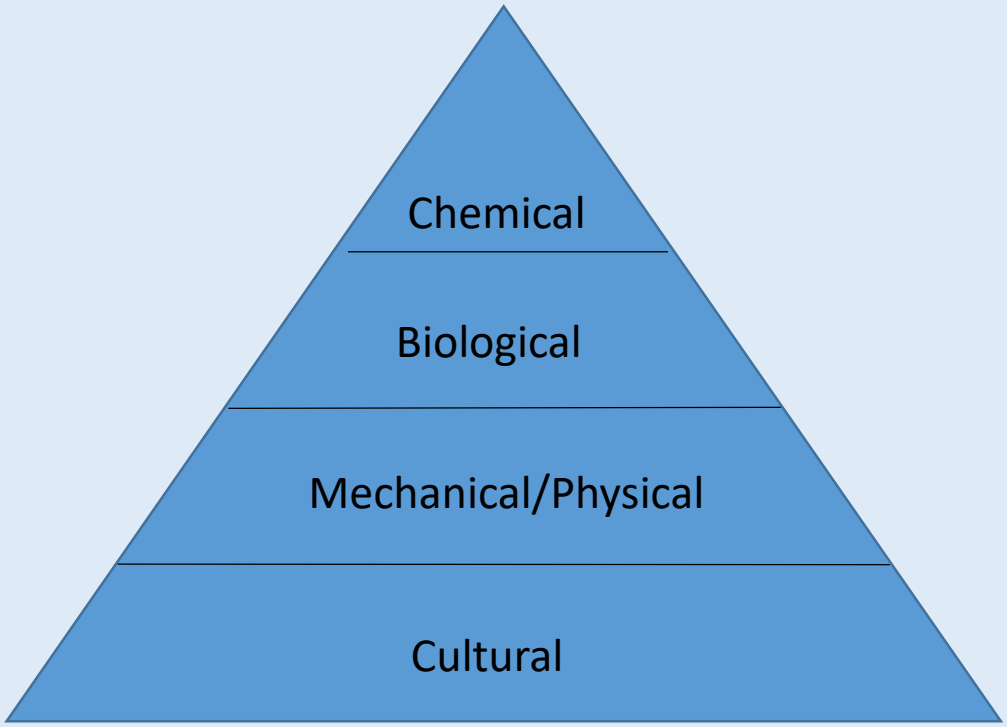
Table 1.—Temperature and moisture requirements for cedar apple rust infection periods.

Temperature (C)	Temperature (F)	Hours Wetting Required A: Basidiospore Formation	Hours Wetting Required B: Infection Light	Hours Wetting Required B: Infection Severe
2	36	-	24	-
4	39	-	12	24
6	43	-	8	10
8	46	7	6	7
10	50	5	5	6
12	54	4	4	5
14	57	4	3	5
16	61	4	3	4
18	64	4	3	4
20	68	4	2	4
22	72	4	2	4
24	75	4	2	4
26	79	-	-	-
28	82	-	-	-
30	86	-	-	-

No basidiospores form at these temperatures.

Light infection—unlikely to cause economic loss.

No infections have been observed at these temperatures.



Chemical:

- well timed chemical products

Biological:

- biopesticides
- mating disruption
- natural predators and parasitoids

Mechanical/Physical:

- mowing weeds
- cultivating prior to planting
- mowing and chopping residues
- kaolin clay
- Mineral oils

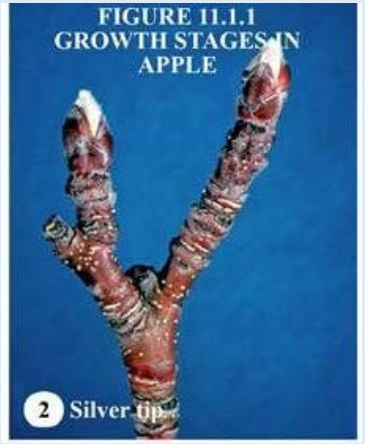
Cultural:

- site selection
- choosing appropriate varieties
- training and pruning
- soil and nutrient management

Seasonal Pest Management

- Proper dormant pruning to open up canopy for disease management
- **Scab:** Mowing, leaf removal, and urea applications to reduce overwintering inoculum

- Dormant oil application for **ERM and SJS** control
- Copper application for **fire blight and early scab**
- Become vigilant for early pest activity



- **Fire blight:** Copper if not yet applied
- **Scab:** sprays when spores are active and weather is conducive

Hours of Wetting for Primary Apple Scab Infection

Number of hours at different air temperatures are approximate.

Avg. Temp. (°F/°C)	Hours of wetting required for infection from primary inoculum		
	Light Infection	*Mod. Infection*	*Heavy Infection*
78°/25.5°	13	17	26
77°/25°	11	14	21
76°/24.5°	9.5	12	19
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62°/17°	9	12	19
61°/16°	9	13	20
60°/15.5°	9.5	13	20
59°/15°	10	13	21
58°/14.5°	10	14	21
57°/14°	10	14	22
56°/13.5°	11	15	22
55°/13°	11	16	24
54°/12°	11.5	16	24
53°/11.5°	11.5	17	25
52°/11°	12	18	26
51°/10.5°	13	18	27
50°/10°	14	19	29
49°/9.5°	14.5	20	30

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45°/7°	17	26	40
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43°/6°	21	30	47
42°/5.5°	23	33	50
41°/5°	26	37	53
40°/4.5°	29	41	56
39°/4°	33	45	60
38°/3.5°	37	50	64
37°/3°	41	55	68
33–36°/ 0.5–2°	48	72	96

Adapted from North Carolina State University and Michigan State University fruit publications and based on the original "Mills" chart developed by W. O. Mills of Cornell University and modified by A. L. Jones. The infection period starts with the beginning of rain.

- **Scab:** sprays when weather is conducive
- **Mites and scale:** Delayed dormant oil if not already made

Scab: sprays when weather is conducive (protectant)

Cedar apple rust: sprays when weather is conducive

Powdery mildew: sprays when weather is conducive

Mites and Scale: can still potentially make oil applications

Heavy disease pressure: Continue fungicide applications when weather is conducive to infection (protectant with single sites)

Dogwood borer: Insecticides and mating disruption should be up by now

STLM: Sample cluster leaves for egg presence to determine if treatment is necessary

Examine buds for insect damage, nymphs, and larvae: Potential Insecticide applications for **tarnish plant bug, scale, rosy apple aphid, and early worm complex (GFW, and overwintering OBLR)**

ERM: Prebloom ovicide-larvacide

Growth Stages

Heavy disease pressure: Continue fungicides for **scab, PM, and CAR** (protectant with single sites)

Fire blight: sprays when flowers are open, inoculum is present, and weather conditions are suitable for infection

Heavy disease pressure: Continue fungicides for **scab, PM, and CAR** (protectant with single sites)

Plum curculio: apply insecticide at petal fall, and continue sprays until 308DD base 50 have accumulated beyond petal fall

OBLR, RBLR, LAW, OFM Larvae: Insecticide application with good lep activity

STLM: Sample for leaf mining, determine if treatment is necessary

Scab: Effective fungicides at least through first/second cover where weather remains conducive. (protectant with single sites) Additional if secondary infections are present

CAR: Continue fungicides through 2nd cover where weather remains conducive

PM: Effective fungicides up until terminal bud set where weather is conducive

Summer Rots: Effective fungicides ahead of weather favoring infection (warm, wet weather)

PC: Continue insecticides until 308DD base 50 have accumulated since petal fall (more sprays in cool seasons)

CM: Insecticide about first and second cover to control first summer generation egg hatch

OFM: Follow up insecticide about 1st cover

Mites (ARM, ERM): worse in hot, dry years. Look closely at leaf undersides for mite presence. Apply appropriate materials if levels are above recommended thresholds (June 2.5 mites per leaf)

Leafhoppers: Begin to monitor in June. Use thresholds to determine if treatment is necessary

San Jose Scale: Use black tape to monitor crawler activity. Insecticides targeting the crawler generation beginning early June

Summer Covers

Scab: Continue if bad secondary infections are present

Fire blight: Monitor for infections, cut out infections on dry days. No strep in the summer unless severe wounding damage! Can apply Apogee shortly after infections to slow growth, and Cueva/Double Nickel blends to slow inoculum.

PM: Effective fungicides up until terminal bud set where weather is conducive

Summer Rots: Effective fungicides ahead of weather favoring infection (warm, wet weather)

Sooty blotch and flyspeck: Effective fungicide based on 190 leaf wetness hours post petal fall, additional applications according to amount of rain/time since the previous application

Summer Covers

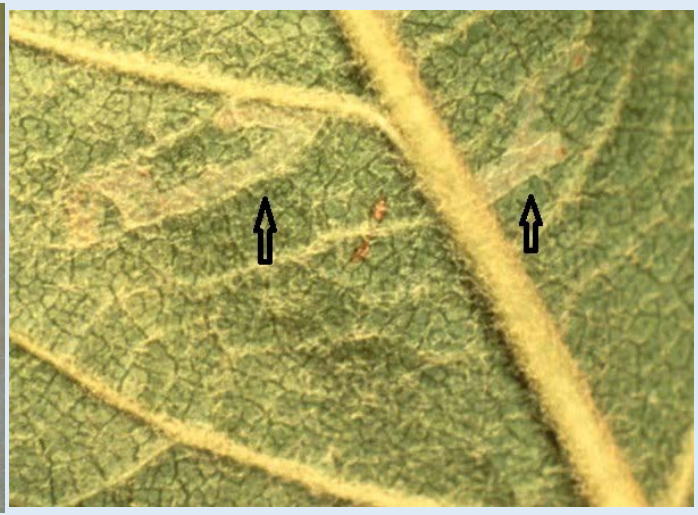
OBLR: Sample early July (WNY July 5) to determine if treatment is warranted

CM: Apply a different FRAC group of insecticide when 2nd generation hatch begins about mid-July

OFM: Insecticides at 2nd generation hatch in July

STLM: Sample for 2nd generation damage around July 9 (WNY) to determine if treatment is necessary

AM: Monitor traps beginning early July, begin counting adults again 7-10 days after the application, stop checking end of August



Stink Bugs: monitor traps beginning in June and examine fruit. Treat at first signs of infestation or when thresholds reached. Reapply if thresholds continue to be reached

Apple aphid: Begin monitoring in June. Use thresholds

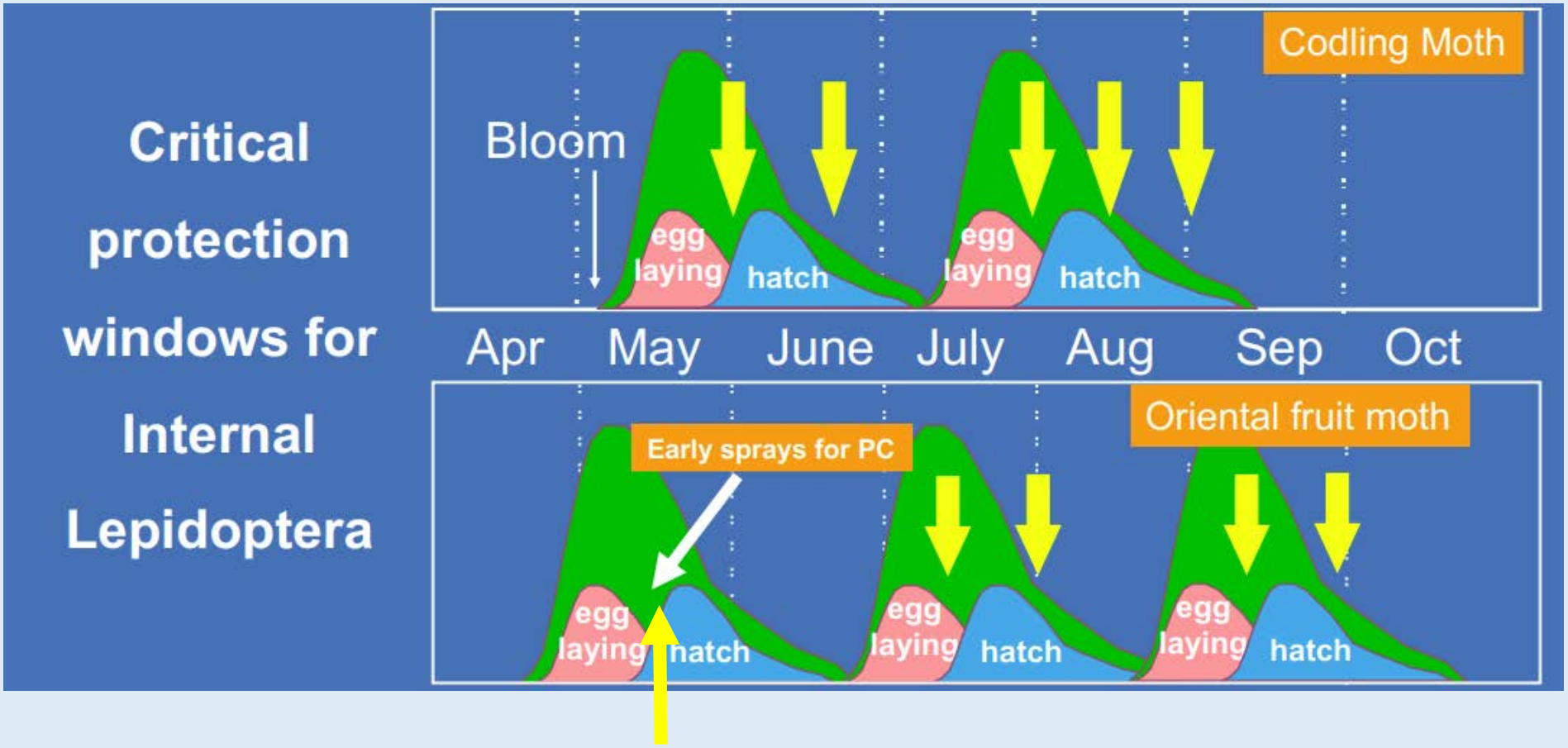
Wooly apple aphids: monitor beginning in June or when colonies become visible. If necessary, apply insecticide in July before colonies get heavily established.

Mites (ARM, ERM, TSSM): worse in hot, dry years. Inspect leaf undersides for mite presence. Apply when counts are above recommended thresholds (July 5, August 7.5)

Japanese beetle: Monitor for adults and leaf damage. Apply controls if necessary

Leafhoppers: Continue to monitor presence on leaves. Use thresholds to determine if treatment is necessary

1C 2C 4C 5C 6C 7C 8C 9C



Courtesy Art Agnello, Cornell University

Treatment	MOA	Rate Per Acre	Phenology	Approx. Date (HVRL)	Target Pests
Cuprofix	M1	3 lbs	Delayed Dormant	5-Apr	Fireblight
Manzate	M3	3 lbs	GT	13-Apr	Scab
Oil		2 G per 100G	1/4 In	15-Apr	Scale, Mites
Vanguard + Manzate	9,M3	5 oz, 3 lbs			Scab
Lorsban*	1B	3 pt	HIG	17-Apr	DWB, RAA, Scale
Vanguard + Manzate	9,M3	5 oz, 3 lbs	TC	22-Apr	Scab
Assail	4A	8 oz			RAA, Scale, Plant Bug
(or) Mustang Maxx*	3A	3.0 fl oz			GFW, Sawfly, OBLR, RBLR, OFM
Fontelis* + Manzate	7, M3	20 fl oz, 3 lbs	Pink	29-Apr	Scab, PM
Inspire Super + Manzate	3 + 9, M3	12 fl oz, 3 lbs	Bloom	8-May	Scab, PM, CAR
Agri-Mycin 17	25	24 oz	Bloom-PF (as needed)		Fireblight
Inspire Super+ Manzate	3 + 9, M3	12 fl oz, 3 lbs			Scab, PM, CAR
Avaunt	22	6 oz			PC, Leps, STLM, EAS
Agri-Mek*	6	3.25 oz	PF	15-May	Mites, Leafhoppers
Inspire Super+ Captan	3 + 9, M3	12 fl oz, 3 lbs			Scab, PM, CAR
Avaunt	22	6 oz			PC
Altacor*	28	3.0 oz	1C	3-Jun	Leps, Leafrollers
Inspire Super+ Captan	3 + 9, M3	12 fl oz, 3 lbs			Scab, PM, CAR
Altacor*	28	3.0 oz			Leps
Admire Pro*	4A	2.8 fl oz	2C	11-Jun	Scale, Aphids, WAA, Plant Bugs, Aphids
Flint Extra + Captan	3, M4	2.9 fl oz, 3 lbs	3C	22-Jun	Scab, PM, Summer Rots
Delegate	5	6.0 oz			Leps CM/OBLR, OFM, LAW, RBLR)
Luna Sensation* + Captan	7+11, M4	5.8 fl oz, 3 lbs	4C	3-Jul	Scab, Summer Rots
Delegate	5	6.0 oz			Leps
Aprovia + Captan	7, M4	13.8 fl oz, 3 lbs	5C	23-Jul	Scab, Summer Rots
Exirel*	28	16.0 fl oz			AM, Leps
Prophyt + Captan	33, M4	6 pts, 3 lbs	6C	1-Aug	Scab, Summer Rots
Assail	4A	8 oz	7C	11-Aug	Stink Bug
Brigade 2EC*	3A	6.4 fl oz			Stink Bug
Ziram + Captan	M3, M4	6 lbs, 3 lbs	8C	20-Aug	Scab, Summer Rots
Assail	4A	16 fl oz			Stink Bug
Merivon* + Captan	7 +11, M4	5.5 fl oz, 3lbs	9C	30-Aug	Scab, Summer Rots
Assail	4A	16 fl oz			Stink Bug
Merivon* + Captan	7 +11, M4	5.5 fl oz, 3lbs	10C	9-Sep	Scab, Summer Rots

* Restricted Use Product

Growth Stage	Chemical Name	Active Ingredient(s)	Dosage Rate (per 100 gal water/acre)	Target Pest	Notes
Delayed Dormant/Silver Tip	Cueva	Copper Octanoate	2 gal	Fireblight, Scab, Powdery mildew	
	Double Nickel 55	*Bacillus amyloliquefaciens* strain D747	1 qt	Fireblight, Scab, Powdery mildew	
	JMS Stylet-Oil	Paraffinic oil	1 gal	Fireblight, Mites, Other arthropod eggs	
Green Tip	Cueva	Copper Octanoate	2 gal	Fireblight, Scab, Powdery mildew	
	Double Nickel 55	*Bacillus amyloliquefaciens* strain D747	1 qt	Fireblight, Scab, Powdery mildew	
	JMS Stylet-Oil	Paraffinic oil	1 gal	Fireblight, Mites, Other arthropod eggs	
Green Tip	Isomate CM/OFM TT	Pheromone	200 ties/A	Codling moth, Oriental fruit moth	Full rate, double rate on borders. Hang them as high as possible in the tree
Full Bloom	Lime Sulfur	Calcium Polysulfide	1-2 gal	Thinning	2 applications based on the Pollen Tube Growth Model
	Stylet Oil	Paraffinic oil	1 gal	Thinning	Could also use Regalia
First Bloom to Petal Fall	Cueva	Copper Octanoate	1 gal	Fireblight, Scab, Powdery mildew	
	Double Nickel 55	*Bacillus amyloliquefaciens* strain D747	1 qt	Fireblight, Scab, Powdery mildew	
Petal Fall	Pyganic 1.4L	Pyrethrum	4 fl oz	Apple sawfly, Plum curculio	Could also use Azera (neem + pyrethrum)
	Microthiol Sulfur	Elemental sulfur	5 lb	Scab, Powdery mildew	
1st Cover	DiPel DF	*Bacillus thuriagiensis*	2 lb	Leafrollers	
	Madex HP	Granulosis Virus	1.5 oz	Codling moth, Oriental fruit moth	Start at 250 degree days after codling moth biofix
	Microthiol Sulfur	Elemental sulfur	5 lb	Scab, Powdery mildew	
	Epsom Salts	Magnesium sulfate,heptahydrate	15 lbs	Magnesium	
	Solubor	Boron	1 lb	Boron	
	Aquapower	Fish powder	2.5 gal	Nitrogen	
2nd Cover	DiPel DF	*Bacillus thuringiensis*	2 lb	Leafrollers	
	Madex HP	Granulosis Virus	1.5 oz	Codling moth, Oriental fruit moth	
	Grandevo	*Chromobacterium subtsugae*	2 lb	Codling moth, Oriental fruit moth	
	Microthiol Sulfur	Elemental sulfur	5 lb	Scab, Powdery mildew	
	Zinc chelate (8%)	Chelated zinc	2 qt	Zinc	
	Aquapower	Fish powder	2.5 gal	Nitrogen	
3rd Cover	Madex HP	Granulosis Virus	1.5 oz	Codling moth, Oriental fruit moth	
	DiPel DF	*Bacillus thuringiensis*	2 lb	Leafrollers	
	Microthiol Sulfur	Elemental sulfur	5 lb	Scab, Powdery mildew	If needed or switch to Regalia
	Epsom Salts	Magnesium sulfate,heptahydrate	15 lbs	Magnesium	
	Solubor	Boron	1 lb	Boron	
	Aquapower	Fish powder	2.5 gal	Nitrogen	
4th Cover	Grandevo	*Chromobacterium subtsugae*	2 lb	Potato leaf hopper	Could also use Neem oil or Azera
	Zinc chelate (8%)	Chelated zinc	2 qt	Zinc	
	Aquapower	Fish powder	2.5 gal	Nitrogen	
	Aza-direct	Neem oil	16 oz	Japanese beetles	If needed, could also use Pyganic or Azera
5th Cover	Cueva	Copper Octanoate	2 qt	Fruit rots	
	Entrust	Spinosad	6 oz	Apple maggot, Codling moth	
	Aza-direct	Neem oil	16 oz	Japanese beetles	If needed, could also use Pyganic or Azera
6th Cover	Cueva	Copper Octanoate	2 qt	Fruit rots	
	Entrust	Spinosad	6 oz	Apple maggot, Codling moth	
	Aza-direct	Neem oil	16 oz	Japanese beetles	If needed, could also use Pyganic or Azera

Courtesy Greg Peck, Cornell University

Choosing products

Many materials will treat multiple pests, while some will only target a specific pest.

Choose materials based on:

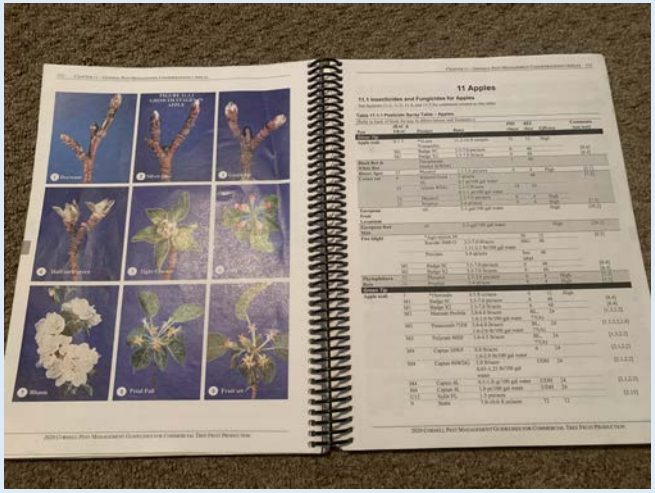
- what you have a problem with at that given time
- their efficacy for those pests
- how they act (mode of action)
- safety

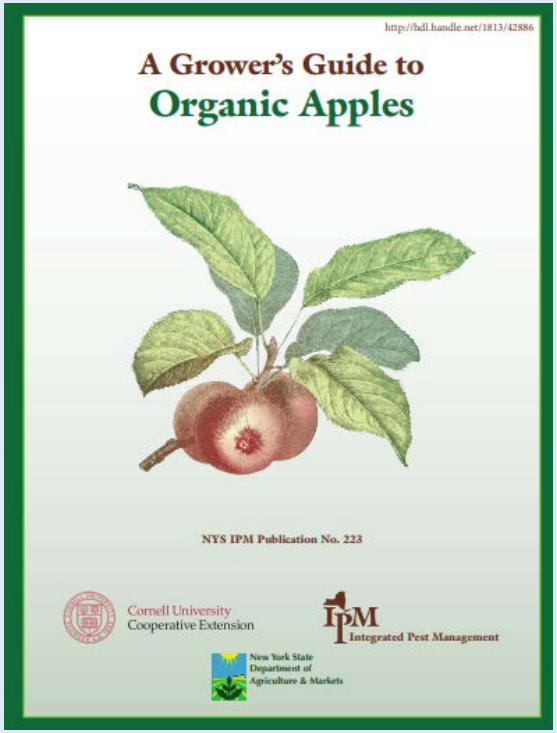
Rotate between different materials to reduce the risk of pesticide resistance

- single site fungicide materials
- insecticides
- check labels

PRODUCT	APPLE SCAB	POWDERY MILDEW	CEDAR APPLE RUST	SOOTY BLOTCH FLYSPECK	BLACK ROT WHITE ROT	BITTER ROT	FRAC CODE
Aprovia	1	1	4	4	4	4	7
Captan	1	4	4	2	1	2	M4
Copper	3	-	-	-	-	-	M1
Double Nickel	3	-	-	-	-	-	F6
Flint	1	1	3	1	2	2	11
Flint Extra	1	1	3	1	2	2	11
Fontelis	1	1	1	-	-	-	7
Indar	1	1	1	1	-	-	3
Inspire Super	1	2	1	1	-	-	3+9
Lime sulfur (Sulforix)	2	2	-	-	-	-	M2
Luna Sensation	1	1	1	1	1	1	7+11
Luna Tranquility	1	1	-	-	-	-	7+9

1 = high; 2 = moderate; 3 = low; 4 = very low to none; - = not registered/no efficacy





https://blogs.cornell.edu/treefruit/ipm/

Post Harvest: Not done yet!

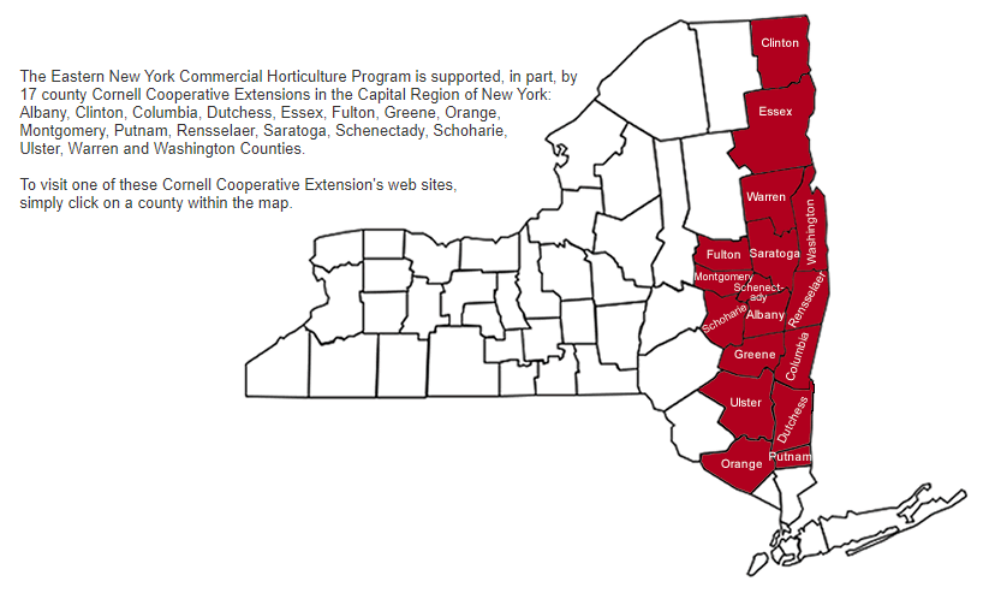
5% solution of urea after leaf fall

- 40 pounds feed grade urea in 100 gallons water
- Apply at 100 GPA

Flail mow to further break up leaves

Mark trees to spot diseased areas to take them out during the winter

- Consider Enrolling the in **Eastern New York Commercial Horticulture Program**



Cornell ENYCHP Tree Fruit E-Alert for May 25, 2020 @ 9:30 pm

In this E-Alert

- Champlain Valley Virtual Thinning Meetings Scheduled
- Frightful Fire Blight Model Cases for Your Review
- Major Scab Infection/s Possible 25-30 or 28-29 May All Eastern NY
- Hudson Valley: Input Last Strep Spray Date in NEWA Fire Blight Model to Time Next Spray; Lake Champlain Valley: First Fire Blight Infection/s 25, 26 May (!)
- The NEWA Apple CHO Thinning v2019 model has Replaced the Original for 2020
- Capital Region Virtual Thinning Meeting #2 Wednesday May 27 at 4pm.
- COVID-19 Safety Plans Required for All Businesses in “New York Forward”
- Capital Region Petal Fall Meeting #1 Now Available on YouTube.
- Hudson Valley Thinning Zoom Meeting #2 Video Now Available on YouTube.
- Zoom Webinar Tutorial – How to Join and Participate

Additional Resources

Cornell blog posts from Peter Jentsch and Dr. Srdjan Acimovic at the Hudson Valley Research Lab

Acknowledgements

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