

Blueberry Production

A to Z

Mark Longstroth
Extension Fruit Educator



Blueberries

- Minor fruit crop of American origin
- Perennial shrub
- New shoots from crown every year
- Bears fruit on last-year's wood
- Requires pruning to maintain young shoots
- Requires moist soils

Growing Blueberries

- Requires Special Soils
- Soil pH 4.5 to 5.5
- Usually Acid Sands or Acid Mucks
- Soil Should be Moist, But Not Wet
- Originally a Wetland Plant

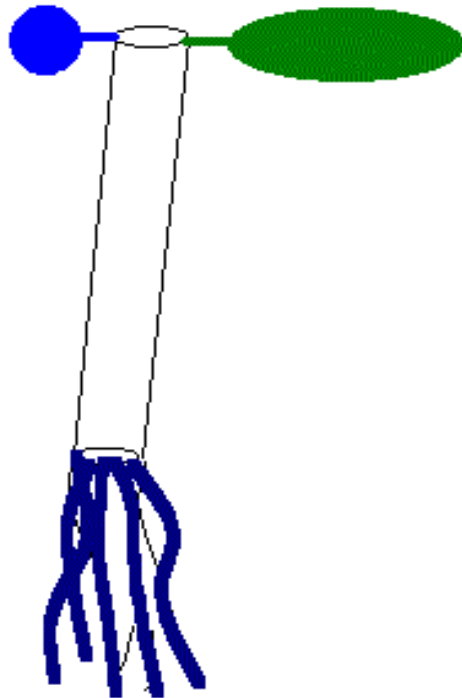


Blueberry sites

- Porous soils with high water tables.



Basic Plant Physiology



- Stems
- Leaves
- Roots
- Fruit
- All made of cells
- Cell growth
- Growth from meristems
- Competition

Plant Growth

Three ways that plants grow.

- Cell Division
- Cell Expansion
- Cell Differentiation

Cell Division occurs

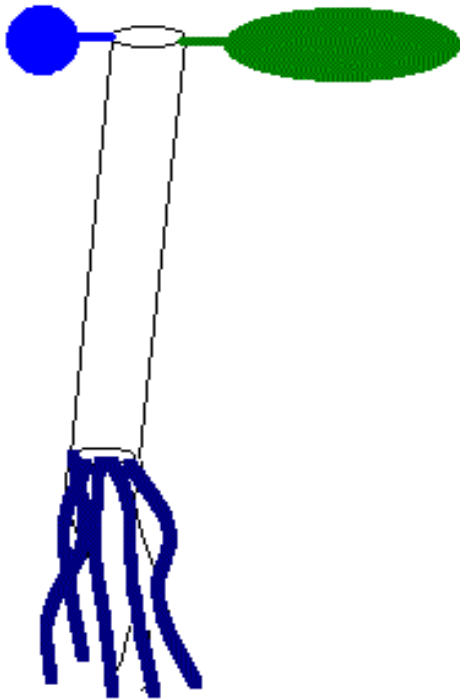
- Apical meristems (shoot and root tips)
- Cambium (cell layer makes wood & bark)

Plant Organs

- Stems
- Buds
- Leaves
- Flowers & Fruit
- Roots
- Annual Growth Cycle



Leaves



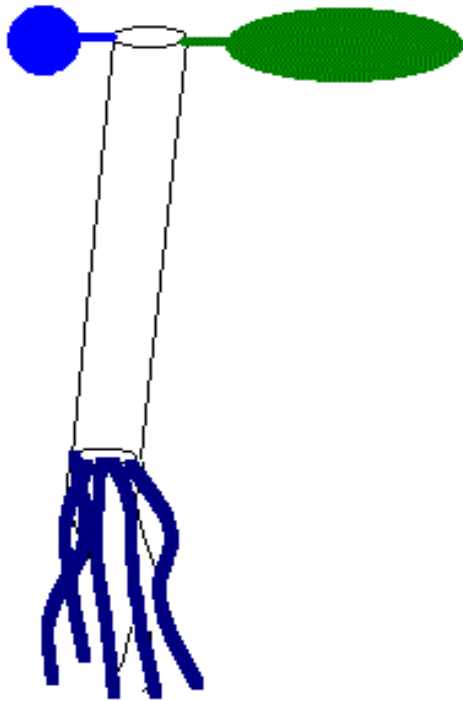
- Green - chlorophyll
- Harvest light
- Carbon Dioxide + Water =
- Sugar + Oxygen
- Photosynthesis
- Plants make their Food

Leaves



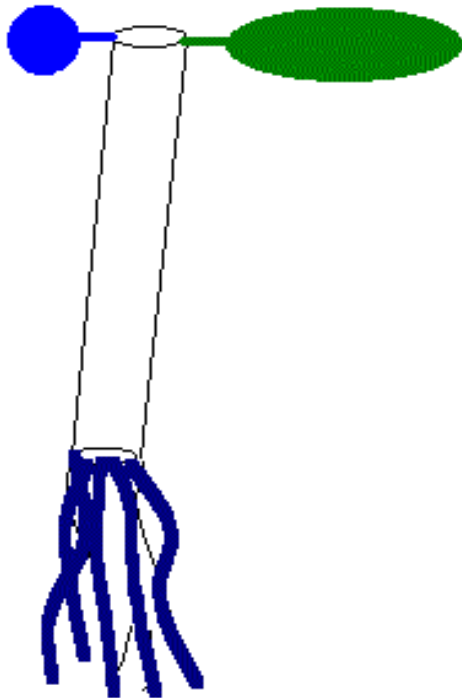
- Harvest Light - Photosynthesis
- Stomates let air in and water out
- Stomates on bottom of leaf
- Transpiration
- Leaf Structure
- Leaf designed to conserve Water

Stems



- Provide support
- Transport water from the roots (xylem) and sugars from the leaves (phloem)
- Storage of sugars and protein for later growth
- Annual Cycle of Shoot Growth and Flower Development

Roots



- Anchor plant
- Absorb water
- Absorb nutrients
- Storage

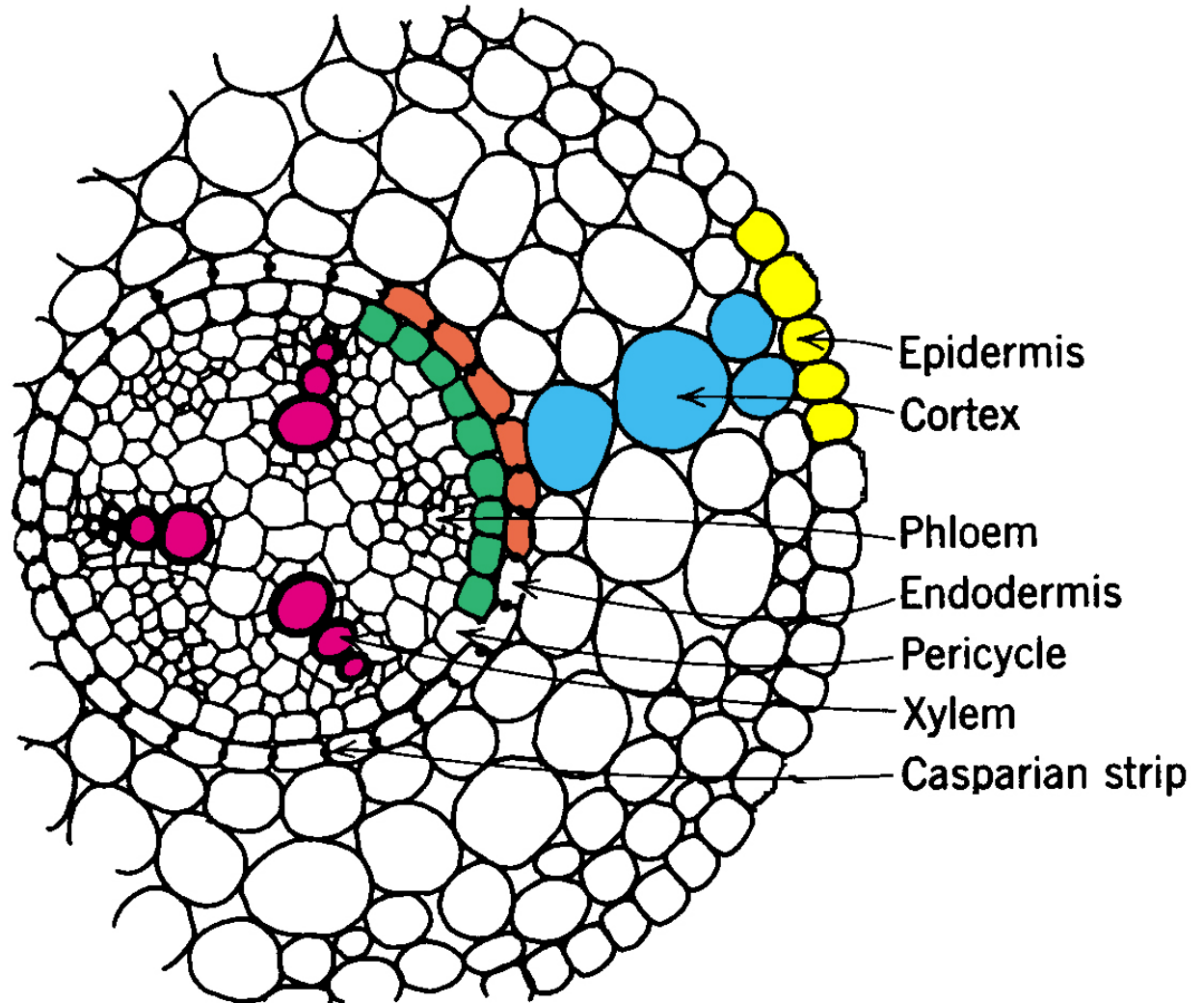
Roots

- Root Growth and Structure
- Absorb Water (passive)
- Absorb Mineral Nutrients (Active or passive)
- Root structure affects absorption
- Blueberries lack root hairs
- Mycorrhizal Fungi
- Blueberries have a small shallow root system.

Blueberry Root

Water carries
Nutrients into
Cortex

Cortex moves
nutrients past
Casparian Strip
and this draws
water into the
root



Root Growth

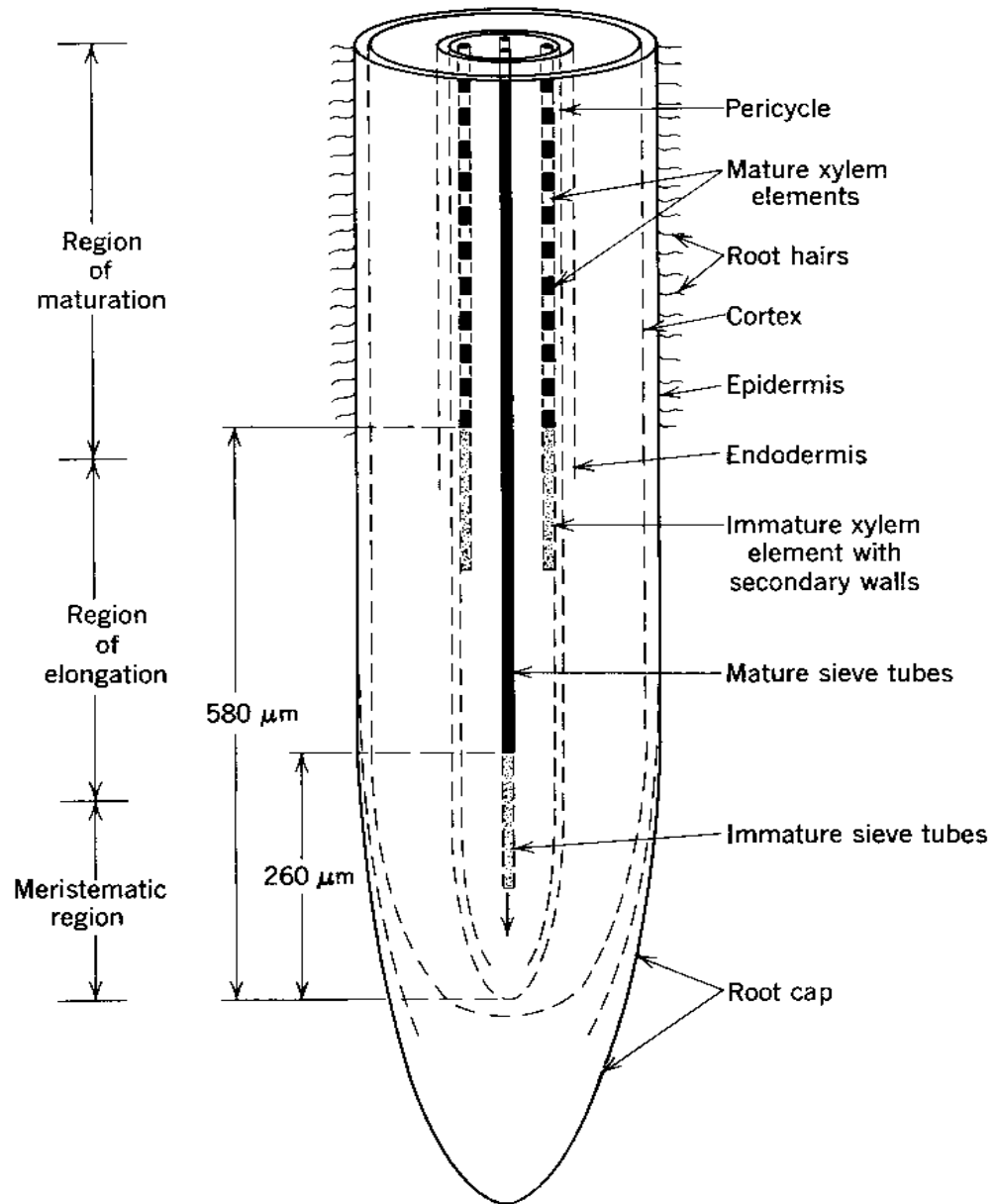
White root

Zone of Maturation

Zone of Elongation

Apical Meristem
at tip

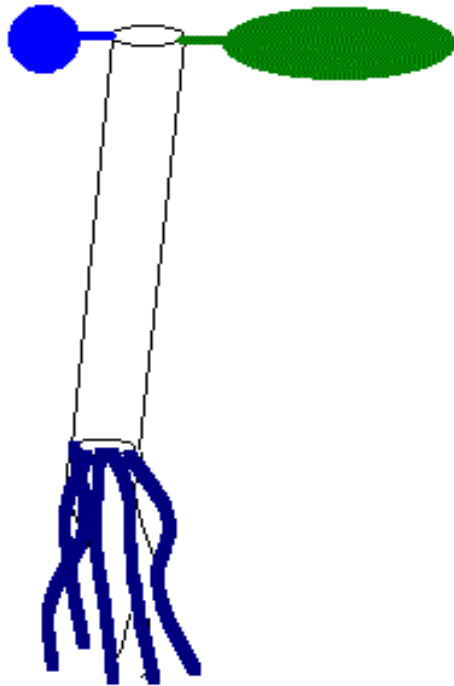
Root Cap



Blueberry Root Zone

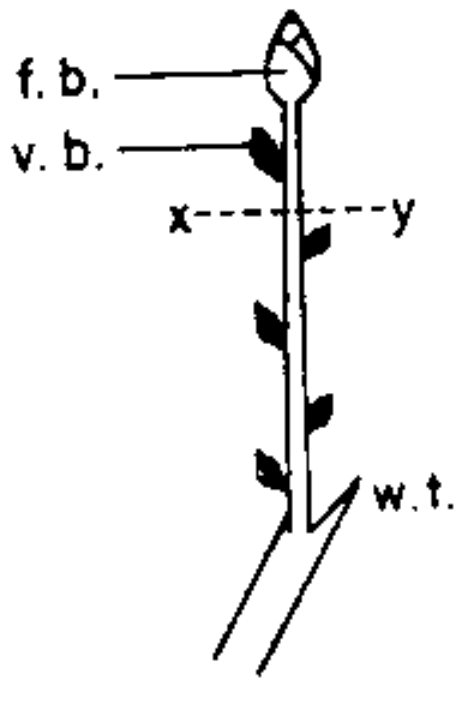


Competition



- Sources vs. Sinks
 - Sources
 - Leaves - carbohydrates
 - Roots - water
 - Storage tissues
 - Sinks
 - New growth
 - Fruit
 - New shoots
 - New roots

Annual Shoot Growth



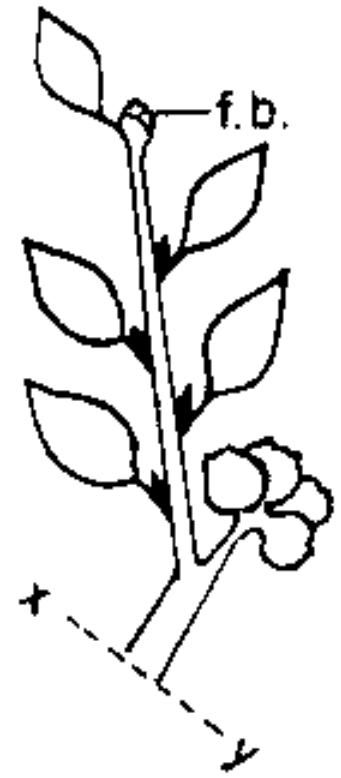
A



B

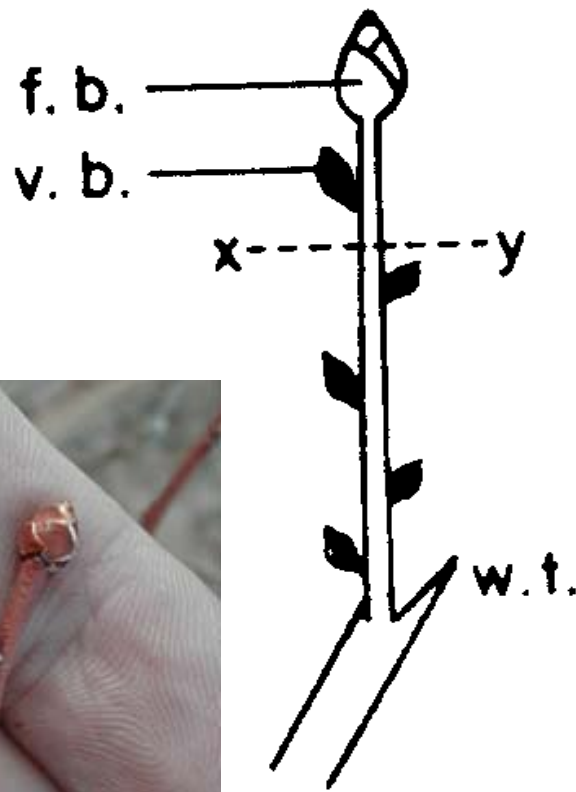


C



D

Dormant Shoot



- Fruit Buds at Tip
- Withered flower Cluster at Base
- Vegetative buds on lower nodes
- Growth begins at tip



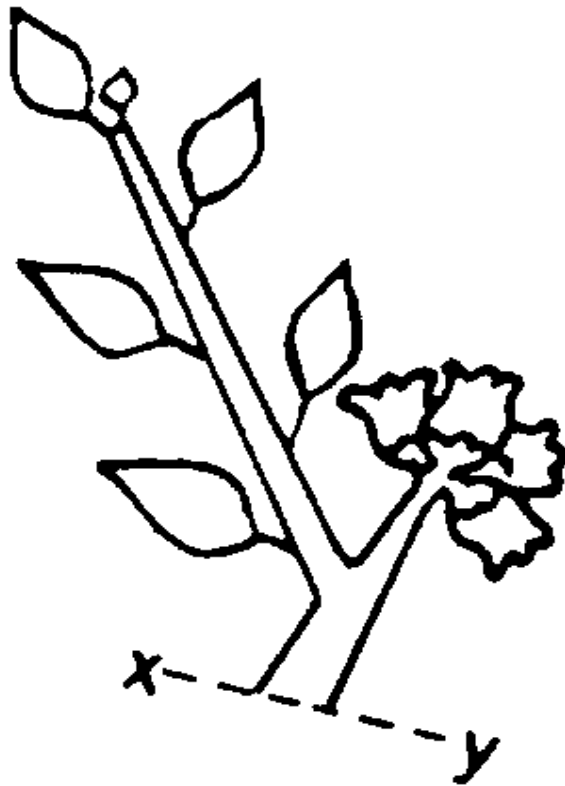
Bud break

- Flower buds swell first.
- Leaf buds begin swelling from shoot tips down the shoot.

Leaf bud stages here are:

- 4 mm green
- 2 mm green
- green tip

Spring Growth



- Flower bud opens and Blooms
- Rapid shoot expansion from vegetative buds
- Growth continues as long as conditions are good
- Buds develop in axils of leaves

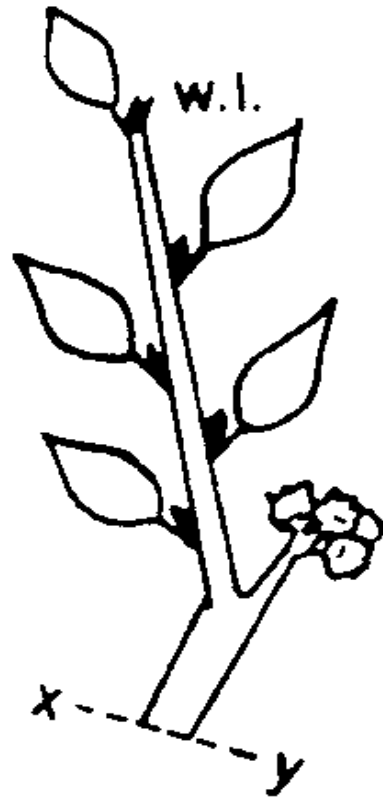
Spring Growth



Spring Growth



Mid-Summer Growth



- Shoots are competing with fruit
- Shoot tip dies
- Shoot growth stops
- New terminal bud develops in axil of uppermost leaf
- Leaf buds develop below

End of Growth Flush



- Terminal Bud Dies
- Shoot growth stops
- No new leaves
- New terminal bud develops in axil of uppermost leaf
- Leaf buds develop in all leaf axils

Bud Set - End of Growth

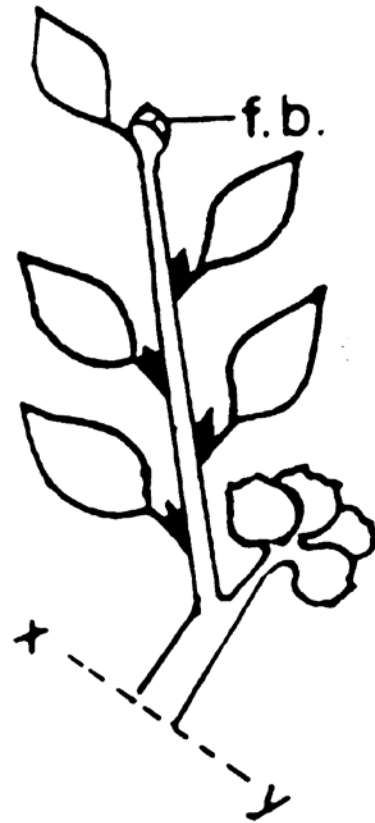


Actively Growing
New leaves at shoot tips



No Growth
No new leaves

Late Summer and Fall Growth



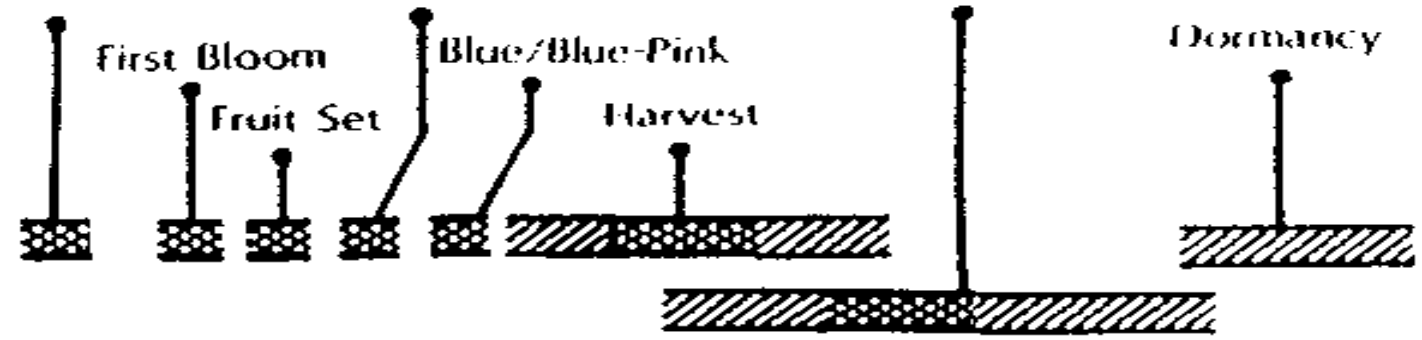
- Fruits Ripen
- Terminal bud develops into flower cluster bud
- Lower buds may develop into Flower buds also

Late Summer Flower Buds



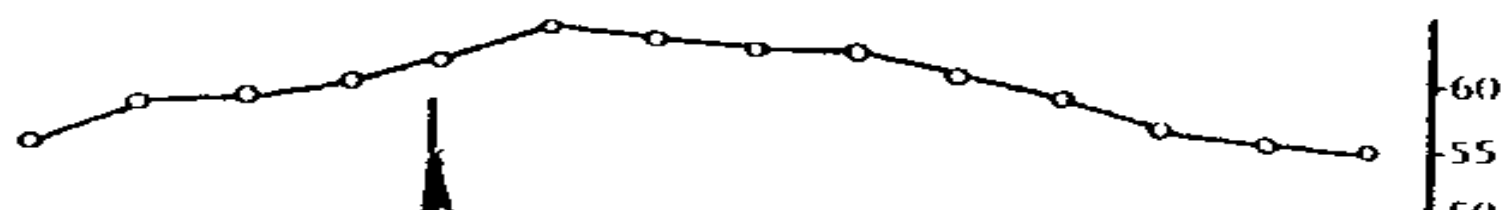
Leaf Bud Swell Immature Green Flower Bud formation

Stages of Plant Development



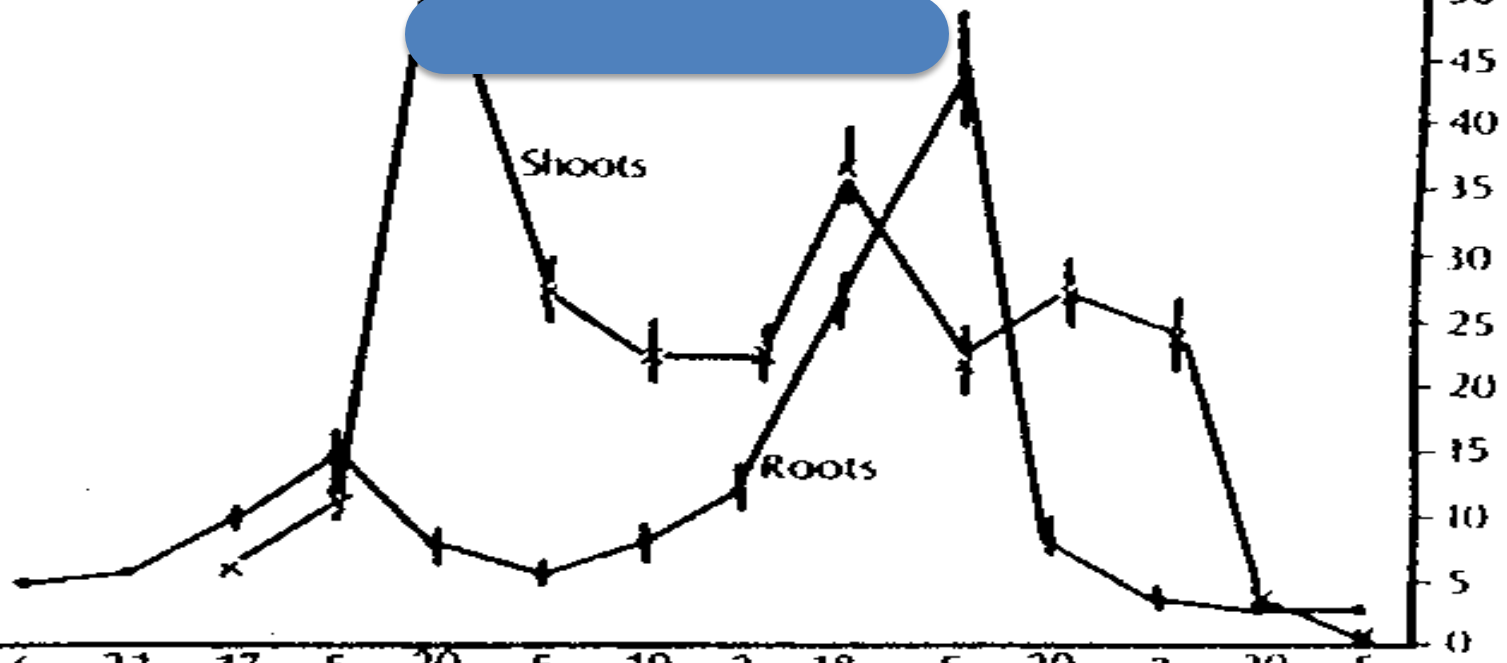
Soil Temp at 15 cm (°C)

22
19
16
13
10
7
4



Mean Length of White Unsuberized Roots (mm)

24
22
20
18
16
14
12
10
8
6
4
2
0



Mean Shoot Growth (mm)

6 21 17 5 20 5 19 2 18 5 20 2 20 5
Apr May June July Aug Sep Oct Nov
Date

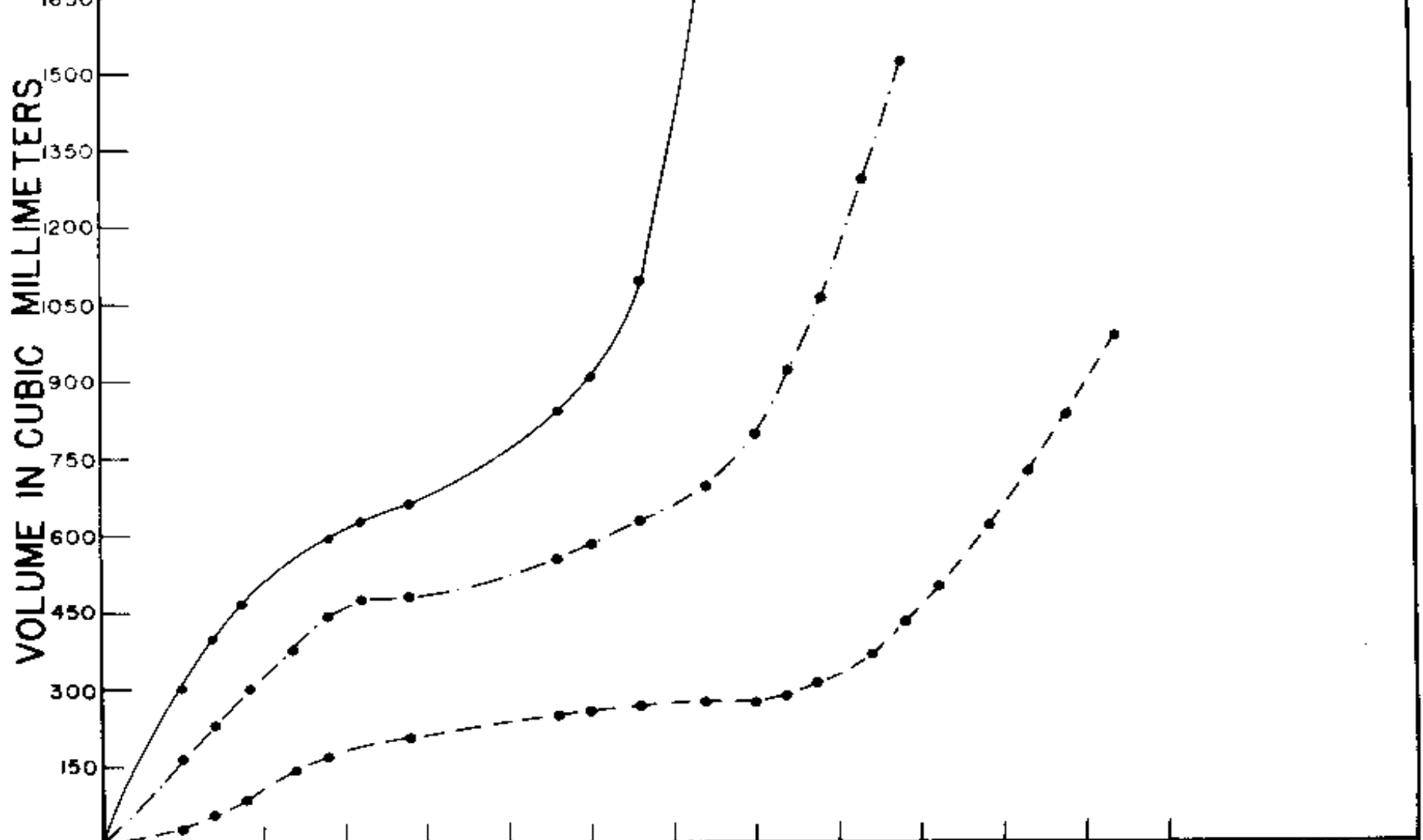
Fruit Growth



- Double Sigmoidal Growth Curve
- Competition between fruits
- First fruit are the Largest Fruit
- Small Fruit are Always Small

EARLIBLUE

— LARGE BERRY
- - - MEDIUM BERRY
- - - SMALL BERRY



GROWING SEASON

Shoot Fruitfulness

- Fruit buds form on last year's wood!
- Vigorous shoots usually have lots of flowers and grow vigorous new shoots for next years crop.
- Less vigorous shoots have few buds on only one or two small shoots with one fruit bud.
- The most fruitful canes are 4 to 6 years old.



Benefits of Mulches

- Increase Organic Matter
- Provide micronutrients increasing fertility of topsoil.
- Increase water holding capacity of soil
- Cool soil in hot summer
- Blueberry roots love the interface between the mulch and the soil.
- Just like Home!

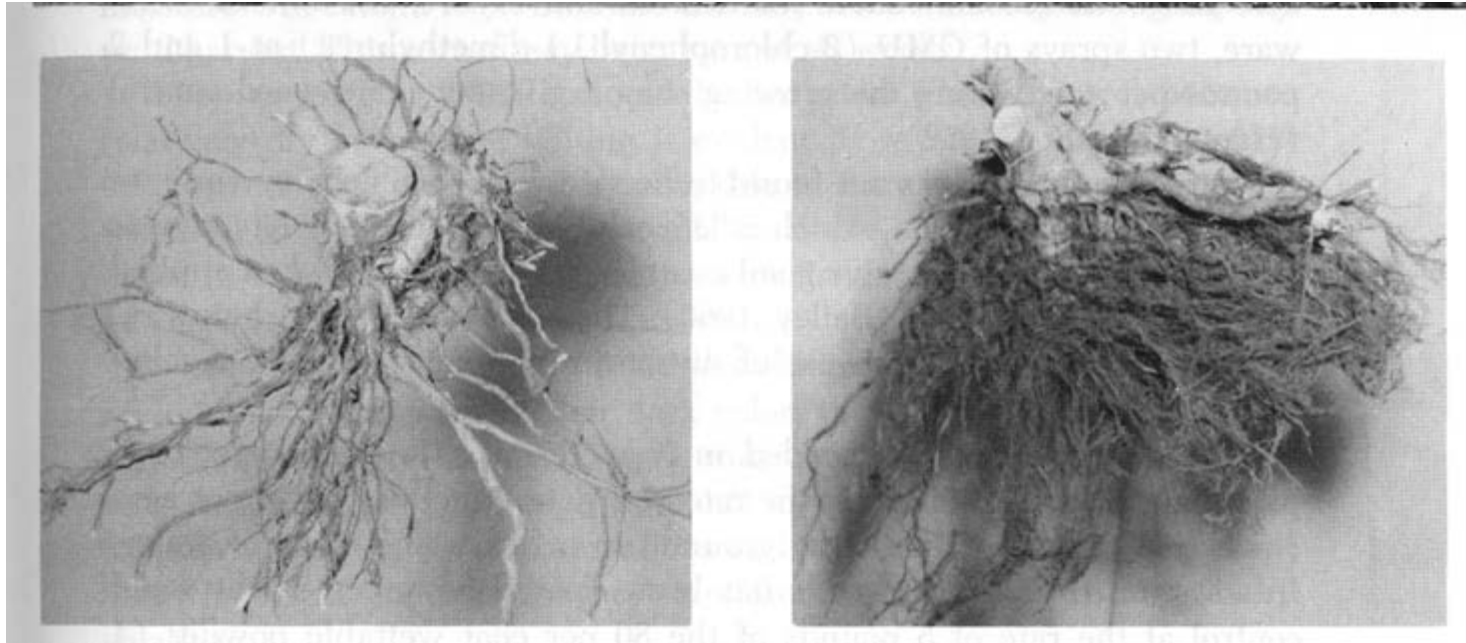


Mulching



- These 3-year old blueberries were both grown in silty clay loam but the one on the right received a 6 inch sawdust mulch

Mulching and Root Growth



- Mulching increases fine root numbers.

Blueberry Sites

- Low pH soils. Below 6!
- Moist soils, ability to irrigate, or drainage



Blueberry Sites

- There are almost always problem spots in the field!
- Fixing the problem may cost more than it is worth



Blueberry Establishment: Does and Don'ts

- Preplant decisions
 - Choosing the right site.
 - Preparing the site.
- Planting mistakes
- Cultural mistakes
 - Irrigation
 - Herbicides
 - Mulching

Site Analysis

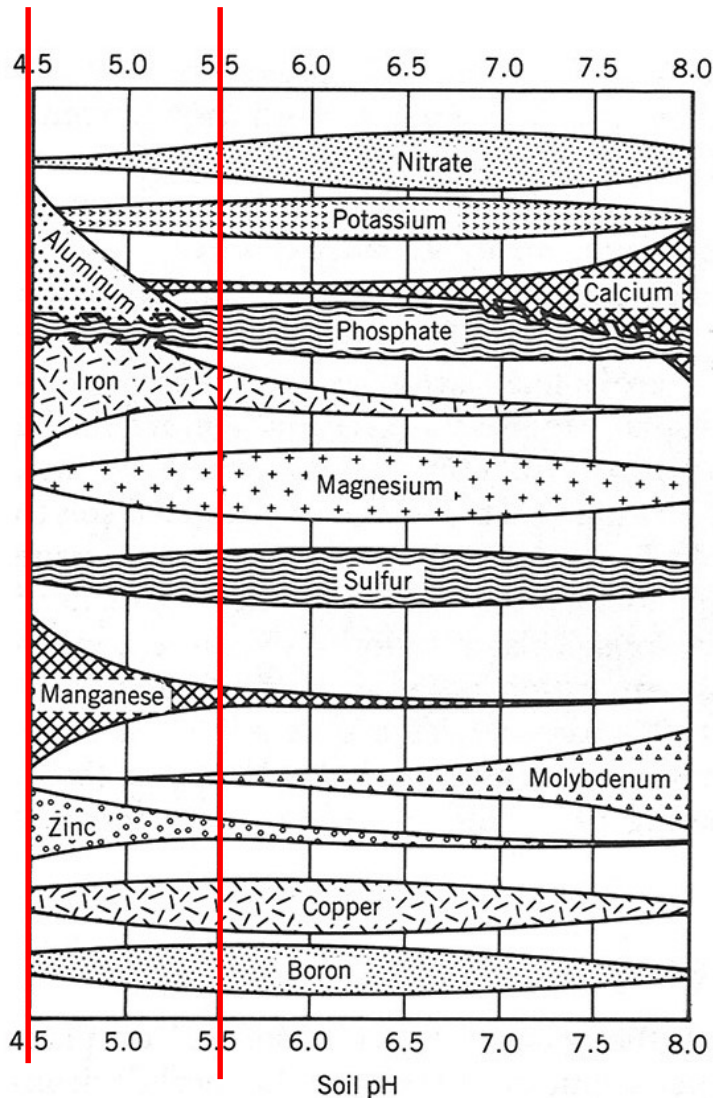
- **Is this a blueberry site?**
- Soil pH
 - Is an acid soil
 - Can I make it acid enough for blueberries.
- Naturally moist soil.
 - Poor drainage.
 - Water table close to surface.
- Is drainage needed?



Blueberry Site Preparation

- Determine soil pH with a soil test.
 - Below pH 5.5
 - Best between pH 5 – 4.5
- Use Sulfur to lower pH
 - 500#/A, sand from pH 6 to 4.5
- Order plants.
- Control perennial weeds.
- Determine if drainage needed
- Prepare irrigation system.

Soil pH and Availability



- Solubility and availability of most minerals is influenced by soil pH.
- Extreme pH can cause mineral deficiencies or mineral toxicities.

This blueberries has an Iron deficiency from a high soil pH



Lowering Soil pH

- Ammonium nitrogen fertilizers
Ammonium sulfate slowly lowers pH.
- Elemental sulfur can be used before planting to really lower the pH.
- Iron sulfate (6 times sulfur requirement)
- Acids in irrigation water

Lowering Soil pH with Sulfur

- Is not a rapid chemical reaction.
- Bacteria use the sulfur for energy and change the sulfur to sulfuric acid.
- It is a slow biological process.
- Soil must be moist. Not Wet! (hydrogen sulfide kills)
- Soil temperature must be 55 F (13 C).
- Conversion takes place in the summer and fall, nothing in winter and early spring.
- Don't apply more than 500 lb/A to annually blueberries or you can injure the plants

Lowering Soil pH with Sulfur

Sulfur needed to lower soil pH to 4.5			
	Soil Type		
Soil pH	Sand	Loam	Clay
5.0	175	530	800
5.5	350	1030	1600
6.0	530	1540	2300
6.5	660	2020	3030
7.0	840	2560	3830

Planting: Dos and Don'ts

- **Don't** plant before soil amendments have worked.
- **Do** break up the root ball when planting.
 - Roots never come out of the peat!
 - Small root mass dries quickly.
- **Do** add peat to the planting hole.
- **Do** mulch the plants
- **Do** Irrigate the planting



Blueberries

Breakup root ball

May need to add organic matter in planting hole.

The peat pot of this plant is clearly visible and dries out quickly.

A good candidate for mulching

Planting Blueberries

- Breakup root ball
- Organic matter added in spring and fall
- Planting in fall is common in Michigan.
- New production systems to bring fields in quicker production.



Planting Blueberries



- Wood chip and sawdust mulch
- Double irrigation lines.
- Above the surface to avoid animals and ease maintenance.
- Weeds in mulch.



y Blueberries

- Woven plastic mulch
- Double irrigation lines in the bed.
- Trickle irrigation allows fertigation
- Need to avoid over fertilization and excess vigor.

Fertilizing Blueberries

You need to use the correct nutrients

Optimize Fertility

- **Soil tests** reveal what is in the Soil, not what the plants is getting from the soil.
- **Leaf Analysis**, Tissue tests reveal what nutrients are in the plant and if any are deficient.
- **Law of the Minimum:** Plant growth is dependent on essential elements and growth will be limited if one of these elements is limited. When that essential elements is added the plants growth is contained by another deficient element.
- **Luxury Consumption**, when an element is abundant the plant will absorb more than it needs. Can cause deficiencies.

Fertilizing Blueberries

- For annual plants corn, tomatoes
More fertilizer = bigger plant, higher yield
- Blueberries are perennial plants
Nutrients are recycled from year to year
Fertilizer this year increased growth this year
Increased yield next year
Too much fertilizer = too much growth
Too much shoot growth reduces yields.

Fertilizers

- Too much fertilizer can cause more problems than not enough.
- Foliar nutrients are OK but can also be overdone.



Nitrogen Fertilizers

- Annual applications,
- Use only ammonium N,
- Split application are best.
 - Bud break & after bloom
- More on sandy soil, less on heavier or organic soils
- Mulching increases demand for Nitrogen.
- Need to adjust Nitrogen based on growth and crop



Nitrogen Fertilizers

- Urea 46-0-0
Use if soil pH is below 5
- Ammonium Sulfate (AMS) 21-0-0
Use if soil pH is above 5 to lower soil pH
- Cost per pound of nitrogen is important, not cost of fertilizer.
- Urea is \$605/ton and 46% N **920# N**
- Urea N is \$0.66 a pound
- AMS is \$390 and 21% N **420# N**
- AMS N is \$0.97 a pound?

Nitrogen per Acre

Nitrogen Recommendations for Michigan Blueberries(lb/acre, broadcast).			
Age (years)	N	Urea	Ammonium sulfate
2	15	35	75
4	30	70	150
6	45	100	215
8	65	150	300

Nitrogen per Plant

Nitrogen Recommendations for Michigan Blueberries (oz/plant).			
Age (years)	N	Urea	Ammonium sulfate
2	0.2	0.4	1.0
4	0.3	0.65	1.5
6	0.5	1.0	2.5
8	0.7	1.5	3.3

Fertilizers

- If you fertilize plants individually,
Do not put the fertilizer on the plant.
- Put the fertilizer in a loose ring at least 6” from the plant.
- Don’t burn the roots off with salt.



Soil Nutrient Levels

- Nutrient levels are higher in heavier clay soils and organic than sandy soils,
- Relative proportions of nutrients is an important measure of status.
- A suitable balance of soil Ca, Mg, and K as percent of exchangeable bases,
 - 60-80% Ca,
 - 15-30 % Mg,
 - 10-15% K.

Phosphorus Fertilizers

Most phosphorus fertilizer do not dissolve well in acid soils, these do.

- **MAP** Monoammonium phosphate
11-48-0
- **DAP** Diammonium phosphate
18-52-0
- **APP** Ammonium Polyphosphate
15-62-0

Potash Fertilizers

- Potassium Sulfate 0-0-50
- Potassium Magnesium Sulfate
(Sul-Po-Mag) 0-22-0-11-22
N-P-K-Mg-S
- Potassium Chloride 0-0-60

Blueberry Nutrition

- Blueberries are perennial plants and recycle their nutrients from year to year.
- Soil availability of nutrients is a poor measure of how to fertilize the plant.
- Tissue tests measure how much of each nutrient is in the plant.
- Tissue tests are taken in late July.

Blueberry Leaf Analysis

Nutrient	Deficient	Sufficient	Excess
N %	< 1.7	1.7 – 2.1	2.3
P %	< .08	0.08 – 0.4	0.6
K %	< 0.35	0.4 – 0.65	0.9
Ca %	< 0.13	0.3 – 0.8	1.0
Mg %	< 0.10	0.15 – 0.3	-
E-2011: Managing the Nutrition of Highbush Blueberries			

Irrigating Blueberries

If you don't water them they won't grow

Water

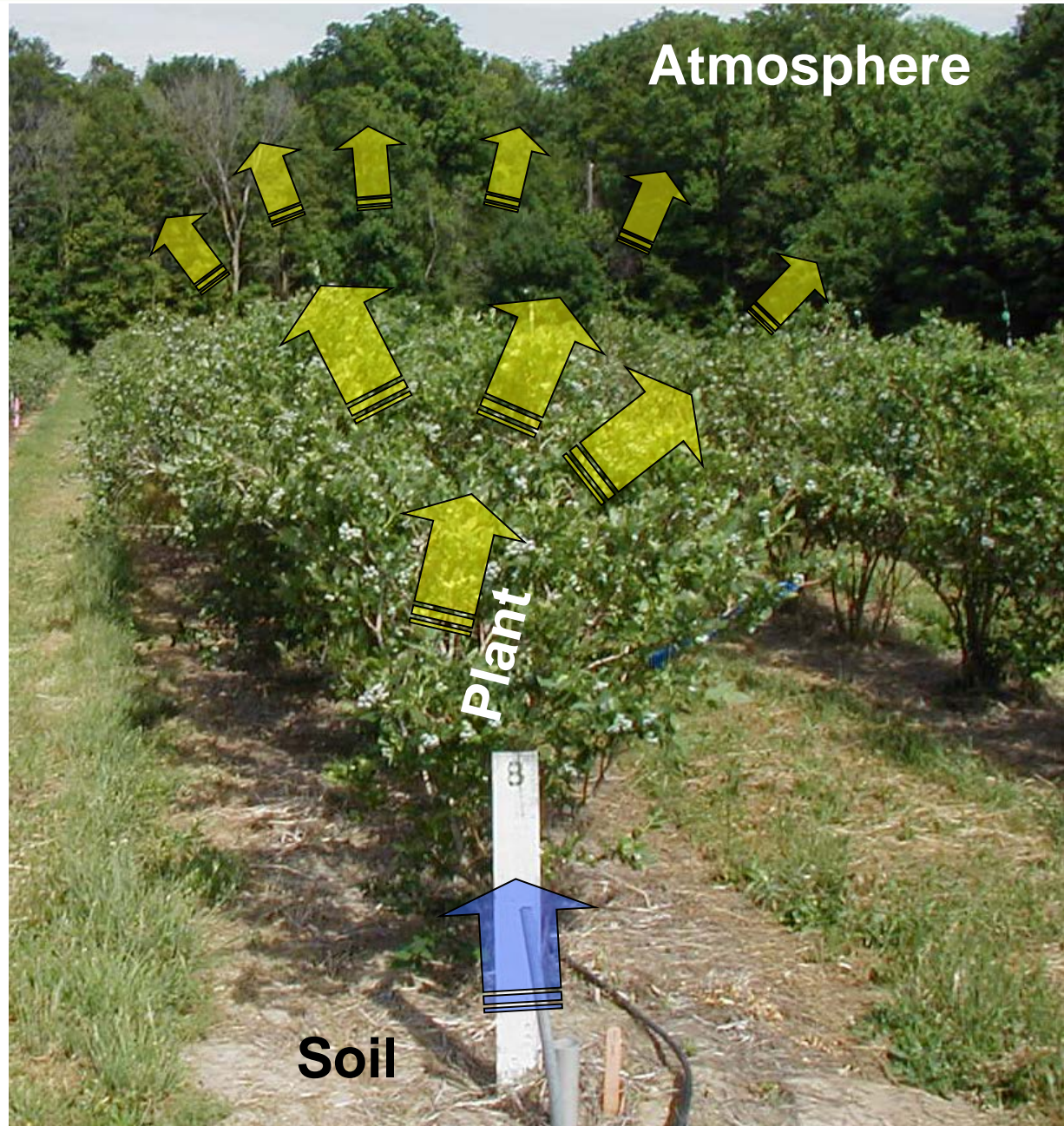
- Vital to Chemistry-Photosynthesis
- Transports materials
- Vital to Growth - Expansion
- Reduced water = smaller plants
 - Smaller stems, leaves, fruits
- Reduced water = more roots

Plant Water Use

- Plants use little water if they have no leaves.
- As the leaves grow, water use increases (Photosynthesis, transpiration).
- Organs grow by expansion.
- Pumped up by water.

Soil Plant Atmosphere Continuum

Evaporation pulls water out of the soil into the plant



Minimum Demand



Maximum Demand



Water Management

- Irrigation adds supplemental water and maintains water in the soil.
- Drainage removes excess water.
- Mulching reduces evaporation and moderates soil temperature.
- Blueberries have a small shallow root system.

Why Irrigate Blueberries

- Plant Growth is Dependent on Water.
 - Shoot Growth
 - Fruit Growth
 - Fruit Set for Next Year
- Blueberries do not manage water well.
- Moist soil is required for good blueberry growth.

Drought Stress



Drought

- Lack of water reduces photosynthesis and causes wilting
- Reduced growth and reduced food reserves available for growth
- Available reserves are shifted to the roots.
- Fruit compete for available reserves

Drought



Drought



Irrigation

- How much water is the plant using?
 - How much water can the soil hold?
 - How much water can you apply?
 - How much rain have you received?
-
- Soil should be recharged when soil water is 50% of capacity.

Water Deficit

- Soil Water Storage
- Plant Water Use
 - Evapo-transpiration
- Precipitation
- Irrigation

Soil Water Management

- Sandy soils do not hold much water
- Smaller more frequent irrigations that do not over fill the soil are better than heavy irrigation cycles that may wash nutrients from the soil.

Soil Water Holding Capacity

Soil Texture	in/in	In/ft
Sand	0.07 - 0.10	0.84 – 1.20
Sandy Loam	0.09 - 0.15	1.08 – 1.80
Loam	0.14 - 0.19	1.68 – 2.28

Water Use in Blueberries

Month	Monthly Use	Weekly Use	Daily Use
May	0.48	0.12	0.02
June	2.87	0.72	0.10
July	5.09	1.26	0.17
August	2.13	0.53	0.07

Soil Water Holding Capacity

Soil Texture	In/ft	in/18 in
Sand	0.84 – 1.20	1.26 – 2.40
Sandy Loam	1.08 – 1.80	2.16 – 3.60
Loam	1.68 – 2.28	3.36 – 4.56

Water Management

- Sandy soils do not hold much water
 - 1 to 2 inches
- Irrigation should be about half of soil capacity.
- Continually recharge as soil gets to 50% of soil moisture.

Irrigation in Blueberries

Month	Weekly Use	Soil holds 1 in	50%
May	0.12	8 weeks	4 weeks
June	0.72	10 day	5 days
July	1.26	5.5 days	2.5 days
August	0.53	13 days	1 weeks

Irrigation in Blueberries

Month	Weekly Use	50% recharge
May	0.12	Every other week
June	0.72	Every 5 days
July	1.26	Every 3 days
August	0.53	Every week

Irrigation Types

- Trickle
 - Cheap
 - Slow application rate
- Sprinkler
 - Expensive
 - Lots of water,
 - Frost protection



Blueberry Water Measurements

- Acre inch = 27,156 gals
- .2 inches = 5,431 gals
- 1452 blueberry plants / acre
(10' rows and 3' between plants)
- 3.7 gal/plant/day ~ 4 gal/day
- Critical times – May to September
Bloom > berry sizing > flower bud forms
- 2 inches a week during hot harvest!

Pruning



- Remove older less productive wood
- Directs growth into new wood which is more fruitful.
- Better distribution of fruit buds by avoiding lots of short shoots with single buds.



Pruning Young Bushes

First 2 seasons:

- Remove flower buds (strip off or prune off).
- Remove low-growing, spindly branches to encourage upright vigorous wood.



Younger Elliott



Goals: pruning mature bushes

1. Promote new replacement canes.
2. Open canopy to increase flower bud initiation, reduce disease.
3. Balance leaf area and fruit load for good berry size.
4. Shape bush so base is narrow and fruiting wood is off the ground.

Desired Cane Mix for Jersey/Bluecrop/Elliott

15-20 % young canes (1-2 year-old)

60-70 % intermediate (3-5 year-old)

15-20 % older (6 years and older)



3-5 year-old

6-8 year-old

1-2 year-old



Keep bushes upright
by removing low-growing wood.



Before



After

Blueberry Pest Management

Mark Longstroth
Extension Small Fruit Educator
Michigan State University Extension



Blueberry Diseases

- Mummyberry
- Shoot Diseases
 - Phomopsis or Fusarium
 - Shoot tip dieback
 - Anthracnose and others
- Fruit rots
 - Alternaria
 - Anthracnose
- Leaf Diseases
 - Powdery Mildew
 - Leaf rust
- Virus Diseases



Blueberry Fruit Rots



- **Anthracnose**, an orange mold appears at harvest but the infection occurred soon after bloom.
- Sprays for Anthracnose should focus on wet periods during the green fruit stage.

Anthracnose Fruit Rot

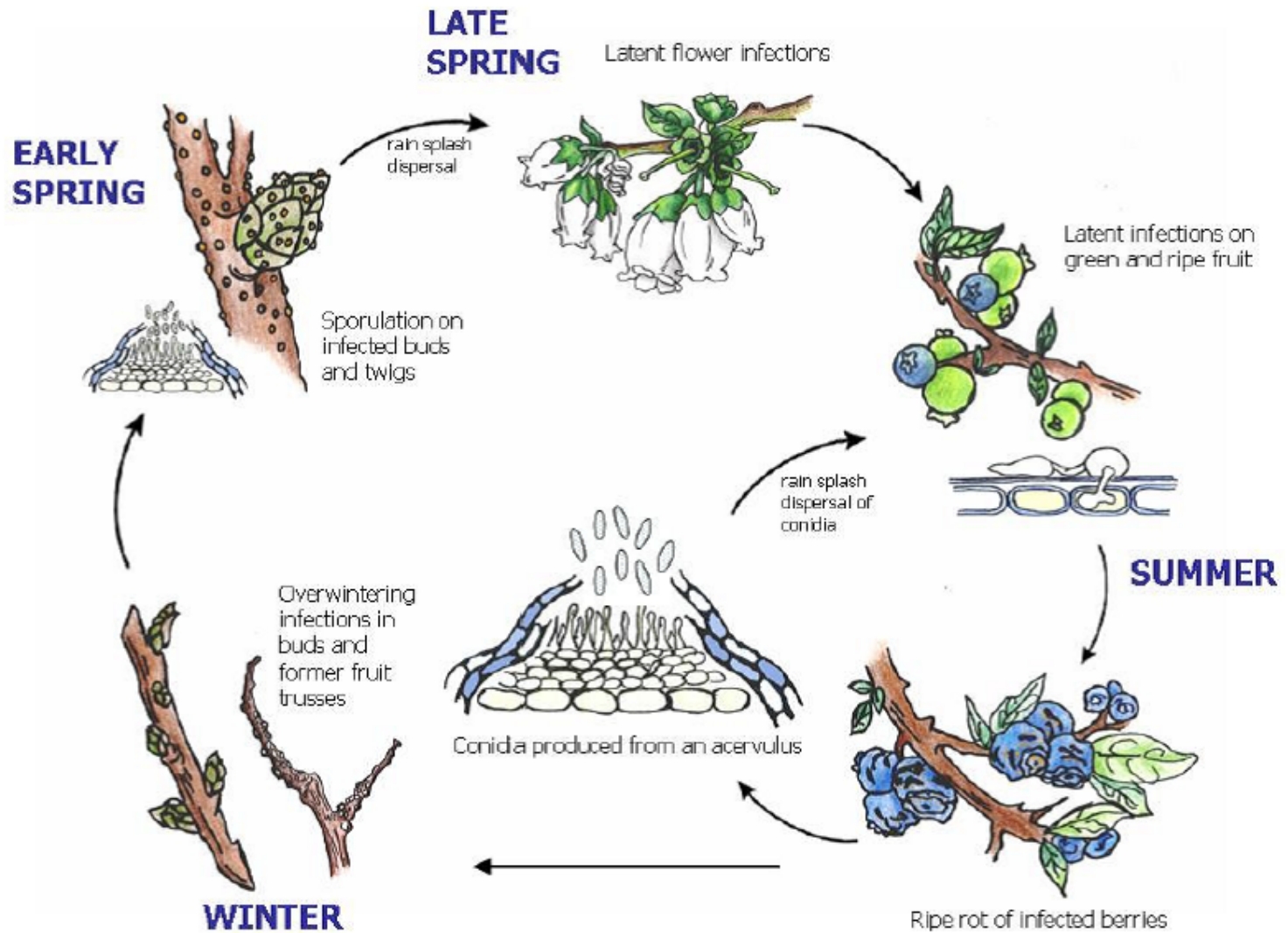


Fig. 6. Disease cycle of anthracnose fruit rot caused by *Colletotrichum acutatum* on blueberries.

Blueberry Fruit Rots

- Alternaria a black sooty mold appears on ripening fruit. The infection occurs just before harvest.



Anthracnose an orange mold also appears at harvest but the infection occurred soon after bloom.

Blueberry Insects

Direct Pests

- Cranberry Fruit Worm
- Cherry Fruit Worm
- Blueberry Maggot
- SWD
spotted wing drosophila

Indirect Pests

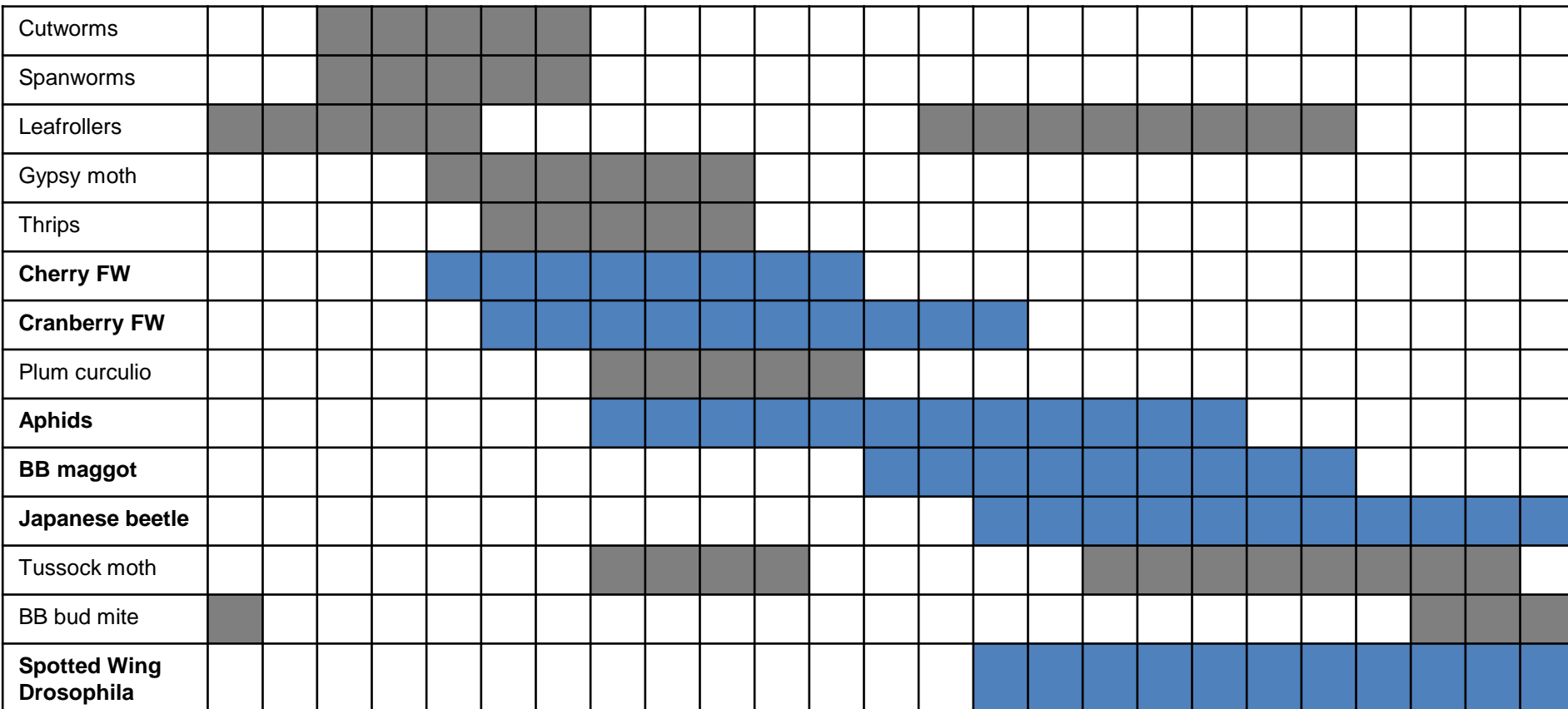
- Aphids
- Japanese Beetle



Pest activity and management periods in blueberry

Growth stage pre-bloom bloom mid-season pre-harvest harvest post-harvest

Degree days
base 50 F from March 1 100 300 400 700 1100 1300 1900 2500



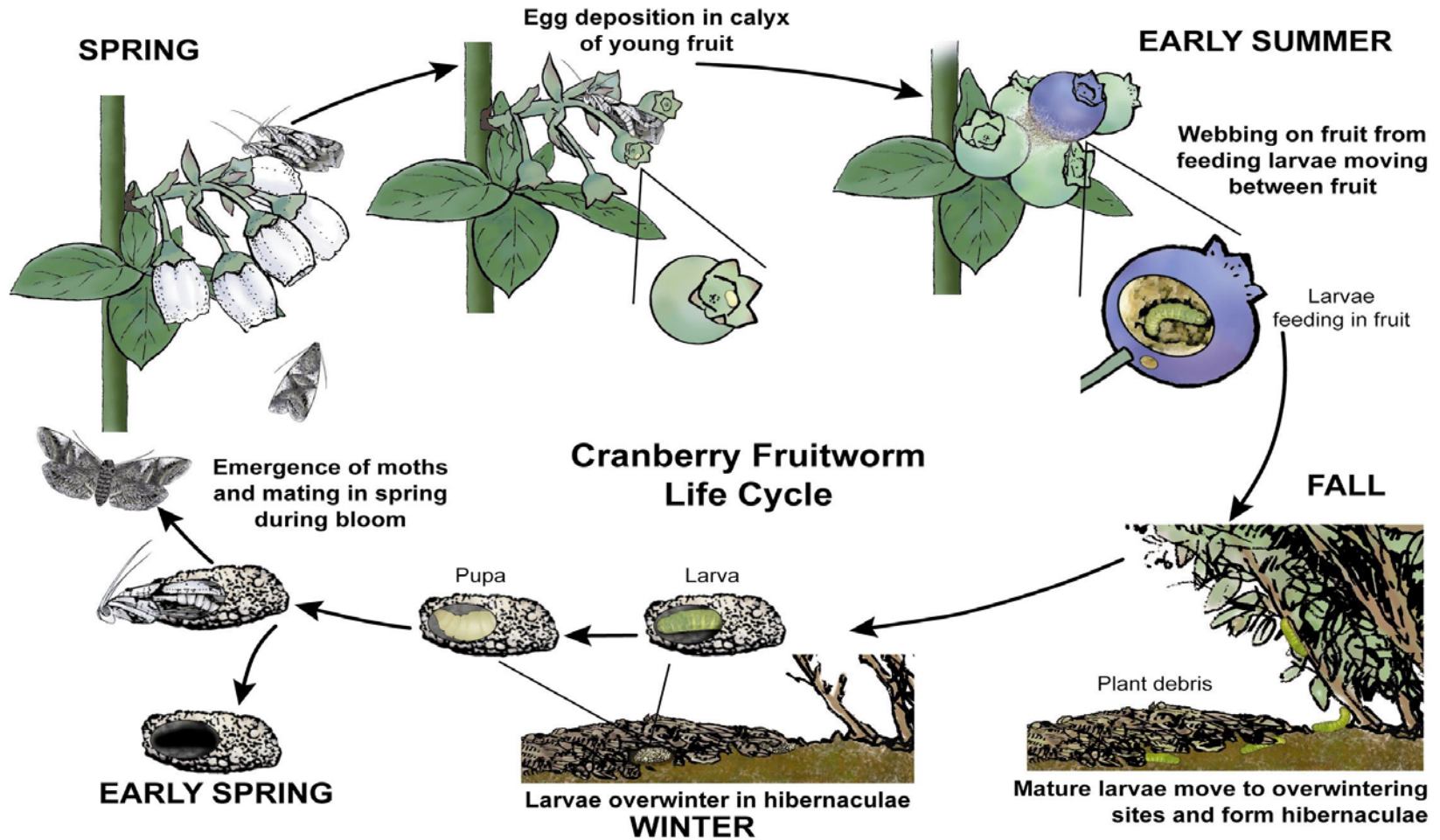
Bars show period when scouting and management of the pest is most important. Blue = key pest

Fruitworms

- Cranberry and Cherry fruit worms attack the young green fruit after bloom.
- The adults lay their eggs on the green fruit and the larvae burrow into the fruit.



CBFW Life-Cycle



Blueberry Maggot



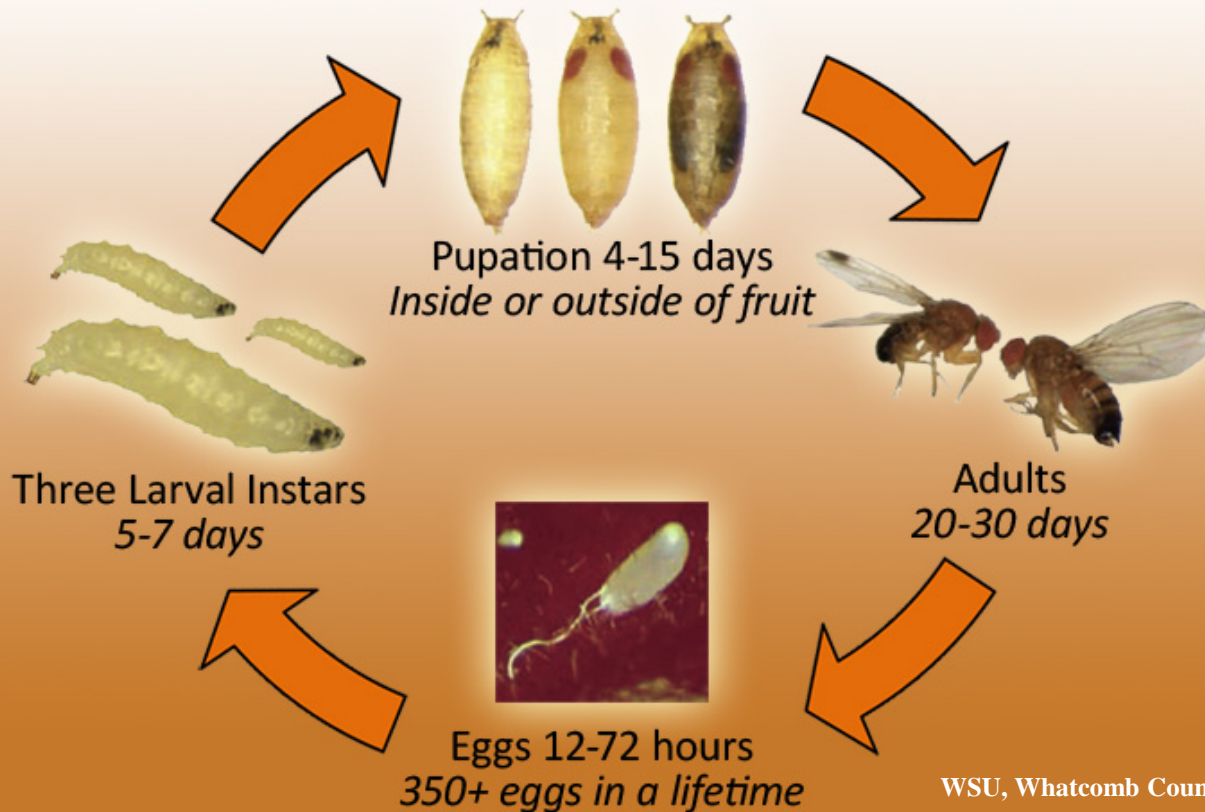
- **Picture Wing Fruit Fly**
- **Harvest Season Pest**
- **Hard to detect**
- **Easy to Kill**
- **Immigrates from wild blueberries and becomes established in planting.**





Biology of SWD

Life Cycle of the Spotted Wing Drosophila *Drosophila suzukii* (Matsumura)



Optimal development at 65-70°F, ~12 day generation time.

Adult flies live for 3-6 weeks, and females can lay over 300 eggs.

Female fly lays eggs into ripening fruit.

Limited by high heat in summer and by winter cold. But, SWD populations are found in cold regions of Japan.

Why Control Weeds in Blueberries?

Weeds compete with the crop:

water

nutrients

Alternate host for insect pests.

Interfere with pollination.

Reduce harvest efficiency.



Plastic Mulches in Blueberries?

- Plastic weed barrier to stop weed growth
- Woven plastic better than plastic sheet?
- Need irrigation under the plastic sheet



Shielded Sprayers

Drift from contact herbicides can injure the crop plants and shielded sprayers are common.



Blueberry Pesticide Recommendations



2018 E-154

**Michigan Fruit Management
Guide**

Pesticide information

Crop specific information

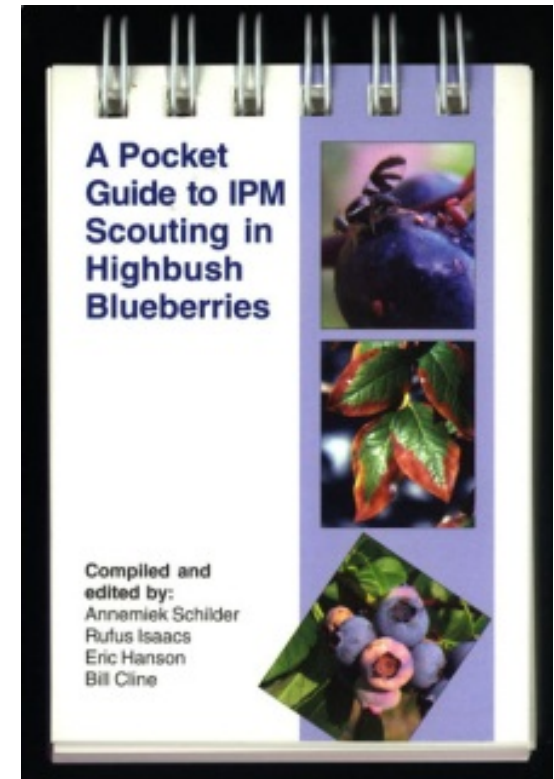
Blueberries, pages 239-256

Herbicides, page 274; BB p. 291

Recordkeeping information

Blueberry Scouting Guide

- Pictures and short descriptions of major insect pests and diseases.
- Also has herbicide injury and other common or not so common problems.
- Used for quick ID of problems.
- No information control.



What Does It All Mean?



- Understanding what is unique about blueberries is important for maximizing yields
- Proper water management insures good plant growth and large fruit
- Pruning increases fruit size.
- Pest and disease control is important to maintain fruit quality

Questions?



www.blueberries.msu.edu