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FIELD GUIDE TO WILD BLUEBERRY PRODUCTION AND INTEGRATED PEST MANAGEMENT (IPM)

3RD EDITION

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For more information, please visit:
www.wildblueberries.maine.edu

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Prune Year Production Guide

April & May: Plant Dormancy → Emergence

Plants: Mow pruning should have occurred in the fall yet burn pruning should be done in the spring. Prune plants to no taller than 1.0 inches. Apply granular fertilizer before a light rain, according to last year's leaf sample analysis. If P levels are not low, apply N and K only. DAP and MAP deliver too much P for regular use. Consider ammonium sulfate plus the P needed based on foliar testing. This is a good time of year to apply mulch or other organic matter material to prune fields.

Weeds: Apply sulfur to adjust soil to 4.0 (organic), 4.5 (conventional) (see pg 70.) on non-saturated soil and at a rate less than 800 lbs/acre. Spot-burn or spot-spray weedy patches. Cut woody weeds to the ground. Apply pre-emergent herbicide according to label before any blueberry shoots emerge. Do NOT use the harder chemistries (hexazinone or rimsulfuron) when any blueberry emergence has occurred.

Insects (May): Sweep for spanworm and flea beetle larvae. Manage early according to economic thresholds. Late emerging plants may indicate insect feeding from below the surface.

Diseases: Burn pruning can decrease disease causing fungi surviving on stems and in the leaf litter. Spot burning plants that dropped or still have a lot of mummy berries after harvest can decrease disease in the next crop year.

June: Vegetative Growth → Tip Dieback

Plants: Collect foliar nutrient samples for analysis at least twice in both prune and crop years. If you have irrigation this is an important time to irrigate. Plants are growing stems and leaves.

Irrigating a little bit, frequently is best. 1/2 to 1 inch of water per week is recommended.

Weeds: Pull or cut weeds above blueberry canopy before they go to seed or cut weeds to base. If needed, apply selective post-emergent herbicides (ex. half rate of mesotrione & clethodim) about three weeks after pre-emergent application.

Insects: Sweep for spanworm and flea beetle larvae. Manage according to thresholds. Scout and trap for thrips. Burn patches early or spot treat according to recommendations.

Diseases: Consider applying fungicides for leaf spots if high levels of leaf spots or leaf loss has occurred in the past.

July & August: Tip Dieback → Bud Development

Plants: Take leaf samples for nutrient analysis again. Take soil samples for soil pH analysis. If you have irrigation this is an important time to irrigate. Plants are developing buds for next year's crop.

Weeds: Pull, mow, cut weeds above blueberry canopy before they go to seed. Cut woody weeds to base 3 times throughout the season. If needed, apply selective post-emergent herbicides (ex. second half rate of mesotrione & clethodim) about two-to-three weeks after first post-emergent application according to the label.

Insects (July): Sweep for adult flea beetle and scout for red-striped fireworm larvae. Manage according to economic thresholds.

Diseases: Look for symptoms of leaf spots and note the types. Check lower leaves for Valdensia and Exobasidium leaf spots which may need further control measures. Avoid traveling through areas with Valdensia leaf spot (in wet conditions).

Fall: Bud Hardening & Leaf Drop → Dormancy

Plants: Early leaf drop is a serious hindrance to bud development. The longer leaves stay on your plants, the bigger and more buds will harden off and be viable in the spring. Leaf drop is a result of fertility and water availability earlier in the season and leaf spot disease control.

Weed: Pull, mow, cut weeds above blueberry plants before they go to seed. Cut woody weeds to the base. Fall can be a good time to manage weeds if you didn't have a chance earlier in the season but keep in mind that weed seed has already fallen to the ground, increasing the weed population.

Crop Year Production Guide

April: Dormancy → Bud Swell → Bud Break

Plants: Pay close attention to flower bud development stages in the Phenology Guide and follow fields across the state with the live Phenology Tracker online.

Weeds: If needed, you can apply a selective herbicide, not hexazinone (watch PHI), with the first mummy berry spray (F2). Do NOT apply herbicide with a second mummy berry spray. This is dangerous to bees.

Diseases: Examine mummy berry plots for germination and monitor plant development. After over 30% of flower buds are at F2 and mummy berry cups are present, use forecast of wet weather, mummy berry reports and AgriNet to determine timing and necessity of fungicide applications. Monitor early blooming clones for Botrytis in May (manage if confirmed). If fungicides are necessary for leaf spot control, apply after bloom and in accordance with pre-harvest intervals.

May & June: Bloom → Green Fruit

Plants: Take foliar samples for nutrient analysis. If you have irrigation this is an important time to irrigate. Cell expansion is occurring. Plants need water to get to nutrients.

Pollination: Place bees in fields the day before the first plant blooms. Bees are most effective within a 500 ft radius of their hives, therefore in larger fields, it might be necessary to disperse the hives throughout. If post-bloom sprays to manage pests are needed remove bees 5-7 days before the last petal fall.

Weeds: Pull, mow, and cut weeds, when possible. If needed, apply a selective post-emergent grass herbicide to grasses 4-6" in height after bloom.

Insect Pests: Once you have one blue berry, BMF and SWD traps should be out (mid to late June). Set yellow sticky traps for blueberry maggot fly (BMF) 25 ft from field edge (1trap/acre). Once cumulative fly number per trap exceeds 10 or 6 in one visit, spray application is needed JUST on the outer edge of fields where flies are present. Sweep for spanworm and flea beetle larvae and mark locations for control in the following prune year. Manage spanworm and flea beetle larvae according to thresholds as needed and after boom, observe bee cautions.

Disease: Monitor early blooming clones for Botrytis. If leaf spot fungicides are needed, apply after bloom and in accordance with pre-harvest intervals.

July & August: Color Change → Ripening → Fruit Drop

Plants: Take foliar samples for nutrient analysis before harvest. Harvest when mature fruit is blue and full. Do not wait for green fruit to develop, they will never mature. Heat and lack of water can decrease berry quality quickly.

Insects (July): Continue to monitor for blueberry maggot fly (BMF) and spotted wing drosophilla (SWD) with red solo cup traps. Use the action threshold table to decide when to spray. Sweep for adult flea beetle and scout for red-striped fireworm larvae, manage according to economic thresholds.

Disease: Look for symptoms of leaf spots and note the types. Check lower leaves for Valdensia and Exobasidium leaf spots which may need further control measures. Avoid traveling through areas with Valdensia leaf spot (in wet conditions). Look for plants with large numbers of mummy berries and collect mummies for plots and mark plants for spot burning if using that control measure.

Fall: Leaf Drop → Dormancy

Plants: Mow prune plants to a height no taller than 1.0 inches by mowing after the first frost or until snowfall. Wait until after a frost so that carbohydrates have been stored in rhizomes for next year. Burn prune in the spring.

Weed: Fall is a good time for weed management. You can wipe weeds taller than the blueberry with post-emergent herbicides until leaf drop. Bunchberry control may be applied until first frost.

Disease: Spot burning plants and leaf litter with a lot of mummy berries (white berries seen in picture above) after harvest can decrease disease in the next crop year.

Why Use IPM

Integrated Pest Management (IPM) is an approach to managing weeds, diseases, and insects in all crops for the best economic returns and the least environmental impact. When the predicted crop loss due to a pest equals the cost of controlling the pest, control measures should be taken. Treating fields that have no or low pest densities is a waste of money.

Monitoring pests and crop development stages on a regular basis is the foundation of IPM and the best crop management practice. Detecting pest problems early and accurately will allow you to manage pests at the correct time. It is important to use crop development stages, pest presence, and environmental conditions to determine when to spray or spot burn, for example. Applying pesticides at the proper time ensures the best possible pest control, less chance of pest resistance, and the least harm to beneficial organisms and surrounding habitats. Timely applications also prevent the need for reapplication, which saves time, money and reduces potential pest resistance and environmental contamination.

Modern wild blueberry farming practices cater more to the developmental stage of the plants rather than the calendar date. Due to weather variability and climate change the calendar date is no longer a reliable method to determine timing of management practices. It is important to learn the plant development stages and manage based on the economic threats at that particular stage.

Because insects, diseases, and weeds can be impacted by the nutrient content of your plants and the pH of your soil, taking foliar and soil samples is essential for pest and crop management.

Bud Stages			
			
Bud Swell (F1): Buds continue to swell with scales separating. Flower parts start to round inside bud.	**Early Bud Burst (F2):** Buds continue to swell with scales separating. Scale tips are pointed.	**Bud Burst (F3):** Bud scales separate fully with to show rounding flower parts.	**Tight Cluster (F4):** Petals (corolla) in flower buds are visible, elongated, but remain closed.

Bloom		Fruit Development	
			
Early Flower (F5): Pre-bloom; petals (corolla) extend beyond the green base of the bud (calyx) but remain closed.	**Open Flower (Bloom):** Flowers may be various shades of white to pink. Flower petals are open for pollination.	**Petal Fall (Pin Head):** Petals drop but the calyx and stamen remain.	**Early Green Fruit:** Fruit swell begins, but fruit remains hard, small, and green.

Fruit Development		
		
Late Green Fruit (Blushing): Green fruit begins to blush around the top but remains green where connected to the stem.	**Color Change:** Fruit is formed and turns various shades of pink and red prior to turning blue. Acid content is still high.	**Blue Fruit:** Fruit is ripe, sugar content is high.

How to Scout

Scouting pests requires monitoring your fields on a regular basis and recording your findings. Understanding the basic biology, life cycle, and timing will help you predict when pests are likely to cause damage and how to use economic thresholds to determine the level of necessary management. IPM data sheets are available as part of Wild Blueberry Fact Sheet 204*, Integrated Crop Management Field Scouting Guide for Lowbush Blueberries.*

Good Scouting Practices

Identify pests by life stage and the damage they can cause.

Develop a field history with knowledge of locations most affected by the different types of pests in your field.

Draw maps of high risk areas and monitor them regularly.

Keep track of weather and pesticide use to distinguish pest and disease damage from physiological disorders and pesticide injury.

Weather monitoring of temperatures and precipitation can explain weather related disorders such as cold injury and predict pests.

Typical Types of Damage to Wild Blueberry

Defoliation in pruned fields: disease or often spanworm or flea beetle

Chewed or scalloped leaves: often spanworm, sawfly, or flea beetle, sometimes strawberry rootworm (shot hole)

Leaf curls or galls: thrips (curled leaves around entire stem), or gall (tip-) midge (terminal end of stem)

Tied leaves: red-striped fireworm

Dead or discolored leaves or flowers: disease, frost damage, nutrient deficiencies, or pesticide injuries

Skeletonized leaves: leaf beetle (brown lace-like leaves)

Stem galls: stem gall wasps (woody growths on central stem)

Stem lesions: disease or plant bugs (red sunken lesions on stem)

Bare patches: disease, spanworm, flea beetle, strawberry rootworm, cutworms, herbicide damage, waterlogged soils

DISEASE IPM

Scout

Walk or drive the field regularly throughout the growing season looking for discolored plants or bare patches. Identify, flag, note and map areas of disease for your records and to monitor for spread or economic damage for future control. See diagram below for when symptoms on some disease will appear in fields.

Identification

Symptoms typically are seen in late June and July with blighting of isolated patches of stems in prune and crop year. The fungus over-winters in blueberry stems infected in the previous.

The primary symptom is blighting of the first year stems with the entire stem dying rapidly. Dead stems usually occurs scattered in patches of one to a clump of a few stems. The infected stem tissue is reddish brown and dead reddish-brown leaves remain attached to the stem for some time. The infection does not appear to spread out from individual patches of infected stems.

Mode of Spread

The pathogen may spread by water-dispersed spores. Typically the spread is very localized to only a few stems.

Management

Cultural: Burn pruning will decrease infected plant material
Chemical: Chemical control is not necessary since this not wide spread.

Identification of the cause of the problem is key for proper management.

Monitor

Watch diseased areas in your field for spread and symptom development for identification. Monitor the weather as wet periods may increase your risk of infection and spread. Treat via cultural and/or chemical methods when disease levels in the past have caused economic damage to the crop.

Cultural

Non-chemical disease management tactics should be employed before resorting to chemical management. Examples of cultural disease management are fire pruning, sanitation of equipment, and disposal of winnowed refuse by composting or burning.

Sanitation:

- Prevent the spread of disease from one field to the next by washing blueberry boxes, harvesters, sprayers, and other equipment between fields.
- Wash with pressurized water to remove most plant debris, including leaves and weed seeds.
- Dispose of winnower refuse via composting or by burning to eliminate sources of future infection.

Burn Pruning:

- Burn pruning after each crop cycle will produce the largest effect but burning every few crop cycles will still break up the cycle of fungi surviving on diseased tissue.
- Fire removes infected plant debris that many fungi overwinter in and therefore decreases the source for infection in the field.
- Blueberry plants near rock walls should also be burned if possible. Plants in rock walls and at the edge of fields can act as reservoirs for disease.

Mulching

- Mulching of at least 1 inch of material can cover up diseased plant material and mummy berries and decrease disease if applied before bud break.

Chemical

When conditions permit diseases to become a problem, fungicides may be used to protect plants from potential infection; they will not cure already diseased plants. **Knowledge of past problems and early detection of some diseases by scouting is essential for determining whether fungicide applications are necessary and when fungicides should be applied to be the most effective.**

Precautions to minimize exposure of pollinators to fungicides are recommended. Avoid applying fungicides during bloom. If a fungicide application is necessary, you should try to make the application after dusk when most pollinators are not active in the field.

Diseases

Blossom & Twig Blight (*Botrytis cinerea*)

Identification

Infection occurs in blossoms if the fungus is present in the field and there are extended wet periods during bloom in the crop year. Blossoms are susceptible to *Botrytis* just before they open (closed but pink in color at the base) and when open. In severe outbreaks, the fungus can spread to leaves and stems.

Within a few days of infection, tissues will turn brown and die but stay attached to the plant. **Dead tissues develop black "hairs" with grayish tips that are spore masses within days after infection. *Look for the hairs as the infected, dead flowers can be confused with frost damage.***

Mode of Spread

If the fungus is in the field, the fungus can spread by wind carried spores. New infections can occur with extended periods of wet weather, and there is a higher risk of infection with warmer temperatures. Fields with regular fog cover are more likely to be infected by Botrytis. Frost damage during bloom (May-June) can also increase severity.

Management

Cultural: Monitor and scout dying leaves on weeds and flowers of early blooming clones. Botrytis presence varies each year.

Control: Blossoms can also be killed by *Monilinia* (mummy berry disease) or frost, so determine the cause of blossom death before applying fungicide. *NOTE: do not apply fungicides unless you are sure you have *Botrytis,* and it is likely to cause crop loss. Avoid applying fungicides during pollination.*

Blossom Blight on wild blueberry flowers

Diseases

Mummy Berry (*Monilinia*)

Identification

Primary-stage symptoms: Symptoms appear late April through June with infected leaves and flowers will wilt, die and turn brown. Typically, individual flower bud clusters and entire branches with all of the leaves will be infected. Gray spore masses (conidia) are produced at the base of leaves and flowers from late-April to early-June and overlap bloom.

Second-stage symptoms Infected berries will have slightly brown patches on their sides and will develop first into a soft, pale brown, shrunken berry. At harvest, the infected berries are hard, pumpkin-shaped, whitish gray to brown pseudosclerotium (mummy berries). The pseudosclerotia that fall to the ground will turn black and hard in the fall and overwinter. Pseudosclerotia will germinate to produce goblet-shaped apothecia in April to May of the following year or two. See pictures, i. immature cups, ii.-and-iii. spore producing cups, iv. old, dying cups.

Mode of spread

The fungus spreads by wind dispersed ascospores produced by apothecia to developing flower and branch (leaf) buds. Environmental conditions favorable to the infection by ascospores include wet spring conditions when the fungal apothecia are present and plants have over 30% of their flower buds at F2 (crown stage). The second set of spores from the dead leaves and flowers spread to healthy blossoms by insects, including pollinators, where the fungus will then infect the developing fruit producing a pseudosclerotia that overwinters. Movement of plant debris from harvesting may move mummy berries around the field or to other fields.

Management

Cultural: Efficient harvesting techniques and disposing of winnow refuse away from the field reduces the number of pseudosclerotia. Burn pruning will also decrease the number of overwintering pseudosclerotia.

Chemical: Fungicide applications may be needed to control primary infection. Fungicides are applied after at least 30% of the flower buds are at F2 (crown stage), apothecia are active in the field and wet weather may cause an infection**.** Fungicides are typically applied before infection periods to protect the plants.

Apothecia ‘cups’ (produces primary stage)	Mummy berry on leaves (primary stage)	Mummy berry on flowers (primary stage)
		

Patch of mummy berry, primary stage in the field	Blueberries with ‘mummy’ berries
	

Cold During Bloom

Cold temperature damage can occur when temperatures dip below 30°F. Almost open and open blooms and immature leaves are the most susceptible to damage. Cold can kill blooms and internally damage pin heads and green fruit so that they do not develop and ripen. It can also prevent leaves and branches from expanding.

Cold temperature damage, particularly of flowers, can be mistaken for mummy berry or botrytis

Diseases

Leaf Rust (*Thekospora*)

Identification

Rust infections are typically not evident until mid-July or later. Leaf drop can be extensive by early-September and can affect flower bud formation in prune year plants.

Leaf rust symptoms consist of small spots with yellow, brown or black centers depending upon the clone. In late July and on, rust **can be distinguished from other leaf spots by raised yellow to rust colored pustules on the lower leaf surface in the center of the lesions.**

The disease can be a problem in non-bearing fields by causing extensive leaf spotting that results in excessive leaf drop and also decrease flower bud productivity.

Mode of Spread

The fungus spreads to blueberry leaves in spring (June) from infections on hemlock needles nearby that were infected by the fungus overwintering on dead infected leaves. From July until the leaves fall off, the leaf lesions will spread by producing wind-dispersed spores that can cause new leaf infections. Leaf spots increase over the growing season.

Management

Cultural: Burn pruning will decrease infected plant material.

Chemical: If there is a history of leaf rust and leaf loss, then application of fungicides in June may be needed. Leaf loss typically occurs after harvest in the crop year.

Yellow pustules on the leaf back

Leaf rust spots on the top of leaf

Diseases
Leaf-and-fruit Spot, Exobasidium (*Exobasidium maculosum*)

Identification

Circular pale green leaf spots appear on leaves in early June. The leaf spots sometimes are reddish to white. As fruit ripen, white to pink and red spots appear on the berries. Lower parts of the plant often have more spots. In July to August on the underside of leaves, the spots produce white powdery spores. These spots darken up and dry up later in August through September.

Mode of Spread

Pathogen appears to overwinter on stems and buds and spread in early spring to developing leaves and flowers. The spores produced on leaf spots seem to spread back onto stem and next year's developing buds.

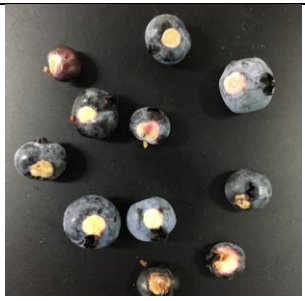
Management

Cultural: Burn pruning may help decrease infected material.

Chemical: Please check the fungicide recommendations. Fungicides need to be applied before bud break.

Exobasidium on leaves and fruit





Diseases

Leaf-spot, Sphaerulina (*Sphaerulina vaccinii*)

Identification

Spots emerge June to July. Defoliation or fruit drop may occur July to August.

Leaf lesions are small (pin-prick) water-soaked spots on the underside of leaves in mid-June, and the spots become necrotic and appear as small red to brown spots on the top of the leaf by July. Stem lesions are visible during bloom and are red with purple margins. Severe spotting can cause defoliation or fruit drop in some clones in dry weather in July and August, which may result in reduced vigor and decreased yield.

Mode of Spread

Leaves and stems become infected approximately around bloom in wet weather. Spores are splashed onto stems and leaves from infected overwintering leaves or stems.

Management

Cultural: Burn pruning can decrease infected plant material.

Chemical: If excessive leaf drop has occurred in the past in July and August, then fungicide applications may be necessary to reduce the incidence of this disease.

Sphaerulina leaf-spot, early pin-prick lesions on underside of leaves, spots later in season on leaves and on overwintered stems

Diseases

Leaf-spot, Valdensia (*Valdensia*)

Identification

Early leaf drop occurring at the end of June and early July is a symptom of this disease. The fungus overwinters in infected leaves from the previous year and will first produce spores after a 3 to 4-day wet period in May to early June.

Leaf spots caused by this fungus are usually round, large (>1/4 inch) brown spots with black margins with a spore that looks like a thorn in the middle of the lesion typically on the underside of the leaf. Young leaves with a single spot may fall off the plant while still green. Heavy infections can cause complete defoliation which can decrease flower bud formation and yield. Leaves infected later in the season do not fall off of the plant and will show more leaf spots.

Mode of Spread

Fallen infected leaves will shoot off new spores after a couple of days of wetness and the spores will infect nearby plants throughout the growing season. Long distance spread is by infected leaves being transferred by leaf contaminated equipment, clothing, or shoes particularly in wet weather when the infected leaves stick to surfaces.

Management

Cultural: A hard burn to destroy all leaf litter in infected areas and 10 feet around that area. Do not enter the field when it is wet. Flag infected areas so no one walks through it or moves equipment through it (including blueberry boxes).

Chemical: There are few registered fungicides for this disease, and they will only suppress the disease and will not remove it from your field.

Valdensia in field with defoliation (left)
Valdensia on blueberry leaves with spore visible on bottom of leaf (right)

Diseases

Leaf-spot, "False valdensia" (*not yet identified*)

Identification

Symptoms typically are seen in late June and July with blighting of isolated patches of stems in prune and crop year. The fungus over-winters in blueberry stems infected in the previous

The primary symptom is blighting of the first year stems with the entire stem dying rapidly. Dead stems usually occurs scattered in patches of one to a clump of a few stems. The infected stem tissue is reddish brown and dead reddish-brown leaves remain attached to the stem for some time. The infection does not appear to spread out from individual patches of infected stems.

Mode of Spread

The pathogen may spread by water-dispersed spores. Typically the spread is very localized to only a few stems.

Management

Cultural: Burn pruning will decrease infected plant material

Chemical: Chemical control is not necessary since this not wide spread.

False valdensia on blueberry leaves and in the field

Diseases
Powdery Mildew (*Erysiphe*)

Identification

Powdery mildew appears on leaves starting in July in both crop and prune fields and is not known to affect yield.

Symptoms appear on the top of the leaves and rarely are seen on the bottom of the leaf. Diseased leaf symptoms range from dark red spots or rings, to large wine red areas with a white mildew covering the top of the leaf. When the disease is severe, leaves can be shed prematurely in some clones.

Mode of Spread

The fungus overwinters in black spheres (cleistothecia) on the surface of infected plants or on fallen leaves. In the spring, spores are spread by wind to leaves. Infections can continue to spread by white powdery spores produced on the surface of infected leaves.

Management

Cultural: Burn pruning can decrease infected plant material.

Chemical: Fungicide treatments may reduce powdery mildew, but treatment is seldom necessary unless substantial amounts of disease and leaf loss have occurred in the past.

Powdery mildew symptoms with red blotches

Severe powdery mildew with white mildew on top of leaf

Black overwintering structures

Diseases

Red Leaf (*Exobasidium vaccinii*)

Identification

Infected plants are recognizable by the irregular portions of leaves that are bright red and slightly thickened; sometimes the whole leaf is red. Few or no fruit develop on infected stems; some twigs may be killed. Plants with red-leaf disease occur singly, in scattered clumps, or in patches. Diseased stems often occur in clusters **coming from the same rhizome**.

In late-June and July the underside of diseased leaves will turn white with the production of spores. In August infected leaves shrivel and dry up and then fall off.

Mode of Spread

The fungus appears to mainly spread through infected rhizomes to attached upright stems. Spores may spread the fungus but not efficiently. The disease persists in stems and rhizomes from year to year.

Management

Cultural: Avoid walking through diseased areas when spores are being produced (when leaf undersides are white).

Control: No fungicides adequately control this disease, but it does not seem to be increasing in importance. It overwinters in the rhizome and stems which make it difficult to eradicate.

White spores on the leaf back

Red leaf blotches

Diseases

Root rot (*Phytophthora*)

Identification

Edges of leaves turn reddish brown and dry extending from the leaves down the stem. A clump of stems or large area can die in a short period of time. Disease occurs in areas with water logged soil such as, in hollows, shallow soil over bedrock or where a lot of water runoff occurs. Roots and rhizomes will have brown patches internally. Often only seen in spring with heavy run-off and plants recover later in year.

Mode of Spread

Pathogen can be spread by spores moving through surface water or in the soil. Spread could also occur with moving contaminated soil and plants.

Management

Cultural: If possible, fill in hollows where this occurs. Avoid moving contaminated soil or plants.

Chemical: Not necessary at this time.

Phytophthora in the field

Diseases

Stem Blights (*Phomopsis* and other fungi)

Identification

Symptoms typically are seen in late June and July with blighting of isolated patches of stems in prune and crop year. The fungus over-winters in blueberry stems infected in the previous

The primary symptom is blighting of the first-year stems with the entire stem dying rapidly. Dead stems usually occurs scattered in patches of

one to a clump of a few stems. The infected stem tissue is reddish brown and dead reddish-brown leaves remain attached to the stem for some time. The infection does not appear to spread out from individual patches of infected stems.

Mode of Spread

The pathogen may spread by water-dispersed spores. Typically, the spread is very localized to only a few stems.

Management

Cultural: Burn pruning will decrease infected plant material

Chemical: Chemical control is not necessary since this not widespread.

Phomopsis in the field

Diseases

Witches broom (*Pucciniastrum*)

Identification

This disease appears as a broom-like mass of swollen stems with small leaves in both prune and crop years. The infected bunches of stems are typically in low numbers and survive over the winter. Infected stems will not produce any fruit.

Mode of Spread

The fungus overwinters on blueberry stems and wind disperses spores from the stems that infect balsam fir needles in early spring. Spores are

then spread from balsam fir by wind to infect new blueberry stems in late spring.

Management

Cultural: Burn pruning will kill off the fungus overwintering on blueberry stems. Removing hemlocks around blueberry fields is not feasible as a control since the spores can travel for miles.

Chemical: Not necessary since it is not widespread.

Witches broom in the field



Disease monitoring tools

AgriNET (Login: BB, Password: Grower)
https://app.agrinet.us/

Blueberry Blog
https://extension.umaine.edu/blueberries/factsheets/blueberry-blog/

Phenology Tracker
https://extension.umaine.edu/blueberries/real-time-wild-blueberry-phenology/

UMaine Cooperative Extension Fungicide Chart:
https://extension.umaine.edu/blueberries/wild-blueberry-pesticide-charts/

INSECT IPM

Scout

Walk or drive the field regularly looking for discolored or bare patches. Identify, fag, note and map areas of insect damage for your records and to monitor for spread or economic damage. **Identification is key for proper management.**

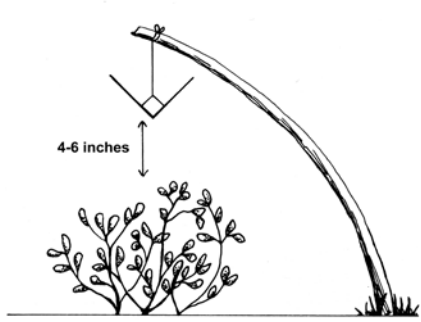
Monitor

Sweep to detect insects in the prune year. As fruit ripens monitor for BMF and SWD adults in your field and record numbers to determine if thresholds have been reached. Treat via cultural and/or chemical methods when disease levels may pose economic damage to the crop.

Tips for Scouting and Monitoring

Sweep net: Sample in a W or zig-zag pattern throughout the field with sets of 10 sweeps, each covering an 180º arc or half circle. Every set of 10 sweeps should be taken at different locations. 10-20 sets of sweeps are necessary for a good sample; large number of sweeps on larger fields.

Yellow-baited panel trap for blueberry maggot fly: Place traps just above (4-6 inches) top of canopy and 100-200 feet apart along wooded edges 25 feet from edge of fields. 1-3 traps per 10 acres. Place traps in field locations that have high weed or fruit density.



Placement of blueberry fly-sticky traps

Red cup trap for spotted wing drosophila: Red cup traps baited with a sugar/yeast solution are the current recommendation for trapping spotted wing drosophila. Traps are baited with approximately 4 ounces of a yeast-sugar-water mixture (1 TBS yeast + 4 TBS sugar + 12 oz water). A minimum of 3 traps per

field should be used and placed along the field edge). Traps should be visited at least once per week, but preferably twice a week. During each visit, fly samples should be collected from the traps and then the traps should be emptied and replaced with fresh bait. Other commercial lures are being tested for their efficacy and selectivity, along with the potential for sticky panel traps. Monitor for larvae in fruit using the Salt Test.

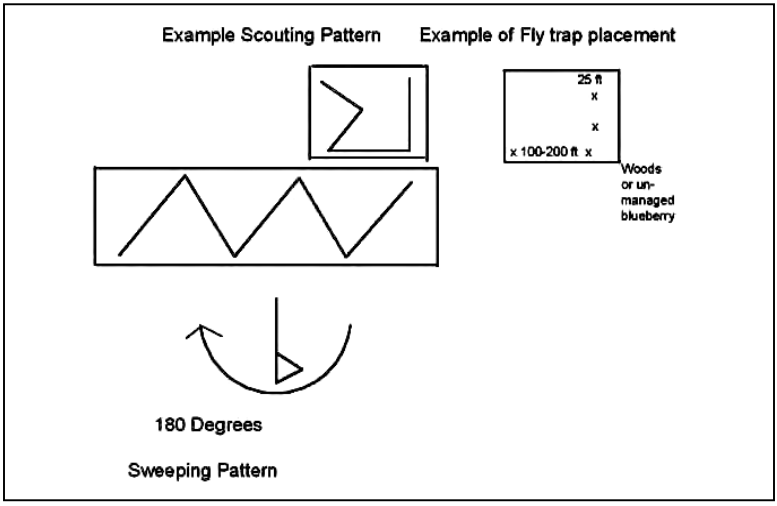
Monitoring for larvae of both blueberry maggot fly and spotted wing drosophila is done using the Salt Test: Monitor adult and larval populations; Refer to Cooperative Extension Bulletin No. 210, *Spotted Wing Drosophila: Pest Biology and IPM Recommendations for Wild Blueberries* for additional information on trap construction and placement, and processing for larvae in fruit.

Thrips Monitoring: Distribution of yellow sticky cards may aid in monitoring and timing of insecticide applications to control thrips.

When and Where to Sample

Sample representative location, be sure to include:

- Edges (especially maggot fly and leaf beetle) and interior of fields.
- Random sites across the field.
- Early morning, mid-day (bees) and late afternoon.
- After a rain event, NOT during one.



Walk in different areas of the field.

Management Approaches

Cultural

Non-chemical disease management tactics should be employed before resorting to chemical management. Examples of cultural insect management including pruning practices (delayed pruning and fire pruning and adjusting harvest timing.

Pruning

- Burn pruning after each crop cycle will produce the largest effect but burning every few crop cycles will still suppress the populations of some insect pests.
- Eggs and other overwintering life stages of insect pests can be targeted with burning (litter must be ignited) and therefore decreasing their populations in the field.
- Delayed pruning can be used to disrupt to the life cycle of some species.

Harvest timing

For frugivorous pests, harvesting early prior to insect populations becoming economically damaging.

Biological
Conservation of natural enemies means these can provide natural pest control. Conservative use of chemical controls using scouting and thresholds is key to protecting natural enemy populations.

Chemical
When populations of pest insect's increase above established thresholds, insecticides may need to protect plants and fruit from damage and infestation. **Early detection by scouting and monitoring by traps is essential for determining whether insecticide applications are necessary and when fungicides should be applied to be the most effective.**

Precautions to minimize exposure of pollinators to insecticide is recommended. Avoid applying insecticides to flowers including weeds in the fields. If insecticide applications are necessary, you should try to make the application after dusk when most pollinators are not active in the field and take actions to reduce drift.

Insect Pests
Blueberry Flea Beetle (*Altica Sylvia*)

Identification

Larvae: Larvae are present from mid-May to late June and are especially active during bloom. Larvae are small, black, and ~3/8-inch long when fully grown. Larvae may damage leaf, buds, and flowers through extensive chewing and defoliation.

Adult: Adult flea beetles emerge in early July and remain through late summer. They are oval shaped, shiny, copper/bronze in color, and less than 1/4-inch long. Adult feeding damage may appear as scalloped, small, square notches along the edges of the leaves, but they may also cause complete defoliation. Adult beetles tend to jump suddenly when disturbed.

Infestations of blueberry flea beetle may be confined to isolated areas or damage may be widespread. Large numbers of flea beetles may completely defoliate large areas in both crop and pruned fields.

Management

Cultural: Eggs can be targeted with burning. A hard burn or fire pruning may reduce the likelihood of damaging populations.

Chemical: Both larvae and adults can be targeted (adults disperse within 2 weeks of emergence). Once the threshold is met or exceeded, spray with insecticide or biocontrol as needed.

Threshold: 50 insects per 10 sweeps for larvae or adults.

Adult (bottom) and leaf damage (top)	Larvae and larvae damage	Widespread larvae damage
		
		

Insect Pests
Blueberry Sawfly (*Neopareophora litura*)

Identification

Larvae: Young larvae, which are rarely seen, are white or flesh-colored with blackheads and black legs. Older, green larvae begin to appear on the blueberry foliage in late May or early June when leaves are well-developed. The larvae continue to feed on the foliage until mid to late June. Fully grown larvae are about 4/10-inch long. When feeding, young larvae feed in inner leaf whorls and leave black feces in the whorl. Full grown larvae coil their body over the edge of the leaf and chew around the edge, scalloping leaf edges. After reaching maturity, the larvae move to the ground and spin cocoons in the litter where they spend the winter.

Adults: Adult sawflies emerge in early May. They are an inch long, black, and generally wasp-like in appearance with wings held flat over the body. Eggs are laid in developing, still folded, leaf whorls of lowbush blueberry.

Management

Cultural: A hard burn or fire pruning may reduce the likelihood of damaging populations

Chemical: Treat based on action threshold. ONLY larvae can be targeted during the crop year.

Threshold: Although not usually an economic concern to growers, in large numbers larvae may cause damage by defoliating small patches of plants.

Sawfly larvae		Sawfly damage in the field
		

Insect Pests

Blueberry Spanworm (*Itame argillacearia)*

Identification

Larvae: Mid-April to mid-June eggs hatch and larvae feed on plant tissues, larvae then pupate in leaf litter in mid-June. The larvae (caterpillars) have a “looping walk” when moving. Young larvae are about 1/8-inch long and dark grey to black, with a series of white bands encircling the body. Mature larvae are an inch long, and are yellowish orange with rows of black spots that may look like continuous black strips running the length of the body. Larvae are most active under low

light conditions, early morning and evening, so this is the best time to sample.

Adults: Adults are a small gray/white moth that emerges in late June and remains active through mid-summer.

Management

Cultural: A hard burn or fire pruning may reduce the likelihood of damaging populations. Cold wet springs can also kill the young larvae and reduce populations. Also, after 2-3 years of an outbreak, virus disease and parasitic wasps often collapse their populations.

Chemical: Treat based on action threshold. ONLY larvae can be targeted during the crop year.

Threshold: Ten larvae per 10 sweeps in the crop year. Three or more larvae per 10 sweeps in the prune year. Early in the season, the larvae damage the berry crop by eating flower buds and blossoms. Later larvae chew out notches on developing leaves. Crop fields may be dotted with areas that appear burned. The first sign of a severe infestation in a pruned field is an area devoid of or with slower developing plants.

Adult spanworm moth	Spanworm larvae	Spanworm damage to blueberry leaf
		

Insect Pests

Red Striped Fireworm (*Aroga trialbamaculella*)

Identification

Larvae: Caterpillar-like larvae with greenish bodies and darker heads (about $^{3}/_{8}$" long when fully grown) emerge in July. As they grow, faint reddish lines running the length of the body appear on the back and sides. The red color becomes more pronounced as they mature. **Larvae tie leaves together with silk webbing to form a shelter.** The larvae can move very quickly and become very active when disturbed. To identify fireworm damage, look for terminal leaves webbed together with silk in July.

Adult: The adult moths emerge mid-May to June. The moths are about $^{1}/_{2}$" long, slender, dark-brown or black, with a white face and white spots on forewings and legs.

Management

Cultural: Larvae overwintering in the duff can be targeted through burn pruning.

Chemical: This insect does not usually occur in large enough numbers to cause significant damage to plants. However, they can be a nuisance pest since they contaminate equipment, boxes and packing lines.

Adult moth	Larval leaf-tie		Mature Larvae
			

Insect Pests

Blueberry Maggot Fly (*Rhagoletis mendax*)

Identification

Larvae: Maggots appear in berries in mid-July. As the larvae feed the berries will shrivel and drop.

Adult: The first adult flies emerge from soil in late June or early July; emergence continues into August. Adults live for ~30 days. Female flies are about 3/16" long with a wingspan of about 1/3". **Wings are clear with black bands.** The shape and placement of the bands is important to properly ID this insect as there are some similar species of fruit fly that may be caught on monitoring traps.

Management

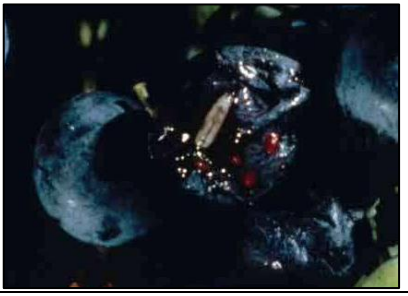
Cultural: Harvest early; clean up winnow piles.

Chemical: Adults (the fly) are the target of control. Perimeter field treatments can be an effective strategy. **Never apply insecticides when less than 3-5% of crop have ripened (July)**

Threshold: Six or more flies on all the traps in the field in a single visit **OR** the cumulative total **of ten flies or more** are captured on all the traps in the field in more than one visit.

Adult female fly:

Larva infesting fruit:



Insect Pests

Spotted-Wing Drosophila (*Drosophila suzukii*)

Identification

Larvae: Larvae hatch in the fruit from mid-July to early-August as the fruit ripens. They very small, thin, white, and soft-bodied with pointed anterior and posterior ends. Spotted-wing Drosophila (SWD) have three larval stages (instars), and all take place inside the berry. The full larval period of all three larval instars takes only four to five days. SWD has been shown to have as many as 15 generations per year

when observed in captivity. These flies can complete their life cycle in as short at 9 days days and the adult flies can live for up to 66 days during the summer. Females lay one to three eggs per egg-laying hole, with an average of 380 eggs throughout her lifetime and multiple female SWD can lay eggs on a single fruit, resulting in large numbers of larvae (5-25) in one blueberry.

Adults: Adults begin to appear in small numbers in mid-June to ealy-July; timing and intensity of population vary from year to year. Females will lay eggs in red and blue maturing fruit. Adults have rounded, pale yellow to light brown abdomens with dark brown horizontal stripes on the dorsal (back) side. They have large, bright red eyes. Males have a single dark spot at the tip of each wing and two rows of spines on forelegs. Females are slightly larger than males and have a large, dark, heavily serrated ovipositor.

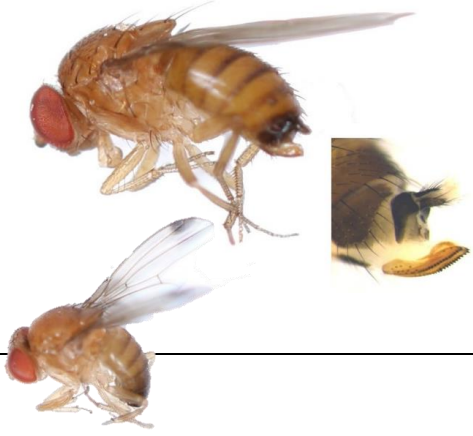
Management

Cultural: Harvest early (prior to August or upon trapping the FIRST Male).

Chemical: A decision to spray should be based on trap captures (see monitoring on page 25). Upon trapping the FIRST MALE (wings with spots) the grower should consider harvesting immediately if practical, or protecting with insecticides until harvest. Apply insecticides based on action thresholds. Perimeter treatments can also be effective early in the year.

Threshold: Risk with average cumulative males per trap with at least 3 traps: 0.5 = Low, 3.5 = Moderate, 7 = High.

Adult female (top) and male (bottom)



Larvae

Insect Pests

Thrips (*Frankliniella vaccinii* and *Catinathrips kainos*)

Identification

Nymphs: Immature thrips (called nymphs) are very small (1/8-inch long) and difficult to see. Uncurling rolled up leaves of actively infested plants may reveal these small, slender, lemon-yellow insects.

Adults: Adult thrips emerge May to early-June to lay eggs on new plant material. The adults are very small flies about 1/8 - ¼" long. Their presence is best identified by the leaf galls they create. The leaf galls are very tightly rolled-together leaves and twisted stems of blueberry plants. Infested leaves turn bright red, are smooth, and typically envelop an entire stem. By late June and July stems are often completely surrounded by curled leaves resulting in no flower buds the following year. Late-July to early-August new adults are found within leaf galls. Mature adult females (and some males) move back into the soil by late summer.

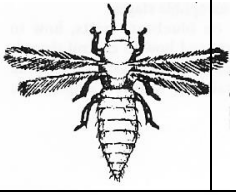
NOTE: It can often be difficult to distinguish between tip midge and thrips and they may inhabit the same galls

Management

Cultural: delayed burning of infested areas in the prune year (as late as mid-July).

Chemical: Effective as spot treatments the following spring (stake out affected areas). Make first application when leaves are 1/4 inch to 1/2-inch-long. Repeat when 1/2 inch to 1 inch. **Timing is critical**.

Threshold: Thrips damaged plants can be found in both crop and pruned fields, but the most economically important damage is in pruned fields**.** Yellow sticky cards may be used to monitor for blueberry thrips for more efficient timing of applications.

Nymph (top), and adult (bottom)	Gall formed by adult thrips
 	

Insect Pests

Tip (gall) Midge (*Dasineura oxycoccana*)

Identification

Larvae: From late-May to early-June the larvae form galls at the terminal ends of blueberry stems. The leaves are loosely curled together (without webbing) providing a shelter where larvae feed. Galls are hockey-stick shaped, dimpled and green and are commonly found in prune fields. Opening a gall may reveal very small, white, yellow or orange larvae that are difficult to see with the naked eye.

Adults: Adult females emerge, mate and deposit eggs in plant tissue. Eggs hatch within three days and feed for 10-14 days. Adults are small, mosquito-like flies, <1/16".

Management

Cultural: A late burn (mid to late June) after most of the galls have formed can suppress populations but will also reduce flower bud cluster production during the prune year.

Chemical: Chemical control is not currently recommended for this pest.

Threshold: Usually not considered too damaging, but in some years, 50% of flower buds.

Adult tip midge fly

Hockey-stick shaped galls formed by Larvae

Insect Monitoring Tools

NEWA

https://newa.cornell.edu/crop-and-pest-management

UMaine Cooperative Extension Insecticide Chart:

https://extension.umaine.edu/blueberries/wild-blueberry-pesticide-charts/

Natural Enemies

Why recognize natural in wild blueberry? These arthropods provide natural pest control. The ability to distinguish natural enemies from pest insects will help you make informed pest control decisions. Promoting natural enemies may even provide a degree of suppression of minor insects and some beetles and field crickets even eat seeds of common weed species. Maintaining a diversity of habitats, especially areas rich in flowering herbaceous plants and shrubs surrounding blueberry fields can promote natural enemies. This is because alternate insect prey often resides upon these plants. When spraying insecticides, care should be taken to choose insecticides with low predator toxicity, and spray only when necessary (see Wild Blueberry Fact Sheet, Wild Blueberry Pesticide Chart- Insecticides). The major insect natural enemies in Maine blueberry fields are wolf spiders, daddy longlegs, ground beetles, ants, and parasitic wasps. Our studies have shown that parasitic wasps regulate blueberry fly populations and blueberry spanworm populations, lowering their potential for extreme infestation levels or reducing the length of the outbreak period. Also, we have shown that spiders reduce spanworm and grasshopper populations, and that ants readily prey upon blueberry flea beetles and blueberry spanworm, reducing their populations up to 50 yards from an ant mound nest.

Natural Enemies **Ants** (Formicidae)	**Natural enemies** **Ground Beetles**
Ants are present in blueberry fields from mid-May through the growing season. There are many species (61) in Maine. Low insecticide input (i.e. organic) tends to result in higher numbers of ant colonies. One of the most common ants in blueberry fields is the Allegheny mound ant. It is a voracious predator. **Identification:** **Adults:** Ant can be recognized by a constricted waist, elbow antennae,	There are many species of **ground beetles**, some are insect predators, and some eat weed seeds. These beetles are found in all parts of the blueberry field from May to August. **Identification:** **Adults:** Usually dark and shiny with tread like antenna. Color varies – commonly black, brown or metallic. Abdomen often much wider than the head or pronotum. Elytra may have striations or pits. Adults rarely fly, run

and wingless (except for reproductive stages).

Allegheny ant mound

Example of common ant

fast. **Eggs:** Deposited singly in or on the soil surface. **Larvae:** Segmented, tapers from head to tail. Heard large with well-developed jaws.

Example of adult ground beetle

Natural Enemies

Wolf Spiders (Lycosidae)

Wolf Spiders are generalist predators present all spring and summer in all parts of blueberry fields. These ground dwelling, non-web spinning spiders ambush insect pests that inhabit the ground surface. Therefore, they tend to concentrate on insect pest larvae just as they move into the soil to pupate such as blueberry spanworm, blueberry flea beetle, red- striped fireworm, and blueberry fly.

Natural Enemies

Phalangids (Phalangium opillio)

Phalangids *(Phalangium opillio)* or **Daddy longlegs** is the most abundant species in blueberry fields and seem to favor agricultural habitats. They become more abundant towards the end of the growing season and are known to eat a wide variety of pest and non-pest arthropods, especially soft-bodied insects such as caterpillars and beetle larvae. Daddy longlegs tend to colonize blueberry fields from field edges and build up to high densities in mid to late summer.

Identification: Hairy, brown to gray in color with various markings or lines. Their eyes comprise three rows; the first row has four small eyes; the second row has two larger eyes and the third row has two medium-sized eyes.

One of the most common wolf spiders in the genus *Hogna*.

Identification: Adults are easily distinguished from long-legged spiders by their fused body regions and single pair of eyes

Example of an adult daddy longlegs

Natural Enemies

Parasitic wasps

Parasitic wasps exhibit complete metamorphosis with a free-living adult stage that may be predaceous or feed on pollen and nectar. Parasitoids require a host insect to develop to develop into adults. In the majority of parasitoids, females lay an egg(s) in, on or near the host, ultimately killing it, and emerging as an adult parasitoid. However, two species specific to blueberry spanworm, at least one species specific to blueberry maggot fly. This species of parasitic wasp can parasitize up to 38% of BMF pupae. Most years, parasitism rates are closer to 3-10%.

However, even at these percentages they do not regulate populations.

Identification: Parasitic wasps have two diagnostic features that greatly contribute to their identification. Female wasps have an ovipositor that allows them to deposit eggs in their host, they also have a narrow "waist," called the etoile, which allows their abdomens to be flexible to attacked their hosts.

Parasitic wasp specific to blueberry maggot fly (*Diachasma alloeum*).

Pollinator Insects

Diversity

There are more than 120 bee species associated with wild blueberry in Maine. Most are native to Maine, have co-evolved with wild blueberry, and are particularly efficient pollinators of the crop. Native bees that visit flowers of the wild blueberry reduce the need for commercial pollination services, and this makes it prudent to support native bee populations through conservation practices.

Andrena vicina, a native solitary bee.

Bees come in a variety of shapes, sizes and colors. Most native bees associated with wild blueberries belong to four families: *Apidae, Andrenidae, Halictidae and Megachilidae*.

Pollinator Conservation

While it is valuable to know which bee species are present, a realistic approach to supporting native bee populations is by promoting bee habitat. This includes alternate forage (flowering plants the bees visit when blueberry is not in bloom) and nest sites such as bare earth, rock walls, standing snags, bunch grasses, plants with hollow or pithy stems, and artificial nests.

Habitats for forage and nesting are at field edges, ponds, access roads, parking areas, and near buildings. A water source may be helpful especially for honeybees; float a piece of wood in the water as a landing platform. Maintain forage habitats by mowing infrequently. Protect bee habitat from pesticide drift.
Pollinator strips and bee gardens can be installed to support bees, including native bees. Many plants considered to be weeds in the field can offer valuable food resources for pollinators at field edges and in bee plantings and conservation areas. In addition to those in the list, bees visit apple, dandelion, pin cherry, wild raisin, serviceberry, mustards, northern fly honeysuckle, and bluets.

A pollinator strip made up of wild flower mix.

To help provide nesting sites for pollinator in and around your field it is important to know when were they nest.

Native Tunnel-Nesting Bees

Native leafcutter bee, *Osmia* sp.

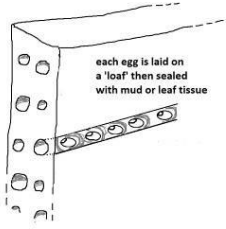
Maine has more than 30 species of **Leafcutters or Mason Bees** (family Megachilidae). Their nests are in the soft pith of some shrubs (elderberry, raspberry) or in old borer holes in trees. Some can cut circular pieces from leaves using their large mandibles, while mason bees collect mud to seal their nests. In the tunnel the female bee lays her egg upon a tiny loaf of pollen, nectar, and saliva, then seals the chamber off.

Fast-moving dark blue bees in the genus *Osmia* can be challenging to photograph on flowers.

If you see round holes in leaves around the farm, this could be evidence that leafcutter bees are present. The bee flies to its nest while holding the piece of leaf.

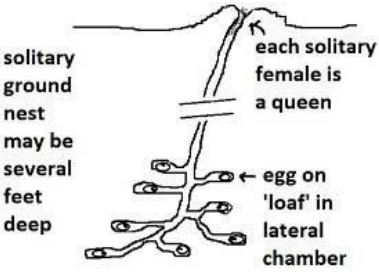
Artificial nest blocks can be set at field edges in an effort to increase the populations of leafcutter bees (see Wild Blueberry Fact Sheet 301, *Field Conservation Management of Native Leafcutting and Mason Osmia Bees*). Use untreated wood, and do not paint or polyurethane the blocks.

Inside a nest block that you might put up around your fields; the nest could resemble this diagram.



Native, Soil Nesting Bees

In general, ground nesting bees are solitary. From the side, the nest could be arranged as in this diagram.



The new bee emerges from the soil, mates, and then the female excavates a nest and lays her eggs. The bee may guard the entrance hole while she waits for sun.

Andrenid nest hole with loose excavated soil, called tumuli.

An aggregation of nest holes. Perhaps several bees use the same hole, or there are inter-connections between nest tunnels.

Bees and Pesticides

Bees are highly vulnerable to pesticide sprays. You can reduce harm to pollinators:

- Ask first, "Is it necessary to spray?" I.D. the pest and scout to determine if it is at threshold levels. Spray only when pest levels are at threshold.
- If threshold is reached, select the least toxic treatment and use the minimal amount necessary. See Wild Blueberry Fact Sheet 630, *Wild Bee Conservation for Wild Blueberry Fields*, for a table ranking toxicity to bees of commonly used pesticides.
- During application, prevent drift onto pollinator habitat by remaining alert to wind direction and other factors that impact drift (pages 72-75).
- Controlling weeds in fields were applications of pesticides are being made will mean that flowers that bees might visit won't be treated.

Commercial pollinators are commonly used to pollinate which blueberry alongside native bees.

Commercial Pollinator Insects	
Honey bees (*Apis mellifera*)	**Bumble Bees** (*Bombus impatiens*)
	
6Honey bees are the most common commercial pollinator because it is possible to stock fields with vast numbers of individuals (see Wild Blueberry Fact Sheet 629, Honey Bees and Blueberry Pollination). The honeybee worker is about 3/4 inch long, with color ranging from light brown to almost black. The eyes are large and usually shiny black, while the thorax (where the six legs and two pairs of wings are attached) is covered with a dense mat of brown hairs. The abdomen is long and often has alternating light and dark bands or rings.	Bumble bees are black and yellow or black and orange, with a hairy thorax and abdomen. The Impatient Bumble bee, Bombus impatiens, is managed for commercial pollination services (Wild Blueberry Fact Sheet 302, Commercial Bumble Bee Management for Wild Blueberry Pollination). Bumble bees are the most efficient pollinators of wild blueberry, on a per bee basis. They visit flowers even during cool, drizzly weather. They buzz pollinate, or vibrate their flight muscles rapidly while collecting pollen, to shake sticky pollen out of the tube-like anthers of wild blueberry flowers. By comparison, honey bees are not able to access the pollen as easily because they do not buzz pollinate.

In addition to honey bees and bumble bees Alfalfa leafcutting bees (*Megachile rotundata)* are another option as a commercial pollinator.

Alfalfa leafcutting bees: These introduced bees are good pollinators of wild blueberry. They are particularly suited for pollinating large, weed- free fields. They do not thrive during a cold spring (Wild Blueberry Fact Sheet 300, *How to Manage Alfalfa Leafcutting Bees for Wild Blueberry Production*).

Alfalfa leafcutting bee on wild blueberry flower.

Native bees	
Bubmble bees (*Bombus spp.)*	**Sweat Bees** (*Halictidae spp.)*
	 
Seventeen species of native bumble bees are in Maine (Family Apidae). Bumble bees are black and yellow or black and orange, with a hairy thorax and abdomen. Most of the smaller black-and-pale-yellow workers seen in blueberry fields belong to the commercial species **Bumble bees are the most efficient pollinators of wild blueberry, on a per bee basis.** They visit flowers even during cool, drizzly weather. They buzz pollinate, or vibrate their flight	Bees in the family Halictidae are native and solitary. These, too, usually nest in burrows in the soil, sometimes in rotting wood (see Wild Blueberry Fact Sheet 630, *Wild Bee Conservation for Wild Blueberry Fields*, for conservation tips). Some are metallic green and easy to recognize, others are tiny, black, and not much noticed. Their effectiveness in wild blueberry pollination is not well-established but

muscles rapidly while collecting pollen, to shake sticky pollen out of the tube-like anthers of wild blueberry flowers.	their diversity and abundance indicate a healthy ecosystem.

Miner and sand bees (*Andrena spp.*)	**Mason and leaf-cutter bees** (Family: Megachilidae)
 Andrenids mating at willow, Blueberry Hill Farm, Jonesboro, ME	 Native leafcutter bee, *Osmia* sp.
Bees in the family Andrenidae are small to medium size bees. Some andrenids resemble halictids in the field and are very difficult to tell apart. Andrenids are a very common native spring pollinator in Maine. All species are soil nesters with side-chambers in which they lay their eggs. A few might have interconnecting nests belowground. Maine has at least 45 species of Andrena, including some excellent pollinators on wild blueberry.	Maine has more than 30 species of Leafcutters or Mason Bees (family Megachilidae). Their nests are in the soft pith of some shrubs (elderberry, raspberry) or in old borer holes in trees. Some can cut circular pieces from leaves using their large mandibles, while mason bees collect mud to seal their nests. In the tunnel the female bee lays her egg upon a tiny loaf of pollen, nectar, and saliva, then seals the chamber off.

Pollinator monitoring tools

Assessment of pollinator activity

During full bloom, stake out 1-yard square areas and count native and honeybees in that area for 1 minute at a time between the hours of 10 a.m. and 2 p.m., in dry and calm weather conditions, and when bees are observed flying. In total, stake out 8-10 of these per field. If possible, visit these 1-yard square areas multiple times during bloom. Counts of native and honeybees can be used to the % Fruit set, see table below and consult the *Estimating the Strength of Your Pollinator Force in Wild Blueberry* publication on the Cooperative Extension website.

See the table below to determine whether it is advisable to add bees to your fields.

Add bees if observation levels are not met (or see calculation for fruitset).	
Bees	**Crop fields**
Honeybees	2 bees / sq yd / minute
Bumblebees	0.1 bees / sq yd / minute
Native bees & honeybees	1 bee / sq yd / minute
% FRUITSET = 14 + (8 x honeybees / min) + (18 x [native + bumblebees / min])	

Weed IPM

A wide variety of woody and herbaceous plant species native to Maine naturally occur in Maine's wild blueberry fields. Any plant occurring in a field other than a wild blueberry is considered a weed. The wild blueberry competes with weed species for space, water, and nutrients. This competition usually results in a reduction in crop yield and prevents the blueberry from spreading. Weeds may also harbor pests or act as alternate hosts for diseases, yet weeds can give shelter to beneficial insects, attract pollinators, and help to reduce erosion on slopes.

Scout

Weed management tactics will be most effective when you can identify the types of weeds or weed species present in your field. If you don't know the exact species, knowing the general type (grass vs. herbaceous broadleaf vs. woody and annul vs. perennial) will help to decide on a management practice.

ID Terminology used in the table below

Alternate: Alternate leaves are alternate from one another in arrangement along the stem.

Lenticels: Raised pores along the stems of woody plants the allow for the exchange of gasses.

Opposite: Opposite leaves occur in symmetrical pairs along the stem (being opposite of one another in arrangement).

Spikelet: Describes the arrangement of flowers in monocots (grasses).

Monitor

Repeatedly scout your field throughout the season as different weeds emerge at different times. Keeping an updated map of areas with high weed pressure can help reduce herbicide applications which saves money and reduces the risk of herbicide injury to the crop.

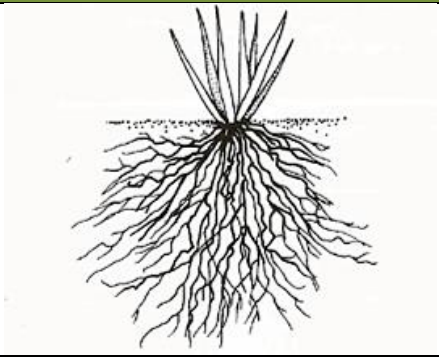
Cultural Management:

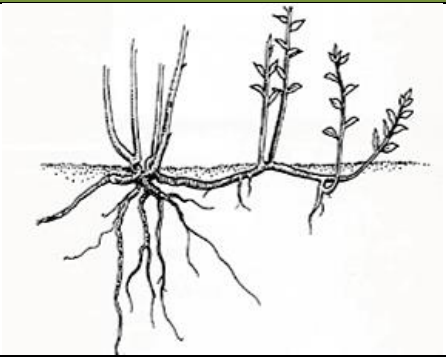
This includes routine management practices that can prevent pests from developing in the first place. Cultural methods include reducing the soil pH, hand-pulling or topping, fire pruning and mulching.

Chemical Control:

Involves the use of naturally derived or synthetic chemicals (pesticides) to kill, attract, repel, or otherwise control the growth of pest plants, animals, and microorganisms. For herbicides, this includes: "pre-emergent" herbicides which are applied after frost and before the emergence of weeds and "post-emergent" herbicides which should be applied at the proper growth stage of the weed.

Weeds
Annual vs. Perennial





Annuals germinate, set seed, and die within a single year. Roots are usually fine and net-like.

Perennials also germinate via seed BUT may live for many years. The roots are generally larger than those of annuals and may help the plant to spread via rhizomes.

The seeds of annuals and perennials spread by wind, water, animals, and equipment and lie dormant in seed beds until conditions are optimal.

Weeds
Herbaceous vs. Woody

Herbaceous weeds have soft, fleshy (green, red, or brown) stems that die back annually in the winter and regrow from the soil the following season.

Woody weeds have woody (brown, red or green) stems that are tough to break. These stems go dormant annually in the winter and resume growth the following season.

Weeds
General Weed Classifications & Management

Broadleaf Herbaceous

Broadleaf weeds are present as annuals and perennials in wild blueberry fields. Broadleaf weeds are defined as having a main vein in the center of the leaves with smaller veins branching out. The leaves are wide, 'broad' and they flower in a range of colors. Many of the herbaceous flowering weeds in this category are ideal for pollinator plots.

Broadleaf Management

Cultural: Burn prune every 3 cycles or as needed. Mulch 2-4" thick in bare spots. Top or pull prior to seed set. Lower the soil pH to 4.0 using granular sulfur.

Chemical: Staking pre and post-emergent herbicides is effective. Rotating group numbers regularly will increase efficacy.

Broadleaf weed management varies based on the target species and 24c labels.. See species-specific management comments below.

Grasses Herbaceous

Most grasses found in wild blueberry fields are perennial in nature. Grasses tend to have 'blades' which are a long slender leaf with parallel veins. They typically have hollow stems and obvious joints or nodes along the stem and at leaf junctions. Sedges and rushes are typically grouped with grasses but don't have stem joints. The stems of sedges have edges

when rubbed between fingers, while the stems of rushes are round.		

Grass Management

Cultural: Lower the soil pH to 4.0 using granular sulfur. Burn prune at least every few years. Applying mulch 2-4” thick in bare spots will also help.

Chemical: Pre or post-emergent herbicides are effective. Rotating group numbers regularly will increase efficacy. Sedges are easily confused for grass species and require different herbicides for optimal suppression.

Woody (Broadleaf) Woody weeds are perennials that include trees, shrubs or vines with a broadleaf or need-like foliage and a hard wood stem. In the winter, woody weeds lose their leaves sending nutrient reserve into the root system for regrowth the following year.		

Woody Weed Management

Cultural: Cut the weeds above the blueberry canopy 3 times during the non-crop year via a string-trimmer or saw. Burn pruning, reducing soil pH and mulch may help in preventing establishment.

Chemical: Pre-or-post-emergent herbicides are effective. Rotating group numbers regularly will increase efficacy. Applying/wiping freshly cut stumps with a non-selective herbicide will prevent regrowth.

Weeds
Herbaceous Broadleaf - Annuals

Family: Asteraceae

Burnweed (*Erechtites hieraciifolius* L.)	Canadian Horseweed (*Conyza canadensis* L.)
 	 
Leaves: Leaves are irregularly toothed and lobed (with few hairs) in both basal (base) and alternate (stem) in arrangement. **Stems:** The stem is thick and green with fine ridges. Each stalk only branching at the top near flowers. **Flowers:** Numerous large tubular flowerheads that appear ¼ open, tiny petals. **Bloom:** July to September. **Fruit:** Many fine seeds with hairs (like dandelion). **Spreads by equipment**	**Leaves:** Long and narrow. Alternate with hairs. **Stem:** Only branched near flowers (top of stalk), hairy. **Flower:** Large tubular flowers that appear ¼ open even in full bloom, with very small white to pink petals and a yellow center. **Bloom:** July to October. **Fruit:** Many seeds emerge per flower with little hairs to travel by wind. **Resistant to group 9: Glyphosate**

Family: Asteraceae

Ragweed (*Ambrosia artemisiifolia* L.)	Wild Lettuce (*Lactuca canadensis* L.)
 	

Leaves: Opposite and alternate. Feathery, smooth, and fern-like with dramatic lobes. **Stems:** Green to purple in color with velvety white hairs. **Flowers:** Thick spikes with many small flowers. Yellow green to purple in color. **Bloom:** Late July to September.	**Leaves:** Long, irregular, and deeply lobed with a defined vein down the center of each. **Stems:** Thick, unbranching and may be green to purple in color. **Flowers:** Clustered at the top of each stalk. Many small yellow to orange flowers with rays of overlapping petals. **Fruit:** Dandelion-like tufts of many brown seed with white hairs. **Bloom:** June to July.
Family: Orobanchaceae	**Family: Violaceae**
Cowwheat (*Melampyrum lineare* Desr.)	Violet (*Viola spp.*, many types)
 	 
Leaves: Simple, alternate, narrow and often purple in color along the edges and tips. **Stems:** Dark brown to red to purple in color. **Flowers:** Small, tubular yellow to white flowers starting midway up the stem. **Bloom:** June to August. **Fruit:** Dry, splits when ripe. **Semi-parasitic on blueberry**	**Leaves:** Stems: Flowers: Fruit: Bloom: Alternate, basal and heart shaped with a lightly toothed edge. **Stems:** Delicate and bunched growing under 1' in height. Flowers are at the tips of leafless stems. **Flowers:** Typically, purple to blue, but may be white to yell with a lighter center. Flowers are funnel shaped and slightly droopy with 5 petals and small hairs in the center. **Bloom:** Spring to mid-June. **Fruit:** Dry, splits when ripe, late May to July.

Weeds
Herbaceous Broadleaf - Perennials

Family: Amaranthaceae

Lambsquarters
(*Chenopodium album* L.)

young plant
(early June)

Leaves: Alternate, lobed and toothed in a wavy pattern. **Stems:** Branching green stem with red-streaks. **Flowers:** Many small green flowers at the top of the stem with 5-petals in a star shape. **Bloom:** June to September. **Fruit:** Dry, seed-like, does not split when ripe.
Prefers bare soil, reproduces via seed

Family: Apocynaceae

Spreading dogbane
(*Apocynum androsaemifolium* L.)

Leaves: Oval leaves opposite, 2″-4″ long and 1″-2.5″ wide, often drooping on short stalks. **Stems:** Reddish stems 1′-4′ tall grow from horizontal rootstocks, branches smooth and spreading. All parts exude white liquid when broken. **Flowers:** Pinkish, bell-shaped and about 1/4″ wide. **Bloom:** June to August. **Fruit:** Seed pods 4″ long and narrow in tandem.
Weed whack for cultural management

Family: Asparagaceae

Canadian Mayflower
(*Maianthemum canadense* Desf.)

Leaves: Broadly ovulate, typically 2-3 leaves per stem, smooth with defined

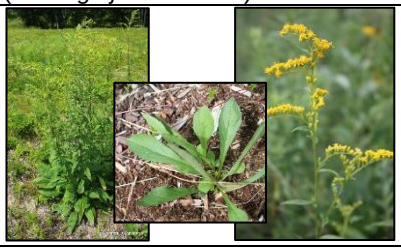
Family: Asteracea

Aster (*Aster spp.*, many types)
(Doellingeria umbellate in photos below)

Leaves: Leaves are alternate, typically smooth and long (1-3”) with 3 main

veins. **Stems:** Jointed in a zig-zag pattern, smooth, short. **Flowers:** Delicate, white star-shaped flowers clustered at the tops of stems. **Bloom:** Spring to June. **Fruit:** Tiny light red berries clustered along the upper half of the stem. June to August.	veins. **Stems:** Stems average 1-6' in height. **Flowers:** Colors can range from white to pink and purple to blue. Petals are numerous, narrow, and flat in rays around centers are yellow. **Bloom:** late July to September.

Family: Asteracea	
Black Eyed Susan (*Rudebeckia Hirta* L.)	Canadian Goldenrod (*Solidago canadensis* L.)
 	 
Leaves: Leaves are alternate, mostly basal and lance-shaped with bristles (hairs). Some small narrow leaves occur higher on stem. **Stems:** At maturity, stems are 1′ to 3′ tall, bristly, and erect with few branches. **Flowers:** Flower heads are 2″-4″ wide, orange yellow with dark purplish-brown centers and occur at the end of each stalk. **Bloom:** June to August.	**Leaves:** Narrowly lance-shaped, sharply toothed, 2″-5″ long and 0.25″-0.75″ wide. **Stems:** Smooth 1′-5′ tall. **Flowers:** Small orange-yellow pyramidal flower heads with conspicuously re-curved branches, usually borne in the upper side of the inflorescence. **Bloom:** August to October. **Hexazinone (group 5) has reduced efficacy**

Family: Asteracea	
Early Goldenrod (*Solidago juncea* Aiton)	Hawkweed (*Hieracium Spp.,* many types)
	
Leaves: Basal and stem. Alternate, long and narrow (fine hairs in places). Sharply toothed. **Stems:** Unbranched (except for flowers) and up to 4' tall with fine hairs. **Flowers:** Small orange-yellow pyramidal flower heads with conspicuously re-curved branches. **Bloom:** August to September. **Fruit:** Cone-shaped seeds with tufts of light brown hairs. Multiple varieties. **Hexazinone (group 5) has reduced efficacy**	**Leaves:** Ovate, hairy, basal untoothed leaves 2″-5″ long and 1/2″-7/8″ wide. **Stems:** Hairy 1′-2′ tall, mostly leafless stems with many leaves at the base. **Flowers:** Dandelion-like flower, orange or yellow, up to 1/2″ across. There may be a single flower per stem or multiple depending on the species or the plant. **Bloom**: May to July. **Fruit:** July to August. *Multiple Varieties (Meadow, Mouseear, Rough & Tall)* 

Family: Asteracea	
Lance-leafed Goldenrod (*Euthamia graminifolia* L.)	Rough Goldenrod (*Solidago rugosa* Mill.)
	
Leaves: Alternate, smooth, long-narrow leaves. 1″-5″ long and 1/8″-1/2″ wide. **Stems:** 2′-4′ tall and branched at the top. May have small hairs. **Flowers:** The flattish flower cluster is made up of small, orange-yellow flowers and found at tips of terminal branches. **Bloom:** July to September.	**Leaves:** Simple, alternate, rough-surfaced and toothed. Known as 'rough' or 'wrinkle'-leaf. **Stems:** Rough, hairy, 1-6' in height. **Flowers:** Small orange-yellow pyramidal flower heads with conspicuously re-curved branches. **Fruit:** Cone-shaped seeds with tufts of light brown hairs. Multiple varieties. **Blooms:** late-August to

	September. **Hexazinone (group 5) has reduced efficacy**

Family: Dennstaedtiaceae	**Family: Fabaceae**
Bracken Fern (*Pteridium aquilinum* L., Kuhn)	Golden (hop) Clover (*Trifolium aureum* Pollich)
	
Fiddleheads (emergence): Brown with silver hairs. Three distinct parts when unfurling. **Leaves:** Three fronds whorl at the top of each stem. Blade are 2′-4′ long, 1′-3′ wide, triangular and lobed with or without hairs. **Stems:** Rigid leaf stalk 1′-3′ long and swollen at base. **Spores:** Light brown masses may be seen on the underside of blades June to August. **Emerges** as fiddleheads Mid to late spring. Reproduces by creeping rhizome or by spores upon reaching maturity. *Aslox (Asulam) has a 24c label for special use on Bracken Fern*	**Leaves:** Alternate and compound in 3's. Pale-green in color and finely toothed. **Stems:** Smooth and branching. **Flowers:** Single oval shaped flower heads comprised of many small yellow flowers. The ages flower heads resemble dried hops. **Bloom:** June to August  *Rabbitfoot clover (*Trifolium arvense* L.) has a similar leaf structure but is an annual with pink-white flowers* 

Family: Fabaceae	
Red/purple, or White Clover (*Trifolium spp.*, many types)	Vetch (*Vicia spp.*, many types)
	
Leaves: Palmate and compound with 3 egg-shaped leaves, each with a whitish "v" pointing away from the stem. **Stems:** Green to brown with fine	**Leaves:** Long, narrow, oval and opposite, with a small, pointed tooth at the tip. **Stems:** Erect and sprawling, many branches. **Flowers:** Purple to

hairs. **Flowers:** Rounded pink to purple or white flower heads consisting of many small tubular flowers that are whitish at the base. **Bloom:** June to September.	pink small tubular flowers in varying arrangements depending on the variety. **Bloom:** May to September depending on variety. **Fruit:** Flat and long or finger-like (depending on variety) pea pod with dimpled peas.

Family: Hypericaceae	
Orange grass/ St. Johnswort ***Annual*** (*Hypericum gentianoides* L., Britton, Sterns & Poggenb.)	St. Johnswort (*Hypericum perforatum* L.)
 	 
Leaves: Simple, opposite, small and scaly. Smell like citrus or peach when crushed. **Stems:** Green, wiry and branching. Stems appear leafless. **Flowers:** Yellow to orange, small with five petals. **Bloom:** July to August. **Fruit:** Bright red, dry and splits when ripe.	**Leaves:** Oblong, entire, sessile, up to 1.5″ long with numerous, conspicuous black dots on leaf underside. **Stems:** Reddish and branching, 1′-2.5′ tall, woody at base. **Flowers:** Numerous, five-parted yellow 3/4″-1″ wide flowers clustered at branch ends. **Bloom:** July to August. 

Family: Onagraceae	Family: Osmundaceae
Fireweed (*Chamaenerion angustifolium* L., Scop.)	Interrupted Fern (*Osmunda claytoniana* L., Metzgar & Rouhan)
  	  
Leaves: Simple, alternate, long and smooth with a lighter midvein. Leaf veins are circular and don't terminate at the edges of the leaf. **Stems:** Sturdy, tall, erect stems that may be reddish in color. **Flowers:** Deep pink to rose colored, with 4 petals. Flowers are at the top of the stem. **Bloom:** July to August. **Fruit:** Dry and split when ripe.	**Fiddleheads (emergence):** Matted with white wooly hairs. **Leaves:** Range from 20-40" in length with distinct forking veins along each leaflet. **Stems:** Rigid with a slight groove. **Spores:** Series of dark green to brown capsules fused to the stock in the middle of each leaf. **Emerges** as fiddleheads Mid to late spring. Reproduces by creeping rootstock or by spores upon reaching maturity.

Family: Plantaginaceae	
Blue Toadflax ***Annual*** (Nuttallanthus canadensis L., D.A.Sutton)	Yellow Toadflax – Butter & Eggs (Linaria vulgaris P. Mill.)
  	 
Leaves: Simple, alternate, and opposite in orientation along stem. **Stems:** Slender, green to purple. **Flowers:** Light blue to purple to white **Bloom:** May to July. **Fruit:** Dry, small and seed-like, splits when ripe.	**Leaves:** Light pale green leaves that are alternate, narrow and smooth, 0.5 -1.5" long. **Stems:** May have clusters of 15 - 20 flowers along each stem. **Flowers:** Are yellow with elongated spurs dropping down. **Bloom:** mid-July to late September. **Fruit:** Dry and seed-like, splits when ripe.

Family: Polygonaceae	Family: Primulaceae
Red (sheep) Sorrel (*Rumex acetosella* L.)	Whorled loosestrife (*Lysimachia quadrifolia* L.)
 	 
Leaves: Alternate and distinctly arrow-shaped with broad lobes and bitter taste, 1″-4″ long. **Stems:** Slender 6″-18″ arising from a crown. **Flowers:** Red to yellow flowers at top of the plant, small and clustered in a whorl, male and female flowers on separate plants. **Bloom:** May to September. **Fruit:** Single capsule per flower containing a seed.	**Leaves:** Leaves are long, pointed and lance shaped whirling around the stem in groups of 3-7. **Stems:** Typically, standalone growing up to 40” in height (may have fine hairs). **Flowers:** Small and yellow with 5-pointed petals forming a star with a slight red tint in the center. Flowers emerge in a whorled arrangement above each whorl of leaves. **Bloom:** June to July.

Family: Rosaceae	
Cinquefoil (*Potentilla spp.*, many types)	Wild Strawberry (*Fragaria virginiana* Duchesne)
 	 
Leaves: Compound (palmate) leaves with 3-7 leaflets. Sharply toothed. **Stems:** Sometimes hairy and red to green in color. **Flowers:** Small and yellow with 5 petals. **Bloom:** June to July. **Fruit:** Dry, does not split when ripe. *Multiple varieties (Dwarf, Rough and Sulfur).*	**Leaves:** Compound with three oval serrated leaflets. **Stems:** Stout crown formed at ground level, leaf stalks 2″-6″ long (vine), hairy. **Flowers:** Flowers white, 5 petaled, 1/2″-1″ wide usually no taller than leaves. **Bloom:** Spring to June. **Fruit:** Red, round and juicy with

	seeds deeply embedded in the flesh. Develop June to July.

Weeds **Woody Broadleaf - Perennials**	
Family: Betulaceae	
Birch (*Betula spp.*, many types)	Speckled Alder (*Alnus incana* L., Moench)
	
Leaves: Triangular, dark green and smooth with a long tapering tip. **Stems:** Bark varies by species from white and papery to gray and smooth. Twigs are smooth, may have hairs and may be green to brown or red in color. **Flowers:** Long drooping catkins from 0.5” to 2.5” depending on the sex. **Bloom:** April. **Fruit:** Thin wings broader than the nut for dispersal by wind.	**Leaves:** Egg shaped, alternate and double-toothed with shallow lobes. Leaves are wrinkled and may have hairs. **Stems:** Twigs are smooth to somewhat hairy with scattered white lenticels. Bark is dark brown. **Flowers:** Buds are two-scaled, reddish brown and blunt tipped. Clusters of catkins emerge in one-year old trees. **Bloom:** March to May. **Fruit:** Short, egg-shaped green to brown cones.

Family: Cornaceae	Family: Ericaceae
Bunchberry (*Cornus canadensis* L.)	Black Huckleberry (*Gaylussacia baccata* (Wangenh.) K. Koch)
	
Leaves: Four to six terminally whorled leaves with one or two pairs of smaller leaves below. Leaves acute at both ends with two to three lateral veins arising from the midvein. **Stems:** 3″-9″ high and woody at the base. **Flowers:** Flowers solitary on a short stem with 4 white petals. **Bloom:** May to June. **Fruit:** Cluster of bright red berries. Fruits June to August. *Express (tribenuron methyl) has a 24c label granting special use as chemical management on Bunchberry*	**Leaves:** Alternate, fine-toothed, dark green and shiny. Midvein has tiny dark glands along the upper side. **Stems:** Woody, gray to brown with scattered lenticels. Shrubby in growth. **Flowers:** Pink to red to yellow tublar flowers (similar to blueberry). **Bloom:** May to July. **Fruit:** Purplish-black, fleshy, edible berries that ripen in late summer.

Family: Ericaceae	
Sheep Laurel/lambkill (*Kalmia angustifolia* L.)	Wintergreen (*Gaultheria procumbens* L.)
	
Leaves: Persistent leaves in whorls of three, oblong, dark green above, light green below and waxy, 1″-2.5″ long 1/4″-7/8″ wide, turn brownish in fall. **Stems:** Short, erect, woody shrub up to 3′ tall. **Flowers:** Flowers crimson 1/4″-1/2″ wide, set in a cluster 3/4 up the stem.	**Leaves:** Darker ‘evergreen’ green, shiny, oval shaped, and blunt tipped. Only 3-5 leaves per stem. Smell and taste minty when broken. **Stems:** Woody, short and creeping like an above ground rhizome shooting up individual stalks. **Flowers:** Small, white, bell-shaped and hanging. **Bloom:** Late July to August. **Fruit:** Small red to purple capsules that hang at the top of each stem.

Family: Fagaceae	Family: Myricaceae
Red Oak (*Quercus rubra* L.)	Sweetfern (*Comptonia peregrina* L., J.M. Coult.)
	
Leaves: Simple, lobed or unlobed. **Stems:** Woody, brown to gray to red and smooth in younger stems. The bark in older trees is ridged. **Bloom:** March to May. **Fruit:** Acorns (only in mature trees).	**Leaves:** Alternate, long, fern-like, scalloped (lobed) with rounded tips. Fragrant when crushed. **Stems:** Reddish brown to gray with lenticels and hairs. **Flowers:** Clusters of catkins, both drooping (male) and erect (female). **Bloom:** May to June. **Fruit:** Green to brown spikey bur-like clusters.

Family: Pinaceae	Family: Rosaceae
Pine (Pinus spp., many types)	Brambles (black, rasp., etc.) (Rubus spp., many types)
	
Leaves: Soft, long, evergreen needles often in clusters. **Stems:** Woody, brown to gray to red with ribs or scales depending on the age. **Bloom:** March to May. **Fruit:** The pinecones are ovoid-conic with thin scales. 	**Leaves:** Brambles usually have palmate leaves with 5-7 leaflets; leaves can have 3 leaflets. Leaves are toothed. **Stems:** Stems are woody and may have large prickles similar to rose thorns, or bristles. **Flowers:** Are delicate and white or pink. **Bloom:** late May to late July. **Fruit:** May be red or black. Fruits July to August.

Family: Rosaceae	
Chokeberry (*Aronia spp.*, many types)	Chokecherry (*Prunus virginiana* L.)
	
Leaves: Alternate, elliptic leaves with fine teeth. Leaves are dark green and shiny with dark tiny glands along the upper midvein. **Stems:** Woody, grey to yellowish brown in color with scattered lenticels. Twigs may be red. **Flowers:** Five white petals with a white to pink center in a flat-topped cluster. **Bloom:** Late May to June. **Fruit:** Resemble blueberries in shape and	**Leaves:** Long alternate leaves tapering to a point with very fine teeth. Leaves are lighter green and dull. **Stems:** Woody, ranging in color from red to gray. May have fine hairs. **Flowers:** Reddish buds have lighter edges. Many small white 5-petal flowers form a long cluster 2-4” in length. Flowers have a yellow center.

size. Black when ripe, edible and fleshy.	**Bloom:** Late May to early June. **Fruit:** Small, shiny, fleshy, and purple to red in color.

Family: Rosaceae	
Meadowsweet (*Spiraea* alba Du Roi var.)	Rose (*Rosa* spp., many types)
	
Leaves: Leaves lance-shaped, finely toothed, 1″-2″ long and 1/4″-1.25″ wide. **Stems:** Erect, woody, shrub 2′-6′ with reddish stems. **Flowers:** Terminal inflorescence usually pyramidal shaped, flowers 5 part, white to pink 1/16″-1/4″ wide in dense groups. **Bloom:** late June to August. **Fruit:** Clustered tiny pods containing seeds.	*Rosa spp. may differ in appearance due to pruning.* **Leaves:** Alternate, shiny and often toothed. **Stems:** Thorny, bristly, woody shrub with brown-reddish stems. **Flowers:** Flowers fragrant with 5 delicate pink-red petals and a yellow center. May not bloom due to pruning. **Bloom:** Early summer if developed. **Fruit:** Rose hips – red berry like fruit containing several small seeds.

Family: Salicaceae	
Aspen/Poplar (*Populus spp.*, many types)	Maple (*Acer spp.*, many types)
	
Leaves: Alternate, smooth and egg shaped with large blunt teeth. **Stems:** Woody, may be red leading up to the leaf. Emerging twigs have dense wooly hairs ranging from white to brown in color. Hairs are shed with maturity. **Flowers:** Hanging catkins 1-	**Leaves:** Broad and smooth, with 3-5 lobes and toothed edges. Opposite in orientation along stem. **Stems:** Woody with light gray bark. Twigs (smaller stems) may be reddish with white lenticels. Often multi-stemmed and shrubby when establishing. **Flowers:**

3” long emerge once the tree is 1 year of age. **Bloom:** April to May. **Fruit:** Green capsules the form along the catkin.	Clusters occur in yellow to red to scarlet depending on the sex of the flower. **Bloom:** April prior to bud-break

Weeds

Herbaceous Grasses - Annuals

Family: Poaceae

Barnyard Grass (*Echinochloa crus-galli* L., P.Beauv)	Witchgrass (*Panicum capillare* L.)
 	  
Leaf blades are flat and rough with a white mid-vein down the center. Blade **sheaths** may be reddish in color, with no hairs. **Stems** are thick, course, and erect, often growing horizontal to the ground. **Spikelet’s** are dense. **Flowers** June to October.	**Leaf blades** are flat, wide and alternate along the stem. Blade **sheathes** have fine white hairs. **Stems** are stout and erect with fine hairs on the sheath. **Spikelet’s** are thin, fine and loose. **Flowers** June to October

Weeds

Herbaceous Grasses - Perennials

Family: Poaceae

Colonial Bentgrass (*Agrostis capillaris* L.)	Fineleaf Sheep Fescue (*Festuca filiformis* P.)
 	  
Leaf blades are very fine grass, pale in color. Grows in creeping patches via rhizomes. **Stems** 1’ to 2’ in length but often bent over or drooping. **Spikelet’s** are very thin and fine. **Flowers** July to September.	**Leaf blades** are very fine. Densely tufted grass that typically remains green the entire season. **Stems** get up to 1’ in height with long **spikelet’s** that turn brown by late July. **Flowers** July to September. Reproduces by seed. **Known to be herbicide resistant in Maine**

Family: Poaceae	
Poverty Wild Oatgrass (*Danthonia spicata* L.)	Quack-grass (*Elymus repens* L., Gould)
 	  
Leaf blades are rough, 5″ to 8″ long and narrow (~1/8″) wide or less. Recognized by the **Sheathes** are shorter than the internodes. **Stems** are smooth. **Spikelet's** are small and narrow. **Flowers** from July to September. Reproduces by seed.	**Leaf blades** are 3″ to 12″ long and 1/8″ to 3/8″ wide, smooth beneath and rough above. **Stems** 1′ to 4′ tall with sheaths usually shorter than internodes. **Spikelet's** are tight and upright. **Flowers** July to September. Reproduces by rootstock and seed. **Considered an invasive species**

Family: Juncaceae	
Common rush (*Juncus effusus* L.)	Common woodrush (Luzula multiflora Ehrh., Lej.)
 	 
Leaf blades are narrow and tufted at the base of tall, round, smooth **stems**. **Flowers** are branched and clumped, 1″ to 4″ off the ground (~2/3 of the way up the stem). The rootstock is stout, branching and proliferous. **Flowers** July to September.	**Leaf blades** are wide and flat with fine white hairs. Leaves may turn reddish with stress. **Flowers** form in round clusters at the terminal end of round smooth stems. Subsequent fruits are small dark capsules. **Flowers** April to June.

Family: Cyperaceae	
Blue Ridge Sedge or Fire Sedge (*Carex lucorum* Willd. ex Link)	Bulrush/Woolgrass Sedge (*Scirpus spp.*, many types)
	
Leaf blades are slender, yellowish-green and may be smooth or rough. **Stems** are triangular and smooth with a sex-specific spike at the terminal end. **Flowers** late-April to May.	**Leaf blades** are wide, flat and vary in color by species. **Stems** are triangular tall and smooth with a branched and sometimes drooping cluster of small flowers. The **fruit** is seed-like and surrounded by hairs. **Flowers** June to August.

Weed IPM Tools

UMaine Cooperative Extension Weed ID Tool:
https://extension.umaine.edu/blueberries/weed-images/

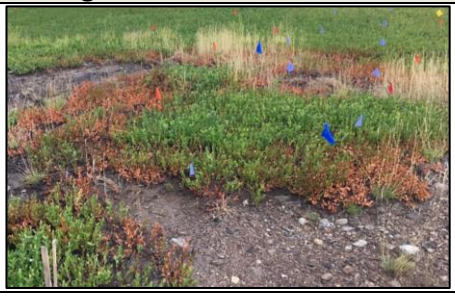
Go Botany:
https://gobotany.nativeplanttrust.org/

UMaine Cooperative Extension Herbicide Chart:
https://extension.umaine.edu/blueberries/wild-blueberry-pesticide-charts/

Abiotic Injury

Abiotic injuries in wild blueberry are those that occur as a result of the environment rather than biological organisms.

Types of Abiotic Injury	
Winterkill	**Cold During Bloom**
 	 
Winterkill occurs when a lack of snow cover, wind and/or extreme cold lead to death of the upper portion of the stem. This is visible at bud-break in the spring and as leaves emerge in the crop year. The damaged buds remain brown and closed. This may occur in large patches or on random stems. Taller stems are more susceptible.	Cold temperature damage can occur when temperatures dip below 30°F. Almost open and open blooms and immature leaves are the most susceptible to damage. Cold can kill blooms and internally damage pin head and green fruit so that they do not develop and ripen. It can also prevent leaves and branches from expanding. **Cold temperature damage, particularly of flowers, can be mistaken for mummy berry or botrytis**

Drought	Nutrient Deficiencies
	
Plants dry out with a lack of water resulting in marginal or complete browning and death of leaf tissue. Drought may also lead to nutrient deficiencies because plants need water to take up nutrients. Drought can greatly impact yield in both prune and crop fields.	Nutrient deficiencies may occur when the required nutrients are lacking from the soil or when there is insufficient soil moisture or poor drainage (affecting transpirtation). Nutrient deficiencies affect the growth and development, crop resilience, fruit-set and yield. Foliar samples should be taken more than once each year to determine crop demand.

Fruit Abortion	Fall Bloom
	 
This physiological phenomenon occurs when resources (water, nutrients) are scarce and the blueberry plant focuses on developing some fruits (pink, red or blue) and aborts others (small green fruits that remain on the stem or fall off, but don't swell or change color). *This is commonly mistaken for delayed ripening, but the small green fruits will not mature*	A physiological phenomenon in response to environmental conditions (temperature and day length) in the fall of the prune year. Fall bloom results in the bloom and sometimes fruiting immediately following the vegetative growth and bud development. Buds that bloom and or fruit in the prune year will not produce in the crop year.

Nutrient Deficiency

The appearance of apparent mineral deficiency symptoms may be the result of an actual deficiency or could be caused by several other conditions or combinations of conditions including:

1. Insufficient or poor soil moisture distribution, and/or topsoil erosion
2. Poor drainage and subsequent restriction of the root system
3. Insects, disease, fertilizer burn, herbicide burn, weed competition, or compaction of the soil, all of which weaken the root system
4. Periods of cool weather during the growing season

*You should be sure that none of the above conditions exist before making additional fertilizer applications. *Keep in mind that plants require water in order to take up nutrients.**

Macro-Nutrient Roles and Deficiency Symptoms			
Nutrient:	**Nitrogen (N)**	**Phosphorus (P)**	**Potassium (K)**
Role in the plant:	Required in the formation of amino acids and chlorophyll. Also impacts the availability of other nutrients in the plant.	Used to store and transfer energy within the plant. Also forms nucleic acids (DNA, RNA), stimulating early growth, flowering, fruiting seed production and root growth.	Important in the formation of proteins, carbohydrates (sugar and starch) and chlorophyll. Necessary for the translocation of sugars and the formation of starch.
Symptom:	Chlorosis: pale leaves due to a lack of chlorophyll. Reddish tint along the leaf edges that moves toward the midvein.	Reduced growth resulting in abnormally small plants with dark green leaves.	Appears as interveinal chlorosis in younger leaves. Severe cases lead to red leaf margins developing into marginal leaf scorch (dead, dry tissue).
Notes:	If leaf redness is reduced after a rain event, the plant is likely nitrogen stressed.		Marginal leaf scorch can be confused with disease symptoms from root rots and stem blights.
Micronutrients (ex. iron, copper, manganese etc.) may also present similar changes in leaf color and plant development. Further research is needed.			

How to Take Leaf Tissue Samples

Leaf samples are used to determine fertilizer needs
Sampling should be limited to *Vaccinium angustifolium* (sweet low) and the *Vaccinium myrtilloides* (sour top) blueberry should not be sampled.

Cut 3 stems from 30 clones throughout the field for one sample.

- Do not include soil particles
- Avoid areas of severe disease or insect defoliation
- Do not mix in other vegetation
- Pesticide and dust residue must be rinsed off
- Store samples in a clean, dry area

Stripping leaves from the stems reduces the cost.

How To Take Soil Samples

Soil samples are used to determine soil pH and assess sulfur needs

1. Each sample box should contain a composite of at least 15 samples scattered over a well-defined area. Walk in a Z through the field, taking samples as you go.
2. Take each composite sample from an area which is uniform with respect to texture, slope, drainage, erosion, color, or past soil management.
3. Use a sampling tube, auger or spade. Each sample should be a depth of 3-4 inches.
4. Place the 15 samples of soil in a clean pail and mix thoroughly.
5. Fill the sample box with the mixed soil for testing.
6. Fill out the form.

Send leaf and soil samples to:

ANALYTICAL LAB
5722 Deering Hall
Orono ME 04469-5722

Forms and sample kits can be found at your local extension office or at the UMaine Analytical lab website: https://umaine.edu/soiltestinglab/

Applying Sulfur to Lower Soil pH

Sulfur is an effective treatment for reducing soil pH to control weeds in wild blueberry fields. The wild blueberries are well adapted to a low pH environment, but the acidic environment is hostile to most weeds. Thus, reducing pH will favor wild blueberry while reducing weeds, especially grasses.

1. Soil sample using the instructions above
2. Apply 100 lbs of sulfur/acre for each 0.1 of desired pH reduction
3. Do not apply more than 800 lbs/acre of sulfur in a given year
4. Do not apply sulfur to saturated or frozen soil or wet leaves as you could burn your plants

*Sulfur is less expensive than herbicides and longer lasting in its effects. However, it may take 2-3 years to see an adequate reduction in soil pH, and therefore, weeds.

Pesticide Sprayer Calibration Tips

Boom sprayers are most efficient. Jacto cannon sprayers are not efficient and produce drift.

Avoid <u>over-applications</u> and <u>unsuccessful</u> applications, these result in: unneeded cost, increased exposure risks, unexpected carryover to the following season and negative impacts on off-target organisms.*

Avoid <u>underapplication</u>, this can result in: pest survival (impacting yield and quality), potential need for retreatment (which is costly) and increased risk of pest resistance (in the populations that survived).

Sprayers still need to be calibrated even if a rate controller is present!

Causes of incorrect sprayer calibration:	
Problem	**Solution/Checklist**
Worn nozzles	Monitor and replace nozzles as needed
Old or dry O-rings on valves	Replace O-rings in a timely manner
Boom height	Adjust relative to nozzle angle and desired overlap (ideally 30%)
Pressure gauge malfunction	Calibrate and monitor. Pressure that is too high can increase drift and cause hoses to blowout of leak

Plugged nozzles	Monitor and unplug. Flag intentionally plugged nozzles with bright tape as a reminder
Faulty speedometer	Calibrate and monitor
Leaky hose	Check for leaks

Influence of tractor speed on application rate:	
Tractor Speed	**Result**
Faster	Less material applied per area
Slower	More material applied per area

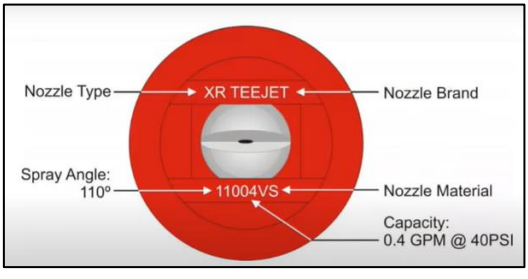
Factors affecting droplet size and drift: *FIND THE HAPPY MEDIUM*		
Factor	**Scenario**	**Result**
Pressure (PSI)	High PSI	Results in smaller droplets which result in better coverage BUT will carry farther resulting in higher drift and lost product
	Low PSI	Results in larger droplets reducing drift BUT can lead to poor coverage, overapplication and unintended spray pattern
Wind speed	10 mph or greater	<u>It's illegal to spray in winds greater than 15 mph.</u> Winds greater than 10 mph are likely to cause off target drift as the wind physically carries the droplets and creates smaller droplets
Boom height	Close to ground	<u>Reduces drift</u> Optimal boom height will depend on spray angle
	Far from ground	More space for wind carry droplets. Uneven ground will tip the boom raising the height even higher at times
Spray Volume (nozzle-output)	High	Higher nozzle output relative to PSI = larger droplets (reduced risk of drift)
	Low	Lower nozzle output relative to PSI = smaller droplets (higher risk of drift)
Tractor Speed	Too Fast	Increases the "shearing effect" creating smaller droplets. Faster tractor speeds can also result in less material applied per acre
Spray Angle	Wider (110˚ or more)	Create smaller droplets BUT require a lower boom height when using a boom sprayer
	Narrower (80˚ or less)	Create larger droplets BUT require a higher boom height when using a boom sprayer

Evaporation Potential	High (RH<50%)	Evaporation occurs more quickly increasing the risk of drift
	Low (RH>70%)	Less evaporation allowing the spray to settle
Adjuvants	Added to mixture	Can increase droplet size, reduce drift, and increase absorption, BUT may reduce coverage

Unneeded nozzles that are not targeted for a low crop should be plugged (*ex. airblast sprayers have top facing nozzles that wouldn't hit the crop*)		
Sprayer nozzles can be safely plugged via:	Brass blanks	Recommended for longer term plugging of nozzles
	Quick shut off valve	A valve that covers the nozzle and can be easily turned on and off as needed
**Plugging nozzles should not change the PSI of the sprayer as long as the pressure regulator is working correctly*		

How to properly clean a nozzle:	
DON'T BLOW ON IT! (Ensure proper PPE when handling)	Carry a can of compressed air with you
	Use a soft bristled brush (not wire)
	End of season method: soak nozzles in a bucket of water. *Dump water properly and clean bucket after*

Calibration Scenario: Boom Sprayer	
1.	Inspect the tractor and sprayer (Be sure to triple rinse before inspecting)
2.	Measure the distance between nozzles (common distance is 18"-20")
3.	Reference a calibration chart! (Ex. nozzle spacing = 20" . Travel distance = 204')
4.	Time the tractor to go 204' at the anticipated rpm or mph that you'll be applying (Ex. 204' takes 37 sec)
5.	Turn on tractor. Match pressure gauge PSI to nozzle PSI requirement
6.	Using buckets or jugs to catch the output, measure how much water comes out of each nozzle for 37 seconds. *Each nozzle should be within 10% (+/-) of eachother*
7.	Calculate an average nozzle output. Calculate the amount of spray output per area and mix rate according to the label. *Use a calibration worksheet for easy math*



Graphic: TeeJet, https://www.teejet.com/

Estimating Wind Speed

Description	Observed Effects	Notes	Approximate Wind Speed
Calm	Smoke rises vertically	Avoid fine sprays on warm sunny days	**Less than 1 MPH**
Light Air	Smoke drift indicates wind direction; weather vanes do not move	Avoid fine sprays on warm sunny days	**1 to 3 mph**
Light Breeze	Leaves rustle; wind felt on face; weather vanes begin to move	Ideal spraying	**3 to 7 mph**
Gentle Breeze	Leaves and twigs in constant motion	Okay to spray	**7 to 11 mph**
Moderate Breeze	Small branches moved, raises dust, leaves, and loose paper	**SPRAYING NOT ADVISED.** Avoid finer sprays or higher boom heights	**12 to 15 mph**
Fresh Breeze	Small trees sway	**DO NOT SPRAY.** Drift regulations prohibit spraying when wind speed is over 15 mph	**Greater than 15 MPH** *Off target movement very likely*
Strong Breeze	Large branches sway	**DO NOT SPRAY.**	
Moderate Gale	Whole trees in motion	**DO NOT SPRAY**.	

Signing Following a Spray

Signing a field before and after a spray ensures safety for the public, workers and UMaine researchers who may have access to enter your field.

Signing requirements are based on Worker Protection Standards (WPS). Federal law (WPS) requires farms to post when:

- the product REI is greater than 48 hours
- the label specifically requires physical posting

The WPS now specifically dictates that signs must be posted no earlier than 24 hours in advance of an application and must be removed/covered within 3 days after the end of the REI. Additionally, workers cannot be in the treated area while it is still posted—even if the REI has expired.

We highly recommend signing after every spray regardless of the REI.

PLEASE NOTE: It is unlawful to use any pesticide for other than the registered use. Read and follow the label on the product container. The user assumes all responsibility for use inconsistent with the label. Trade names are used for identification. No product endorsement is implied, nor is discrimination intended against similar materials. Cooperative Extension

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Land Acknowledgement

The University of Maine recognizes that it is located on Marsh Island in the homeland of the Penobscot Nation, where issues of water and territorial rights, and encroachment upon sacred sites, are ongoing. Penobscot homeland is connected to the other Wabanaki Tribal Nations — the Passamaquoddy, Maliseet, and Mi'kmaq — through kinship, alliances, and diplomacy. The University also recognizes that the Penobscot Nation and the other Wabanaki Tribal Nations are distinct, sovereign, legal and political entities with their own powers of self-governance and self-determination. The Wild Blueberry Cooperative Extension & Research team recognizes that the ongoing cultivation of wild blueberry in Maine is based on the knowledge and experience gained by generations of Passamaquoddy, Mi'kmaq, Maliseet, and Penobscot communities; these communities continue to cultivate and celebrate wild blueberry today.