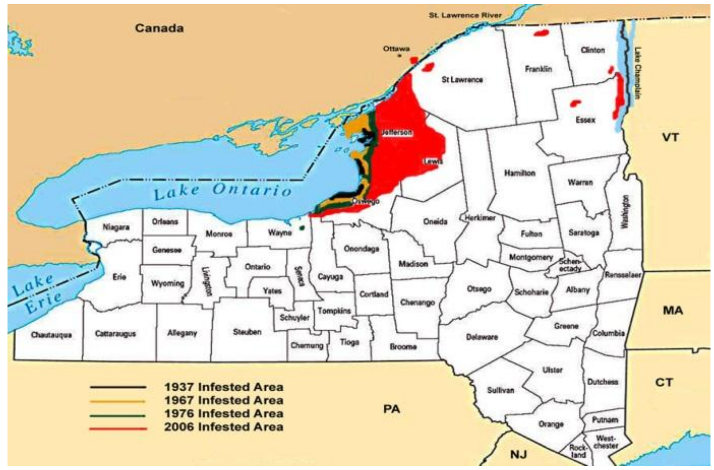
Cornell University
Cooperative Extension

Management of Alfalfa Snout Beetle



Alfalfa snout beetle (ASB), *Otiorhynchus ligustici*, was brought to North America from Europe during the 1800s in shipping ballast and was first introduced in the Port of Oswego, New York. When alfalfa was introduced as forage for the dairy industry in the 1920s, ASB became a significant pest almost immediately. Today, this insect infests more than 500,000 acres in nine counties in northern New York and remains a severe pest of alfalfa. The ASB larvae feed on the roots of alfalfa plants and cause severe economic damage for alfalfa producers and dairy farmers. Successful management of ASB relies on an understanding of the pest's history, two-year life cycle, and behavior. Since 2007, fields throughout the ASB infested counties of Clinton, Essex, Franklin, Jefferson, Lewis, and St. Lawrence have been applied with a solution of NY-native entomopathogenic (insect-attacking) nematodes (microscopic worms). These nematodes can reduce ASB populations, thus increasing alfalfa production.

Alfalfa Snout Beetle Life Cycle

Year 1: April – May
Adult beetles emerge and feed on alfalfa foliage for 3 weeks to build fat reserves for egg laying. They can be seen crossing roadways in search of new feeding ground. (Top left figure)

Year 2-3: September – May
Fully developed adults remain underground until emergence in April/May. (Top right figure)

Year 1: May – June
Adults enter non-feeding dispersal phase laying eggs at the base of host plants. One adult can lay up to 500 eggs.

Year 2: June – August
Larvae remain in hibernation but finish developing and turn into adults.

Year 1: June – October
Larvae feed on alfalfa plant roots. Most heavily damaged plants begin to die in August and remaining death occurs September-October. (Bottom left figure)

Year 1: November
Larvae burrow deep into the soil for a full year. They become adults the following summer.

Year 2: April – May
Stand loss is seen, fields are patchy or barren. Surviving plants may fill in quickly and damage may not be observable. (Bottom right figure)

A Brief History of Alfalfa Snout Beetle	
1896	First ASB detection in United States. It was introduced to the Port of Oswego through shipping ballast between 1845 and 1896 from Europe.
1920s-1930s	Alfalfa introduced as new forage for dairy industry.
1933	ASB discovered as a pest in multiple fields totaling 3,000 acres.
1939-1972	ASB populations were managed using widespread broadcast of poison bait containing heptachlor and other insecticides with molasses.
1972	Above methods were banned due to environmental contamination concerns.
1976-1986	ASB populations explode and start to rapidly expand over large areas. 2 million beetles per acre exist in some areas.
1988-1989	Potential insecticides were evaluated as a temporary management option, but were not shown to be effective tools.
1990-1995	Potential biological control organisms – entomopathogenic (insect-attacking) nematodes were isolated from the soil. Trials performed in laboratories, greenhouses, and fields demonstrated 90-94% reduction in ASB larvae and only 15% stand loss. Seventy-seven current alfalfa varieties planted and field screened for ASB resistance. No indication of resistance was identified.
1996-1997	Breeding program initiated to develop potentially ASB-tolerant or ASB-resistant alfalfa varieties. 10-20 years of intensive research effort required.
1995-2002	Field evaluations of entomopathogenic nematodes continued focusing on persistence, application techniques using commercial sprayers, timing of application, and dose rates.
2002	Entomopathogenic nematodes that moved from test plots throughout the Peck dairy farm were responsible for the first farm-wide ASB population crash.
2004-2012	Research focus changed to developing producer-friendly nematode rearing and application techniques. Extension efforts focused on teaching producers and agribusiness professionals new techniques for rearing and applying nematodes. Entomopathogenic nematodes have been inoculated on more than 150 ASB-infested fields in 6 counties. Extension efforts for on-farm rearing of nematodes continue.
2008	After screening more than 150,000 alfalfa seedlings for ASB resistance, the first field trial to evaluate resistant varieties was planted with encouraging results.
2008-2012	Subsequent trials for resistant varieties have been planted annually. The first ASB-resistant alfalfa variety is scheduled to be available in 2013 on a limited basis. Breeding work is continuing in an effort to increase the level of resistance to ASB in alfalfa.

Direct Costs of ASB

A detailed economic analysis including the points made below can be found at the end of this document.

- In a **3-cut system, 4-year rotation**, ASB can cost a producer up to $381 per acre if 100% stand loss occurs.
- In a **3-cut system, 4-year rotation**, ASB can cost a producer up to $21 per acre if 50% stand loss occurs.
- In a **4-cut system, 3-year rotation**, ASB can cost a producer up to $487 per acre if 100% stand loss occurs.
- In a **4-cut system, 3-year rotation**, ASB can limit the total profit to $130 per acre if 50% stand loss occurs.
- In a **4-cut system, 4-year rotation**, ASB can cost a producer up to $239 per acre if 100% stand loss occurs.

Indirect Costs of ASB

Root feeding by ASB.

- Increased purchases of off-farm protein sources and other feed.
- Increased cost of milk production per cow.
- Quality grass forage production can require larger harvest equipment, more acreage, and more tile drainage due to the narrower harvest window and lower tonnage per acre.
- Impact on nutrient management plan.

ASB Management Strategies

ASB larval feeding on crop roots can destroy entire fields within a single year. For the past 22 years, research has been conducted to identify and evaluate viable and cost-effective options for managing ASB.

Insecticides have not performed well and are not recommended under any circumstances.

Crop rotation is not a practical strategy because producers typically do not plow a viable alfalfa crop after the 2nd production year, which would reduce ASB populations by interrupting the two-year life cycle. Simply adding a 3rd production year to the stand life allows the beetle population to explode to very high levels. Limiting stand life to 2 production years can manage beetle populations on a farm.

ASB-resistant alfalfa varieties in development at Cornell demonstrate promising results, but they are still a few years away from being widely accessible to producers. The first ASB-resistant variety is scheduled to be available in 2013 on a limited basis. If ASB is already present in large populations, the ASB variety's resistance may be overrun, therefore, it may be more effective to reduce ASB populations with biological control prior to planting resistant alfalfa varieties.

Biological control using entomopathogenic (insect-attacking) nematodes is a successful management strategy. NY-native persistent nematodes are available for application on grower fields to reduce ASB populations. Producers are now able to rear and apply nematodes to their own fields. More than 72 farms have applied biological control nematodes on more than 154 fields in six northern NY counties.

ASB crossing an asphalt road in Lewis County.

Establishing Biological Control for ASB on Your Farm

Inoculating fields with persistent entomopathogenic nematodes is different from purchasing and applying commercially available nematodes. Commercial nematodes rely on high application rates and will not persist more than a single growing season. NY-native nematodes are available and persistence has been documented under NY conditions. The following are instructions for NY-native nematode usage.

Timeline to Successfully Rear and Apply Your Own Nematodes

Before you begin:

1) **Decide which field(s)** will be inoculated and inform local extension agent to develop inoculation schedule a minimum of 6 weeks before harvest.
2) **Communicate with Shields Lab** at Cornell University for starter cups (**607-591-1493**)*

17-21 days before harvest	Order wax worm field cups from bait supply store to arrive 1-3 days before fields are cut. **Make sure starter cups have been ordered from Shields Lab.**
1-3 days before harvest	Starter cups and field cups will arrive.
24-48 hours after harvest	Inoculate field cups. Store between 65 and 75°F.
3 days after inoculation	Should see 90-100% death of wax worms in field cups.
12-14 days after inoculation	Should see emergence of infective juvenile nematodes from field cups.
3-7 days after emergence	Nematodes can be collected and applied to field(s).

**Reminder: Alter your field cup orders if harvest schedule changes.*

Supplies Needed

- **Wax worms** (wax moth larvae) – Starter cups and field cups contain about 250 wax worms each.
- **Utensil** to collect and spread nematode solution (e.g., teaspoon measuring spoon, 1-2 teaspoon medicine spoon, 10-30cc syringe, OR teaspoon dosing dropper).
- **Small container** to collect nematodes from starter cups (e.g., 16 oz. or larger measuring cup or dishpan).
- **Non-chlorinated water**

- **Paintbrush** or toothbrush
- **Large container** to collect nematodes from the field cups for field application (e.g., 20 gallon garbage can OR 5 gallon bucket).
- **Mesh screen** to prevent wax worms and sawdust from falling into the nematode solution.
- **Spray rig** – You can build your own or contact a local extension agent to inquire if one is available. If using one that has been used for any other pesticides, etc., be sure to rinse thoroughly before using for nematode application. Examples of Shields Lab spray rigs can be seen in the "Field Application of Nematodes" section.

Rearing Your Own Nematodes

1) Order field cups from bait supply store **(see timeline)** with a minimum purchase equaling recommended application rate of 8 cups (4 cups of SC***** and 4 cups of SF***** nematodes) for every 2 acres to be applied. Cost will be approximately $50 per 2 acres. A more aggressive application rate can be implemented if needed.

   ***** *SC and SF are abbreviations for the two species in the starter cups: SC: S. carpocapsae and SF: S. feltiae. Do not mix species until ready to use mesh screen.*

2) Communicate with Shields Lab about the number of field cups ordered so the lab can coordinate arrival of starter cups needed for application. Starter cups will contain microscopic nematodes living inside wax worm cadavers.
3) Starter cups will arrive. Nematodes will be emerging from larvae and will appear as a yellow film on edges of cup and lid. If no film is seen, check date on cups and emergence should be seen within 12-14 days. Field cups will arrive with fresh larvae and will only contain wax worms.

Nematodes are located inside of host wax worm larvae.

4) Fill small container with **non-chlorinated water** and have paintbrush ready.
5) Take the starter cups labeled SC and use the paintbrush to gently scrape the yellow film areas into the container of water. Repeat until most of the film has been collected.
6) Shake water gently to avoid nematode settling. Using utensil of your choice, take out 4 teaspoons or 20cc of the nematode water and cover entire surface of **HALF** of the field cups ordered.

7) Replace lid over field cup with live wax worms and the nematode water just added.
8) Label each cup with SC and the date inoculated.
9) Use a new small container and a new paintbrush or clean the ones previously used with alcohol or Clorox and rinse thoroughly.
10) Repeat steps 3-7 with starter cups labeled SF. Inoculate the remaining field cups.
11) Store cups between 65 and 75°F.

Applying Your Own Nematodes

A yellow film should be seen in each of the inoculated field cups within 12-14 days. The SC cups may emerge more quickly than the SF cups. Application can begin 3-7 days after emergence is seen.

1) Place screen over large container (bucket or trash can).
2) Using **non-chlorinated** water, wash each field cup (both SC and SF cups can now be washed together) over the screen allowing the nematodes to pass through screen and into container while sawdust and wax worms remain. A water hose works well here.
3) Spray screen thoroughly to separate remaining

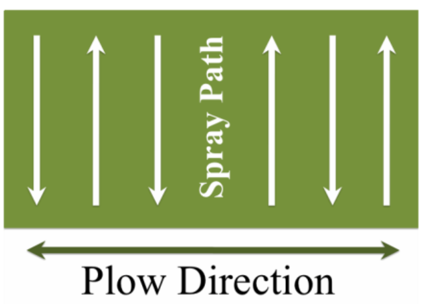
Using screens over trash cans to filter sawdust and wax worms from nematodes for field application.

nematodes from sawdust and wax worms. If possible, use screen again to filter any particles that may have passed through the first time. **Screening prevents clogging of spray nozzles and pumps.**

4) Nematode water in container is ready for field application.
5) If more volume is needed to cover area in fields, add more **non-chlorinated** water to spray rig tank.
6) **Application rate:** Apply 8 cups (4 SC cups and 4 SF cups, now mixed in solution) per every 2 acres.

Field Application of Nematodes

Nematodes move throughout the soil and to adjacent areas on their own, and are helped by plowing and other farm activities that move soil around. Applying nematodes in strips perpendicular to or against the grain of the plow direction allows spread to non-inoculated strips by plowing of soil. Some growers choose to apply nematodes to the entire field for quicker results. The decision to apply nematodes to the entire field or in strips is dependent on budget and how quickly a grower wants full coverage against ASB.



ATV and truck spray rig examples. For more information on building your own spray rig, contact the Shields Lab.

Trash can screen examples. For more information on building your own screen, contact the Shields Lab.

We would like to thank Kara Dunn and the following agencies for their continuing support:

NY farm viability INSTITUTE

Northern New York Agricultural Development Program

For More Information:

Visit our website: **www.alfalfasnoutbeetle.org** or contact your local Cornell Cooperative Extension Office.

To contact the **Shields Lab** at Cornell University directly:
Tony Testa, Cornell University, at28@cornell.edu, 607-591-1493
Elson Shields, Cornell University, es28@cornell.edu, 607-279-1849
Melissa Keller, Cornell University, mdk236@cornell.edu

YEAR 1*
Establishment
Loss = $136/A

3-Cut System, 4-Year Rotation

Alfalfa Snout Beetle is costing you up to $381 per acre.

NO STAND LOSS

YEAR 2 (1ST full production year)

Mowing and Raking 3 times	$75
11.4 tons (35% DM) at $8/ton	$91
Land Cost, Overhead	$150
Nutrient Removal (0-40-240)	$135
Total 2nd Year Cost	$451/A
Profit: 4 tons DM at $170/ton	$680/A
2nd Year Cost	-$451
Total Profit Year 2	**= $229/A**

YEAR 3 (2nd full production year)

Mowing and Raking 3 times	$75
10 tons (35% DM) at $8/ton	$80
Land Cost, Overhead	$150
Nutrient Removal (0-35-210)	$118
Total 3rd Year Cost	$423/A
Profit: 3.5 tons DM at $170/ton	$595/A
3rd Year Cost	-$423
Total Profit Year 3	**=$172/A**

YEAR 4 (3rd full production year)

Mowing and Raking 3 times	$75
8.6 tons (35% DM) at $8/ton	$69
Land Cost, Overhead	$150
Nutrient Removal (0-30-180)	$100
Total 4th Year Cost	$394/A
Profit: 3 tons DM at $170/ton	$510/A
4th Year Cost	-$394
Total Profit Year 4	**=$116/A**

TOTAL FROM YEARS 1,2,3,4

Year 1 (Establishment)	**LOSS = $136/A**
Year 2	**PROFIT = $229/A**
Year 3	**PROFIT = $172/A**
Year 4	**PROFIT = $116/A**
Total Profit	**= $381/A**

50% STAND LOSS

YEAR 2 (1ST full production year)

Mowing and Raking 3 times	$75
11.4 tons (35% DM) at $8/ton	$91
Land Cost, Overhead	$150
Nutrient Removal (0-40-240)	$135
Total 2nd Year Cost	$451/A
Profit: 4 tons DM at $170/ton	$680/A
2nd Year Cost	-$451
Total Profit Year 2	**= $229/A**

YEAR 3 (2nd full production year)

Mowing and Raking 3 times	$75
5.7 tons (35% DM) at $8/ton	$46
Land Cost, Overhead	$150
Nutrient Removal (0-20-120)	$67
Total 3rd Year Cost	$338/A
Profit: 2 tons DM at $170/ton	$340/A
3rd Year Cost	-$338
Total Profit Year 3	**=$2/A**

YEAR 4 (3rd full production year)

Total Loss Year 4 = $116/A

If 50% loss of stand occurs following the second full production year, ASB damage will result in a loss of $21/A across the 4-year life of the stand.

TOTAL FROM YEARS 1,2,3,4

Year 1 (Establishment)	**LOSS = $136/A**
Year 2	**PROFIT = $229/A**
Year 3	**PROFIT = $2/A**
Year 4	**LOSS = $116/A**
Total Loss	**= $21/A**

100% STAND LOSS

YEAR 2 (1ST full production year)

Mowing and Raking 3 times	$75
11.4 tons (35% DM) at $8/ton	$91
Land Cost, Overhead	$150
Nutrient Removal (0-40-240)	$135
Total 2nd Year Cost	$451/A
Profit: 4 tons DM at $170/ton	$680/A
2nd Year Cost	-$451
Total Profit Year 2	**= $229/A**

YEAR 3 (2nd full production year)

Total Loss Year 3 = $172/A

If 100% loss of stand occurs following the first full production year, ASB damage will result in a loss of $79/A across the 3-year life of the stand.

YEAR 4 (3rd full production year)

Total Loss Year 4 = $116/A

If 100% loss of stand occurs following the second full production year, ASB damage will result in a loss of $195/A across the 4-year life of the stand.

TOTAL FROM YEARS 1,2,3,4

Year 1 (Establishment)	**LOSS = $136/A**
Year 2	**PROFIT = $229/A**
Year 3	**LOSS = $172/A**
Year 4	**LOSS = $116/A**
Total Loss	**= $195/A**

* Total 1st year cost $510/A (Land Cost/Overhead $150, Tillage/Planting $70, Seed $80, Fertilizer/Manure $80, Herbicide $30, Mowing/Raking $50, Chop/Haul/Ensile 6.3 tons at $8/ton $50). Profit estimated at $374/acre (2.2 tons DM x $170/ton). Source: 2012 Pennsylvania Custom Rates Table

We thank Everett D. Thomas, Michael E. Hunter, and Thomas F. Kilcer for contributions to this effort.

4-Cut System, 3-Year Rotation

Alfalfa Snout Beetle is costing you up to $487 per acre.

YEAR 1*
Establishment
Loss = $136/A

NO STAND LOSS

YEAR 2 (1ST full production year)

Mowing and Raking 4 times	$100
12.9 tons (35% DM) at $8/ton	$103
Land Cost, Overhead	$150
Nutrient Removal (0-45-270)	$152
Total 2nd Year Cost	$505/A
Profit: 4.5 tons DM at $170/ton	$765/A
2nd Year Cost	-$505
Total Profit Year 2 =	**$260/A**

YEAR 3 (2nd full production year)

Mowing and Raking 4 times	$100
10 tons (35% DM) at $8/ton	$80
Land Cost, Overhead	$150
Nutrient Removal (0-40-240)	$135
Total 3rd Year Cost	$465/A
Profit: 4 tons DM at $170/ton	$680/A
3rd Year Cost	-$465
Total Profit Year 3	**=$215/A**

IF STAND PERSISTS - YEAR 4

Mowing and Raking 4 times	$100
10 tons (35% DM) at $8/ton	$80
Land Cost, Overhead	$150
Nutrient Removal (0-35-210)	$117
Total 4th Year Cost	$447/A
Profit: 3.5 tons DM at $170/ton	$595/A
4th Year Cost	-$447
Total Profit Year 4	**=$148/A**

TOTAL FROM YEARS 1,2,3,4

Year 1 (Establishment)	**LOSS = $136/A**
Year 2	**PROFIT = $260/A**
Year 3	**PROFIT = $215/A**
Year 4	**PROFIT = $148/A**
Total Profit - 3 years	**= $339/A**
Total Profit - 4 years	**= $487/A**

50% STAND LOSS

YEAR 2 (1ST full production year)

Mowing and Raking 4 times	$100
12.9 tons (35% DM) at $8/ton	$103
Land Cost, Overhead	$150
Nutrient Removal (0-45-270)	$152
Total 2nd Year Cost	$505/A
Profit: 4.5 tons DM at $170/ton	$765/A
2nd Year Cost	-$505
Total Profit Year 2 =	**$260/A**

YEAR 3 (2nd full production year)

Mowing and Raking 4 times	$100
6.4 tons (35% DM) at $8/ton	$51
Land Cost, Overhead	$150
Nutrient Removal (0-23-135)	$76
Total 3rd Year Cost	$377/A
Profit: 2.25 tons DM at $170/ton	$383/A
3rd Year Cost	-$377
Total Profit Year 3	**=$6/A**

IF STAND PERSISTS – YEAR 4

Total Loss Year 4 = $148/A

If 50% loss of stand occurs following the second full production year, ASB damage will result in a loss of $18/A across the 4-year life of the stand.

TOTAL FROM YEARS 1,2,3,4

Year 1 (Establishment)	**LOSS = $136/A**
Year 2	**PROFIT = $260/A**
Year 3	**PROFIT = $6/A**
Year 4	**LOSS = $148/A**
Total Profit - 3 years	**= $130/A**
Total Loss - 4 years	**= $18/A**

100% STAND LOSS

YEAR 2 (1ST full production year)

Mowing and Raking 4 times	$100
12.9 tons (35% DM) at $8/ton	$103
Land Cost, Overhead	$150
Nutrient Removal (0-45-270)	$152
Total 2nd Year Cost	$505/A
Profit: 4.5 tons DM at $170/ton	$765/A
2nd Year Cost	-$505
Total Profit Year 2 =	**$260/A**

YEAR 3 (2nd full production year)

Total Loss Year 3 = $215/A

If 100% loss of stand occurs following the first full production year, ASB damage will result in a loss of $91/A across the 3-year life of the stand.

IF STAND PERSISTS – YEAR 4

Total Loss Year 4 = $148/A

If 100% loss of stand occurs following the second full production year, ASB damage will result in a loss of $239/A across the 4-year life of the stand.

TOTAL FROM YEARS 1,2,3,4

Year 1 (Establishment)	**LOSS = $136/A**
Year 2	**PROFIT = $260/A**
Year 3	**LOSS = $215/A**
Year 4	**LOSS = $148/A**
Total Loss - 3 years	**= $91/A**
Total Loss - 4 years	**= $239/A**

* Total 1st year cost $510/A (Land Cost/Overhead $150, Tillage/Planting $70, Seed $80, Fertilizer/Manure $80, Herbicide $30, Mowing/Raking $50, Chop/Haul/Ensile 6.3 tons at $8/ton $50). Profit estimated at $374/acre (2.2 tons DM x $170/ton). Source: 2012 Pennsylvania Custom Rates Table

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