



## Biology and management of stem gall wasp in highbush blueberries

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### Key points

- » Some highbush blueberry cultivars are susceptible to blueberry stem gall wasp, others are highly resistant.
- » Gall wasp populations are suppressed by natural enemies, but many of these insects are disrupted by current pest management practices.
- » Pruning off galls during the dormant season is critical for preventing spread of infestations.
- » Effective insecticides applied after bloom can reduce gall size and gall density.



Figure 1. Adult blueberry stem gall wasp.

### Introduction

Blueberry stem gall wasp, *Hemadas nubilipennis*, is an insect pest that attacks highbush and lowbush blueberries. This species can be found on wild blueberries growing in natural areas, but it has historically been only an occasional pest of commercial blueberry fields. More recently, stem gall wasp has become a significant pest in some regions of commercial blueberry production. To help growers manage this insect, we have prepared this summary of its biology and management based on recent research.

### Life cycle

Blueberry stem gall wasp is a tiny, 2-3 millimeters long black wasp that lays its eggs directly into the young stems of highbush and lowbush blueberry plants during the spring (Figure 1). There is one generation per year with adult wasps emerging during bloom. The female wasps lay eggs at the tip of young shoots and will often stab the shoot tip repeatedly with the ovipositor, causing it to stop growing.

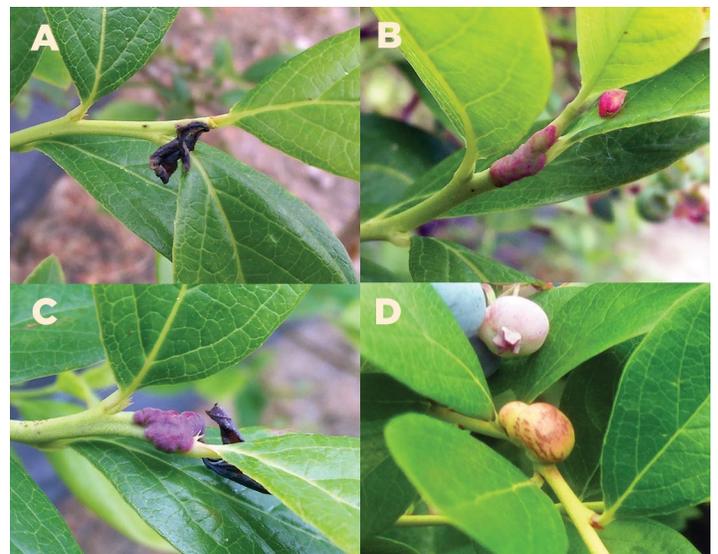


Figure 2. Development of a blueberry stem gall from immediately post-bloom to mid-season. **A.** Dead shoot tip from damage caused by the female wasp's egg-laying. **B.** Initial swelling around the eggs laid in the stem. **C.** Dark red swelling. **D.** Swollen gall near ripe blueberries.

The wasps have been observed laying eggs into multiple cultivars in the same field. However, there is strong variation in susceptibility to this pest with some highbush blueberry cultivars completely resistant (e.g., Bluecrop), others highly susceptible (e.g., Jersey) and some newer cultivar releases, such as Liberty, being moderately susceptible. Our recent surveys of blueberry fields provide information on how the different northern highbush blueberry cultivars vary in their susceptibility (Table 1).

**Table 1.** Variation in galls per bush in commercial blueberry fields that were sampled for gall wasp in 2017-2019. The numbers after the cultivar name show the number of fields sampled for each cultivar.

Variety	Average galls per bush
<b>Highly susceptible</b>	
Jersey (18)	102.4
Northland (2)	28.5
Pemberton (1)	20.1
Bluejay (6)	19.0
<b>Moderately susceptible</b>	
Liberty (6)	6.7
Aurora (4)	4.9
Duke (7)	1.7
Legacy (1)	1.8
Bluetta (3)	0.2
Brigitta (7)	0.2
Patriot (1)	0.8
<b>Low susceptibility (resistant)</b>	
Elliott (21)	0.1
Rubel (6)	0.01
Spartan (2)	0.02
Bluecrop (23)	0
Blueray (8)	0
Draper (2)	0
Nelson (4)	0
Weymouth (3)	0



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**Figure 3.** Mature gall in fall that developed after eggs were laid in the shoot in spring.



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**Figure 4.** Maturing gall wasp larva inside a gall. This will pupate in spring before emerging from the gall during bloom.



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**Figure 5.** Emergence holes of wasps previously living inside a gall.

In susceptible cultivars, after the female wasp lays eggs into a young shoot it begins to swell around the eggs within the first week (Figure 2). This area becomes red as the swelling continues with the gall expanding to become kidney-shaped and darker red/green by mid-summer.

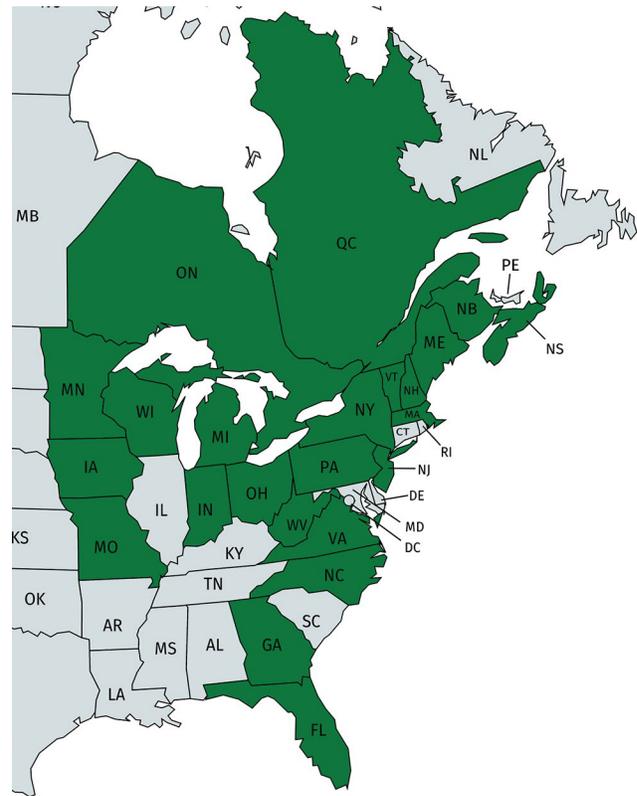
The galls swell to 0.25 to 1.5 inches by the end of the season (Figure 3) depending on how many eggs are laid with each gall containing multiple small, cream-colored larvae that feed in individual cells within the gall (Figure 4).

Mature blueberry stem gall wasp larvae overwinter inside the galls with no effect of freezing temperatures and they pupate inside the galls in the spring before bloom. During bloom, adult wasps chew their way out of the galls with each wasp making a small round hole to exit the gall (Figure 5). Gall wasps are only active during daylight hours and can be seen flying above the bushes, especially during warm weather. Gall wasps walk around on leaves and stems to locate young shoots for laying eggs, and their activity declines after bloom.

## History and distribution

The first published report on blueberry stem gall wasp was in 1887 by Ashmead. This was followed in 1927 by B.F. Driggers at the New Jersey Agricultural Experiment Station who described varying susceptibility of different cultivars and reported on some of the additional species of wasps emerging from blueberry galls. There was a significant body of research conducted to understand the biology of this pest on lowbush blueberry by J.D. Shorthouse in the 1980s, followed by studies on pruning and economic impact in lowbush blueberries during the early 2000s by D. Hayman and colleagues. This insect is native to eastern North America and its distribution overlaps with the distribution of the various species of blueberries across this region. It is reported from Minnesota east to Newfoundland and as far south as Georgia and Florida (Figure 6).

In Michigan, gall wasp infestation in commercial blueberry fields began increasing after the phaseout of Guthion (azinphosmethyl) and the invasion by spotted wing *Drosophila*. This insecticide was used to control fruitworms with application timing that overlapped the gall wasp activity period. Managing spotted wing *Drosophila* has resulted in increased late summer insecticide applications, and these are during the period when two parasitoid wasp species are emerging from the galls. Loss of these natural enemy species due to spraying during the harvest season may also allow stem gall wasp populations to increase.



**Figure 6.** Distribution of blueberry stem gall wasp across eastern North America based on records submitted to iNaturalist and reports provided to the authors.

## Economic impacts

At low population levels, blueberry stem gall wasp is a nuisance pest that can be pruned off the bushes during normal dormant season without adding greatly to pruning costs. However, if populations increase, the costs of pruning increases and some heavily infested fields have even been abandoned because the cost becomes too great. Blueberry stem gall wasp infestations also reduce growth and productivity of blueberry bushes due to galls taking resources that would otherwise go to new growth. In addition, highly infested fields that are not pruned risk contamination due to galls dropping off during harvest and contaminating the blueberries. This is another reason to ensure effective management of this pest.

## Gall wasp management

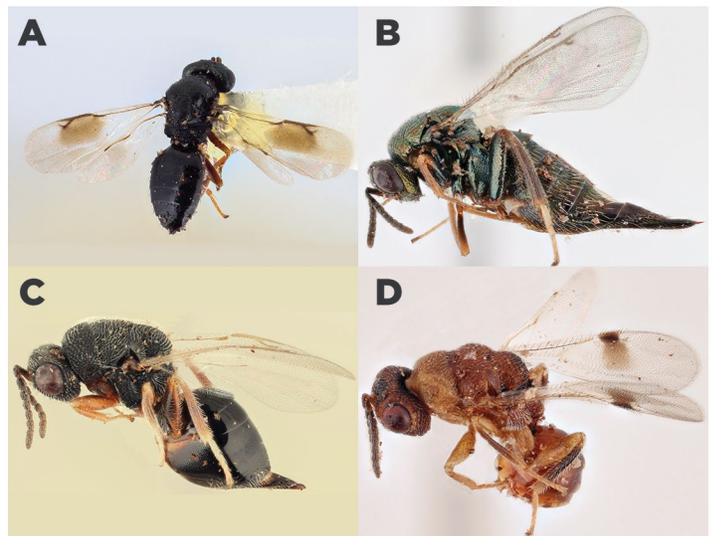
**Resistant cultivars.** Planting resistant cultivars is the long-term solution for any gall wasp management program. Host plant resistance is very effective and avoids the need for additional management inputs. Refer to Table 1 for a list of moderately or completely resistant cultivars. The Michigan State University breeding program is screening for the level of susceptibility to gall wasp in new selections and expects future cultivar releases to have resistance to this insect.

**Replanting susceptible fields.** If growers have fields planted with highly susceptible cultivars, for example Jersey, gall wasp infestations and the associated cost of managing it may be enough justification for replanting. A simple field renovation letting the shoots grow back will not eliminate this pest because the vigorous new shoots are still highly susceptible to gall wasp. Bush removal should be followed by at least a year of soil assessment and improvement using soil amendments and a cover crop as needed before replanting. This is also a good time to test for nematodes and adjust soil pH. At the time of this writing, there is a cost-share program available in Michigan from the United States Department of Agriculture (USDA) Farm Service Agency to partially cover the expense of replanting a field.

**Pruning.** During the dormant winter months, galls can be pruned off the bushes. These should then be destroyed either by burning or deep burial (more than 1-foot depth). Previous research by Hayman et al. (2003) showed that dropping the galls on the ground and mowing them will not prevent the wasps from emerging and will not reduce the population. Pruning the smallest galls can be highly time consuming and is likely to increase removal of fruiting buds, so there is a balance between aggressive pruning and yield loss. Pruning of galls is only possible by hand and is therefore labor intensive and costly, so in sites with high density this can be cost-prohibitive.

**Parasitic wasps.** Other wasp species may also be present within the galls, either parasitic wasps (parasitoids) feeding on gall wasps or other species using the gall as a protected place to live. Two of these parasitoid species, *Eurytoma solenozopheriae* and *Ormyrus vacciniicola* (Figure 7), are active during the spring when stem gall wasps are active, plus they have a second mid-summer generation during harvest.

The third prominent parasitoid is *Sycophila vacciniicola*, which is similar to blueberry stem gall wasp in having one generation per year and being active during bloom. Our recent studies in Michigan revealed that 50% of insects emerging from galls collected at blueberry fields without insecticide applications were blueberry stem gall wasps with the remainder being parasitoids or other insects. In fields treated with conventional insecticides, 99% of galls inhabitants were blueberry stem gall wasps with only 1% comprising parasitoids, primarily *S. vacciniicola*. This species' activity during only bloom means it avoids post-bloom and harvest-time insecticide applications that are toxic to the beneficial parasitoid wasps.



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**Figure 7.** Insect inhabitants of blueberry galls. **A.** Blueberry stem gall wasp, *Hemadas nubilipennis*. **B.** *Ormyrus vacciniicola*. **C.** *Eurytoma solenozopheriae*. **D.** *Sycophila vacciniicola*.

**Predation.** Predation by birds and small mammals is found in most fields and is noticeable by pecking damage on the galls on the bush or by piles of discarded galls at the base of a bush next to the entrance of a rodent nest. This damage usually occurs in late winter and early spring and the levels of predation vary widely within and between fields and depending on the length and severity of the winter. In Michigan, studies on the effects of this damage showed that it only slightly reduces the number of blueberry stem gall wasps emerging and is not likely having a significant impact on gall wasp populations.

**Chemical control.** A major challenge for controlling this pest is that the adult activity period overlaps with the blueberry bloom period when bees and other insects are pollinating the flowers. Blueberry is highly dependent on pollination for economical yields, and rented honey bees are the beekeepers' livelihood, so it is important to avoid insecticide use to control stem gall wasp during bloom. Applications before bloom have not been found to be very effective, furthermore, they also risk affecting bees and pollination levels.

The most effective approach for gall wasp control with broad spectrum insecticides is targeting it immediately after bloom is finished. Research trials at MSU over the past five years have found a few different strategies for reducing populations of stem gall wasp and for stopping the development of young galls. We found that treating infested fields with the carbamate insecticide methomyl (Lannate) immediately after bloom followed one week later with a pyrethroid such as zeta-cypermethrin (Mustang Maxx) or esfenvalerate (Asana) can significantly

reduce infestation. Imidan (phosmet) is also effective, as is the newer insecticide Verdepryn (cyaniliprole). These products applied at this timing can also protect berries from cherry fruitworm and cranberry fruitworm, so growers can get control of those pests while reducing gall wasp infestation.

A final option is to use spirotetramat (Movento). We found that application of this insecticide to the canopy of Liberty blueberry bushes in the weeks after bloom (applied with a penetrating adjuvant) led to 99% control of larvae in newly formed galls. In addition, the few galls that developed were smaller and the larvae inside did not complete development. Movento also controls aphids and scale insects but does not have activity against fruitworms. This should be considered if spirotetramat is incorporated into an integrated pest management program.

For all pesticide applications against gall wasp, and especially if using Movento, a penetrating adjuvant is recommended to ensure the pesticides get into the galls to target the eggs and larvae. These are typically applied at 0.5-1% by volume and may be light summer oils or more complex formulations. Follow the label directions for this and discuss with your pesticide distributor or crop advisor.

It is also critical that insecticide applications are made with excellent coverage. The insecticide spray needs to reach all parts of the canopy to protect plants against this insect. We found that high gallonage (60-80 gallons of water per acre) provides improved control compared to lower gallonage (30-40 gallons of water per acre).

For organic growers, there is a relative lack of effective insecticide options against stem gall wasp. In this setting, non-chemical approaches such as gall removal and host plant resistance will be key to reducing the impact of this pest.

**Post-harvest removal.** If gall wasp populations are high and fields are machine harvested, it is important for processing line personnel to be trained to identify galls so they can be removed at this last step in production. Removal may be by hand on the sorting lines and electronic sorters can also be trained to recognize the different colors and reject galls.

## Summary

In areas where stem gall wasp is present, reducing infestations can be achieved through an integrated pest management program that combines approach-

es. Completely resistant cultivars are the long-term and sustainable strategy, but replanting a field is very expensive in the short term. Fields that are moderately susceptible cultivars may only require either hand pruning during winter or chemical control after bloom to reduce the population to manageable levels. For infested fields of susceptible cultivars such as Jersey or Liberty, all strategies should be combined in an integrated approach with winter-time pruning combined with applying effective insecticides after bloom.

## Acknowledgements

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