ASIAN SOYBEAN APHID AS A VECTOR FOR BEAN VIRUSES: WHY THE BIENNIAL CYCLE?

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Cucumber mosaic virus (CMV) has caused significant yield losses in snap beans in New York over the past 10 years. This is thought to be largely associated with the arrival of the soybean aphid, *Aphis glycines* Matsumura. Although soybean aphids do not reproduce on snap beans, they move from other infected plant sources (possibly alfalfa or weeds) and spread the virus as they probe the beans with their mouthparts. Soybean itself is usually not a major source of CMV. Epidemics of CMV in snap beans in New York have been severe every other year (2001, 2003, 2005, 2007, 2009). This pattern seems to follow population levels of the soybean aphid, although three other aphid species are known to spread CMV in New York as well. Research and Extension personnel in numerous states have put forth significant effort to monitor and understand the population dynamics of soybean aphid. A review of this information will help snap bean growers understand why CMV has been severe in odd numbered years to date and whether that trend may or may not hold true in the future.

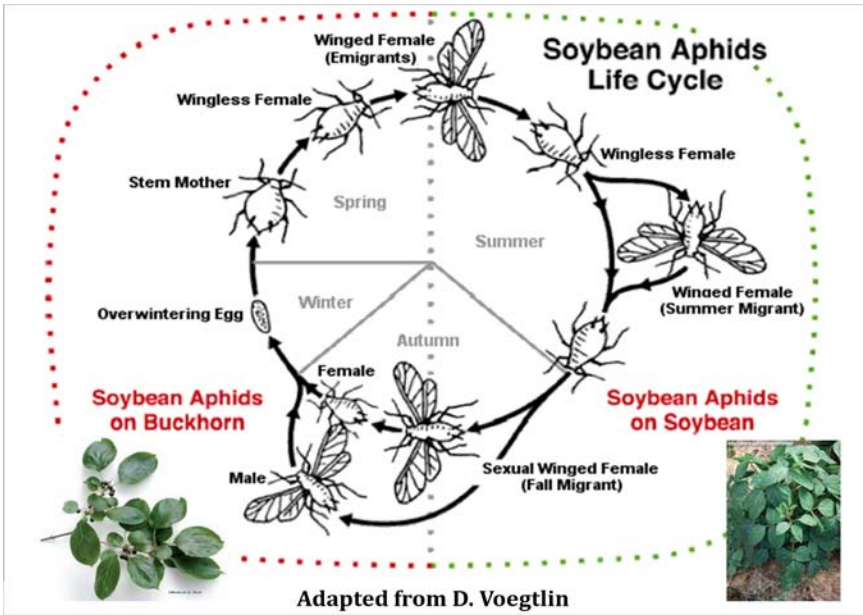
The soybean aphid is the only aphid in North America that will develop large colonies on soybeans and has become our single most important arthropod pest of soybeans. Native to a region of Asia from China to far eastern Russia, this aphid was accidentally introduced into the United States. It was discovered for the first time in Wisconsin and Illinois during the summer of 2000 and has spread rapidly throughout the northcentral United States, much of southeastern Canada, and the northeastern United States (Ragsdale et al, 2011, http://www.ncsrp.com/planthealth/soyaphid.htm). Soybean aphids can cause direct reduction to soybean (*Glycine max* and other *Glycine spp*) yield (10-15% or more) and seed quality. Some studies suggest that aphid reproduction is possible on Carolina horsenettle and red clover. No other herbaceous crop plants are known to be preferred hosts.

Since their arrival, soybean aphids have been a major interest for the New York soybean industry. Several factors contribute to this status: 1) New York soybean acreage has increased annually from 135,000 acres planted in 2000 to nearly 300,000 acres planted in 2010, 2) buckthorn (*Rhamnus spp*), the overwintering host of the aphid, is a common understory plant in many areas of New York, and 3) this aphid has on occasion, caused significant damage to soybeans in New York. An additional factor of consideration is that soybean aphids can vector viruses including Cucumber Mosaic Virus a major disease of snap beans and Potato Virus Y (Ragsdale et al, 2011).

<u>Soybean aphids have a complicated lifecycle</u>

Soybean aphids overwinter as eggs on buckthorn (*Rhamnus* spp.) a common understory shrub. In the spring, the eggs hatch and winged adult aphids move from the local buckthorn to soybeans in late spring – early summer. A second source of aphids comes from a migratory influx of aphids on storm fronts around July 1 (usually much larger than local sources). Once established on soybeans they may produce as many as 15 generations during the growing season under ideal

conditions. All of the aphids on soybeans during the summer are females and reproduce parthenogenically. Most of these individuals are typically without wings. In the fall, a winged (alate) generation of female *and* male aphids migrate from the soybeans to buckthorn and mate. Female aphids lay eggs in small clusters near buckthorn buds where they will overwinter until hatching the following spring.



Several factors can contribute to the size of soybean populations including: the size of colonizing population from buckthorn in spring, soybean variety (varieties with resistance became commercially available in 2010), soybean plant health (aphid populations are higher on stressed plants), aphid mortality from natural enemies such as predators, such as the multicolored Asian lady beetle and insidious flower bug, that feed on aphids during the summer and eggs on buckthorn in the fall, fungal outbreaks, heavy thunderstorms, and temperature (the optimum temperature for soybean aphid population growth is 75-80°F. Soybean aphid population growth will slow, stop, and may even decrease when temps are hot (greater than 90°F).

<u>What have we seen in New York?</u>
During 2001, Cornell University researchers and Cornell Cooperative Extension educators first documented the presence of soybean aphids in all twenty-three soybean producing New York counties surveyed (Losey, et al, 2002). Since then Cornell Cooperative Extension educators have continued monitoring efforts to detect presence, distribution and potential impact of this pest.

New York soybean aphid populations have been variable in time and distribution with alternating years of high and low aphid populations. In high soybean aphid years, their numbers have tended to increase in late June through July. This increase in soybean aphid numbers is generally accompanied by a gradual increase in numbers of natural enemies such as lady bugs, syrphid fly and lace wing larvae and fungal pathogens. These predators and parasites can significantly curb soybean aphid populations.

New York soybean aphid populations have shown a tendency to be problematic in alternate (odd numbered) years (2007 and 2009). Soybean aphid populations were very low or very localized during 2006, 2008 and 2010). (Waldron et al, 2009. http://nysipm.cornell.edu/grantspgm/projects/proj09/lfc/waldron.pdf)

These observations are similar to soybean aphid population trends observed in other areas of the United States (Table 1).

State	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
NY	Low	Low	Local	Low	Low	Low	Local	Low	High	Low
PA	Low	Low	Local	Low	Low	Low	Low	Low	High	Low
OH	High	Low	High	Low	Low	Low	Local	Low	High	Low
MN	–	Low	High	–	–	–	–	–	–	–
MI	–	–	High	Low	High	–	–	–	–	–
IA	High	Low	High	Low	High	Low	–	–	–	–
IL	High	Low	High	–	–	–	–	–	–	–
IN		Low	High	Low	High	Low	–	–	–	–
ONT	Local	Low	Low	Local	Local	Low	Local	Low	High	Low
QUE	–	–	–	–	High	Low	–	–	–	–

Source: Rhainds, M. et al 2010. Supplemental information added from other state cooperative extension sources.

The following information is drawn from a recent paper by Rhainds et al (2010) that reported on the population dynamics of soybean aphids during an 8-year period in Indiana, shortly after its detection in North America. Sampling conducted at multiple Indiana locations revealed that *A. glycines* exhibited a 2-year oscillation cycle that repeated itself four times between 2001 and 2008: years of low aphid abundance were consistently followed by years of high aphid abundance. The authors found similar patterns of abundance of soybean aphids and lady bug species (Coleoptera: Coccinellidae) in soybean fields, both within and between-years, suggesting that late season predation by coccinellids plays a role in the oscillatory cycle of aphids.

The inverse relationship between aphid densities before and after the start of the autumn migratory period changes direction in alternate years. High aphid density on soybean in the summer is associated with a reduced number of winged (alate) migrants produced in the autumn. Conversely, years with low density aphids on soybean in the summer are characterized by high numbers of alates that migrate to buckthorn the primary host in the autumn.

These observations are also consistent with those reported by the Midwestern soybean aphid suction trap monitoring network (http://www.ncipmc.org/traps/; Rice, et al, 2007). In general, more soybean aphids were caught in suction traps during the fall *before* a growing season when outbreaks were common during July and August. This is interesting because soybean aphids make migratory flights during the fall to buckthorn, their over- wintering host. By contrast, during the fall *following* an outbreak year, very few, if any, aphids were collected. Based on this anecdotal evidence trend, the relative abundance of the fall aphid flight has been useful in helping to predict the potential for out-breaks in the following growing season (Rice, et al, 2007).

Rhainds, et al (2010) note that this 2-year oscillation cycle of soybean aphids is a desirable

attribute, from a pest management perspective, with respect to population dynamics because, it implies that aphids have tended to pose significant economic risk only in alternate years (as opposed to every year) http://www.ncipmc.org/traps/. Cultural practices enhancing the conservation biological control of Coccinellidae may help to preserve the periodicity of aphid infestation and restrict the pest status of *A. glycines.*

For more information on soybean aphids and monitoring techniques see: Soybean aphid (http://www.planthealth.info/aphids_basics.htm) and The Cornell Guide for Integrated Field Crop Management (http://ipmguidelines.org/Fieldcrops/). Growing season observations on soybean aphid and other pest activity of field and forage crops can be found in the NYS Weekly Field Crop IPM Pest Report: http://nysipm.cornell.edu/fieldcrops/tag/pestrpt/default.asp

Managing soybean aphids and viruses in snap beans

Will the odd-numbered year cycle of severe CMV outbreaks continue in snap beans? No one really knows for sure. Some Midwestern state entomologists have recently observed what may be potential shifts in soybean aphid population cycles towards a more consistent annual problem in some areas. The lack of tools available to combat the aphid-virus complex in snap beans has had some growers turning away from this crop. Planting varieties of snap beans that are tolerant or resistant to viruses is the best method to reduce yield loss from virus. Research is underway at Cornell to develop virus resistant snap beans, but these are still several years away. However, a few commercial varieties such as 'Huntington' appear to continue to yield well when infected with CMV (Reiners, et al, 2010). Generally, the risk of yield loss is also reduced if snap beans are planted before late June, because soybean aphids are not as likely to spread CMV to young snap bean plants during that period (Nault and Kikkert, 2010). However, early high populations of soybean aphid as seen in 2009 can infect snap beans and even cause direct feeding damage. Insecticides can be used to minimize feeding damage to young snap beans as in 2009, but does nothing to control the spread of CMV. Insecticides simply do not work quickly enough to stop aphids from spreading viruses. Widespread use of soybean aphid resistant soybeans in the future may help reduce aphid populations over our landscape enough that they become less problematic in snap beans as well.

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