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The Suction Trap Network Documents Soybean Aphid Migrations

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Abstract
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Introduction

Following the accidental arrival of the soybean aphid in the Midwest, seven suction traps were set up in Illinois to monitor the seasonal movement of the soybean aphid. The data proved to be interesting in that the catches demonstrated the seasonal spread of this aphid across the landscape. Unfortunately it was geographically limited so in the spring of 2005 additional traps were built and placed in Indiana (6), Iowa (4), Michigan (5), Minnesota (4), and Wisconsin (5). Since then traps have been added in Wisconsin (2), Minnesota (1), Missouri (2), Kentucky (2), Kansas (1), and South Dakota(1). The maximum number of traps in operation was 42 but some are no longer in operation. The most southern and northern traps are about 1,000 km apart as are the most western and eastern. They cover the majority of the area of soybean cultivation in the Midwest. Collections are removed from the traps every Friday and sent to the Illinois Natural History Survey where the aphids are removed from the sample, counted, and identified. Suction trap counts for the soybean aphid across the Midwest can be seen at: http://www.ncipmc.org/traps/index.cfm. This web page has data from 2007–2010.

Materials and Methods

What insects are caught in a suction trap and where do they come from? The answer to the first part of this question is easy. Each suction trap pulls about 100 cubic meters of air per minute through a fine mesh screen funnel with a collection bottle at the bottom. Most of the insects caught are small and an average sample contains flies, beetles, parasitic wasps, thrips, leafhoppers, psyllids, whiteflies, and aphids. The answer to the second part of the question is not so easy. Research done in southern Idaho, where similar traps were in use, found that suction trap catches reflected aphid activity within a fifty-mile radius. They found that if a large number of one species of aphid was collected in a trap that they could find a field within 50 miles upwind of the trap that was heavily infested and producing winged migrants. There is no reason to believe that what occurs in the Midwest is much different. However, the distance that the soybean aphid moves every season suggests that there are many occasions each year when longer migrations of the soybean aphid occur. It is becoming clear that the soybean aphid does not overwinter in any significant numbers in the southern part of the Midwest, very roughly defined as south of Interstate 80. The appearance of aphids in soybean fields south of this is due to migratory flights by winged aphids produced on soybeans farther north. When the soybean aphid is first caught each year in one of the southern traps it is most likely a longer distance migrant and sometimes the source, i.e. populations heavy enough to produce large numbers of migrants, may be hundreds of miles away. Once local fields are heavily infested it is not possible to say if the aphids caught in a trap are from a local or distant source.

The original trap network set up in Illinois in 2001 was primarily to observe the seasonal movement of the soybean aphid. The network has been successful, however, there are questions as to the utility of the data. Attempts to correlate trap catch at a particular date with the aphid population in surrounding fields have not been successful and in actuality this correlation is unlikely. As far as is understood, the traps collect immigrating aphids, that is aphids that are terminating their flight and descending into the crop fields in the area. Because these aphids are not originating from the immediate area it is not surprising that the correlation is not good. A better correlation might be made by comparing trap catches and field populations a couple of weeks later. This would be especially useful when the first aphids are caught in any suction trap.

Each year from the end of August into early September the number of soybean aphids caught in the traps drops. For example, in 2007 there were only 11 caught in the entire network during the first week of September. This is the time period when the aphids are switching their host preference and, beginning in mid-September, winged aphids that are produced on soybean emigrate in search of buckthorn. The number of aphids caught during this time period varies considerably from year to year. As an example, over 100,000 were caught in the fall of 2009, the highest fall flight, and in the fall of 2010 only 260 were caught, the lowest fall flight ever. This is a quantitative measure of the potential for the production of overwintering eggs. A low number of fall migrants is more predictive than a high number. The potential of high numbers to produce lots of overwintering eggs is not always realized as the huge fall flight in 2009 was followed by an almost complete fungal kill of soybean aphids on buckthorn. In the fall of 2006, over 12,000 aphids were collected in September and October and egg deposition on buckthorn was the highest ever seen. At some buckthorn locations, overwintering eggs were found on every randomly selected twig. The potential of this heavy egg deposition was not realized because in mid-April of 2007 a hard freeze across the Midwest, with several days of night temperatures in the mid-twenties, caused buckthorn to drop its leaves and killed most of the soybean aphids. There is much that can influence the outcome of a large fall flight but little that can increase the possibility that a low fall flight can produce large numbers of overwintering eggs. Ideally the fall flight counts should be combined with observations on egg deposition to provide an indication of what might be expected the following year.

Trap catches in Iowa from 2005–2010. An examination of the trap catches in Iowa for the six years they have been in operation shows some interesting data. With the exception of 2007, the first soybean aphids were caught in the traps from the second to fourth week of July. This is usually 1 to 2 weeks later than the first trap collections in Minnesota and Wisconsin, the likely source of the migrants. In 2007, the first aphids were caught in the Sutherland and Nashua traps in the last week of June matching the first collections in Minnesota. This suggests successful overwintering in northern Iowa and development of local populations on soybeans by spring migrants from buckthorn. The first collection of soybean aphids in the trap at the McNay Research and Demonstration Farm, Chariton, IA is usually from one to three weeks later than the other three traps in Iowa.

The Midwest Suction Trap Network documents other aphid species. Although this trap network was set up to monitor soybean aphid migrations, we have attempted to identify and count all the other aphid species that we collect. To date we have collected over 200 species of aphids of which the majority is not of economic interest. We have abundance and phenology data for the aphids that can be pests on other Midwest crops either through direct feeding or the transmission of plant disease causing viruses. The cereal aphids such as the corn leaf aphid (*Rhopalosiphum maidis*) and the oat bird-cherry aphid (*Rhopalosiphum padi*) are the most abundant aphids in the suction trap catches, exceeded only by the soybean aphid in its outbreak years. *Rhopalosiphum padi* can build up large populations on and transmit barley yellow dwarf virus (BYDV) into winter wheat plantings in the fall. The cowpea aphid (*Aphis craccivora*) has become more common in alfalfa, a previously unused host by this aphid, and has been common at times in some locations.

Results and Discussion

Douglas Johnson (University of Kentucky) operated the trap at Princeton continuously for five years primarily to monitor the cereal aphids. In the first year of operation there was only a seven-week period during which there was not at least one aphid caught in the trap. He was also interested in knowing if the rice root aphid (*Rhopalosiphum rufiabdominalis*) was present in Kentucky. It is a virus vector to cereals and had never been recorded from Kentucky. The second suction trap sample he collected had this aphid in it.

The suction traps have also been useful for documenting the spread of exotic aphid species. Two tree aphids have come into the Midwest during the time that the network has been in operation. The first, *Shivaphis celti*, lives on hackberry and was first found in the southeastern states. Our first catch was at the Dixon Springs trap in southern Illinois and it has since been caught in traps farther north. An aphid (*Tinocallis saltans*) living on Siberian elm has moved into the Midwest from the western states and has been gradually expanding across the area over the past several years.

As a specialist in the taxonomy and classification of aphids the trap catches have been interesting because of the diversity of species they catch. I have collected aphids from their host plants over a lot of the Midwest and have never seen many of the species caught in the trap. There are also specimens that show up in the trap that cannot be identified and are probably undescribed species. Distributional records for many species have been expanded and we have information on time of flight and relative abundance. The trap caught specimens have been very useful in the development of a key to the species of the genus *Aphis* that are found in the Midwest: http://ctap.inhs.uiuc.edu/lagos/index.asp. This is important as these species are close relatives of the soybean aphid, and as such may be available as hosts to biological control agents of this pest.