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SUBJ: Virus Infections in 2012-2013 Strawberry Crop

Within 4 to 6 weeks of planting last fall, a number of strawberry producers in Virginia (and other growers in the Southeastern and Mid-Atlantic US) began noticing poor growth in their fields, sometimes in spots within fields, sometimes in virtually the entire field. Older leaves sometimes turned bright red in color, while the edges of leaves around the crowns of plants, and/or emerging leaves, showed a distinct yellowing, which sometimes developed into patterns of marginal necrosis (i.e., dead tissue along the margins of leaves). Roots and crowns of most of these plants showed no sign of fungal infection. Initially, the cause of these problems was thought to perhaps involve soil and/or fertility conditions, such as low soil moisture and/or pH, boron toxicity, or fertilizer burn, perhaps associated with weather and/or errors in custom-blended fertilizers. However, similar problems were observed in Florida, North Carolina, and other southern states, including Virginia. The images below were taken from strawberry fields in Virginia Beach and Chesapeake that Roy Flanagan, Watson Lawrence, and I visited on December 19th:

Because of the widespread nature of these symptoms, and an apparent association with bare-root plants or tips from the Great Village area of Nova Scotia, Dr. Barclay Poling of NCSU travelled to the area in early December to visit with Canadian strawberry plant growers and Extension staff. While there, Barclay was told that apparent strawberry virus symptoms had started showing up in fields of some strawberry cultivars in Great Valley in October (about the same time we started getting reports of problems). The Canadians had not had this problem before, and brought Dr. Bob Martin, a USDA-ARS small fruit virologist located at Oregon State University, in to help determine the cause. Dr. Martin is the top expert, as far as I know, on small fruit/strawberry viruses. He collected plant samples in early November to take back to Oregon for laboratory testing, and his results were received while Barclay was in Canada.

Dr. Martin found Strawberry Mild Yellow Edge Virus (SMYEV) and Strawberry Mottle Virus (SMoV) in samples from several matted row varieties. Barclay noted that he had never before seen strawberry viruses to be a problem. Barclay also noted that Chandler plants in Canada looked healthier than other varieties he saw, such as Camarosa and Winter Star. Upon returning to NC, Barclay collected and submitted 7 plant samples to Dr. Martin's lab, and found one with SMoV and five with SMYEV. All infected plants were plug plants produced from tips grown by one nursery in the Great Valley area. Although four of Barclay's samples were Chandlers, one such plant that looked "good" tested negative for both viruses, while another "good" plant tested positive for SMYEV only. Dr. Martin also tested 20 strawberry samples from Florida and found SMYEV and SMoV in 15 (75%).

As many may already know, Roy Flanagan, Keith Starke, and Watson Lawrence had been monitoring this situation in the Virginia Beach/Chesapeake area. With (very) little help from me, they collected plant samples from strawberry growers in their area and sent the samples off to Dr. Martin just before Christmas. Most of the samples (15 or 43%) were the Chandler variety, but other varieties that were tested included Albion, Camarosa, Camino Real, Festival, San Andreas, and Sweet Charlie. Of the 35 samples sent, 86% were infected by SMYEV, 69% with SMoV, and 66% with both viruses. Only 17% were non-infected. All of the infected plants were originally sourced from the one nursery in the Great Valley area of Nova Scotia, but four different vendors grew-out tips from that same nursery. Whenever there were 3 or more samples of a particular variety, at least one was either not infected or only infected by SMYEV.

Based on all this information, Virginia strawberry producers with plants originally sourced from anywhere but the one nursery in the Great Valley area of Nova Scotia should not worry about possible virus infection, because, as far as I know now, no 2012-2013 plants produced from any other source have tested positive for a strawberry virus. Unfortunately, most of the plants tested so far that "traced back" to the one nursery have been infected by SMYEV, and usually SMoV as well. Growers with plug plants may not know where their plant supplier purchased the strawberry "tips" that were grown-out into plugs, and should check with their supplier.

Although this is our first experience with virus problems on strawberry, SMYEV and SMoV are very common around the world, and often occur together and with other viruses. In fact, it may be that they only cause significant problems to strawberry growers when they occur together. Yield losses (probably when 100% of plants are infected) can be expected to range from 0% to 30%, and can differ among strawberry cultivars and also depending on which "strain" of each virus may be present. These viruses are usually only a problem in matted-row strawberry production, where plants are in the field for a much longer period of time and plantings are not destroyed at the end of each growing season. Heat treatment combined with meristem tip culture usually eliminate viruses from strawberry genetic material before tips are grown-out for plugs or bare root transplants.

All of the virus-infected plants diagnosed this year had SMYEV, which is a "persistent, circulatively-transmitted" virus spread by some (but not all) aphids – *Chaetosiphon fraegolii* (the strawberry aphid), *C. thomasi*, and *C. jacobi*. "Persistent" means that these aphids need to feed for hours or days in order to "get" and spread the virus. However, "persistent" and "circulative" mean that a virus spreads through the body of an insect once the virus has been acquired, and once an aphid has the virus, the virus remains in the aphid through most or all of its life. If a grower only has a small percentage of infected plants in fields with low to moderate aphid populations, promptly spraying an insecticide that kills aphids quickly should be more likely to kill the insects before they can acquire and transmit viruses like SMYEV. Some more "good news" about SMYEV is:

1 – It infects no weeds or crop plants other than strawberry (wild *and* cultivated).

2 – It is only supposed to be a problem when other viruses are also present.

Most of the virus-infected plants diagnosed so far also had SMoV, which is also aphid-transmitted (*C. fraegaefolii*, several other *Chaetosiphon* species, and the melon aphid, *Aphis gossypii*). However, SMoV is "semi-persistently" transmitted, which means that aphids can "get" and transmit the virus within only a few minutes as they probe infected plants and then move to nearby healthy plants. However, aphids also "lose" the virus within a few hours as they probe plants, potentially slowing the initial rate of virus spread if most of the plants that aphids probe are healthy, such as when only a low percentage of plants in a field are infected. In addition to wild and cultivated strawberry, SMoV also infects several species of *Chenopodium*, including common lambsquarters. Aphid control programs are also supposed to be effective in reducing SMoV spread in strawberry fields.

So, **what are *we* in Virginia to do about this situation? I have the following suggestions:**

1 – Growers with fields that "look good" and contain plants that weren't sourced from the one nursery in the Great Valley area of Nova Scotia should NOT be "at risk". One cautionary note: because these viruses are both transmitted by aphids, it is possible that active aphid populations in Virginia strawberry fields could cause "secondary spread" from infected to non-infected plants in the same field or in nearby fields (I doubt anyone knows exactly how close "nearby" is). However, given the time of year we're in, I think this situation should be rare.

2 – Plants that *were* sourced from the one nursery of concern are likely to be infected by one or both viruses. Plants traced back to other, nearby sources in Nova Scotia could also be involved, but not as far as we know at this time. However, it's very important to remember that apparent symptoms of plant virus infection can be very misleading. Sick plants may have similar symptoms, yet can be suffering from very different causes, none of which may involve virus infection. *My experience with viruses in another crop (tobacco) suggests that* factors such as *production practices and weather conditions could have a major impact on apparent damage and yield loss.* Even if a grower knows that their plants are infected, ensuring that they are *doing everything that they possibly can to minimize stress on their crop could significantly improve their outcome this growing season.* The factors that come to my mind for strawberry are frost protection, fertility, and irrigation/moisture stress.

3 – There is no cure for plant virus infection. Once infected, plants are infected for life, and every cell in an infected plant will eventually contain virus. There are no "silver bullets" or miracle cures, despite what some may claim. Infected plants can't be saved, although growers could see some improvement in their appearance and growth between now and harvest. We don't know why that is, so we don't know how to promote it. This means that growers with infected plants should focus on preventing spread to healthy plants. Since we can't test every plant, the safest assumption is that apparently symptomatic plants are infected, while those that "look good" aren't, even though we know this isn't always true. Therefore:

a – If almost all of the plants in a field are stunted and symptomatic, applying an insecticide will not help them. The *only* possible benefit from such a spray would be to minimize possible spread to nearby healthy strawberry fields. Treating severely-infected fields that are isolated is extremely unlikely to produce any benefit whatsoever.

b – If there are enough good plants in a field that look to be worth saving, application of a systemic insecticide should be an effective treatment to prevent or minimize spread of these viruses. Scientists disagree to some extent on the effectiveness of this approach, but the plant pathology literature suggests treating can reduce further disease spread. Remember that this only works if there are aphid populations in the field. If there are no aphids, what is an "aphid-killer" going to accomplish? Growers may consider treating to prevent aphid populations from developing this spring as a type of "insurance", but an alternative approach that should be cheaper and more environmentally friendly would be to scout fields more closely for aphids so that a crop is treated only if when determined necessary. *If a grower decides to treat, the systemic insecticides need to be applied at least 14 days before bloom* to avoid injuring pollinator populations. Recommended insecticides include imidacloprid (Admire Pro for drip, Provado for foliar applications) and thiamethoxam (Platinum for drip, Actara for foliar spray). There may also be some generics labeled for strawberry that have the same active ingredients, but may be cheaper.

4 – Don't be too discouraged. This virus situation is yet another plant disease problem in strawberries tied to transplants that look healthy, but aren't, but should be "containable" to this year. Those involved in strawberry plant production in Nova Scotia are aggressively working to correct their virus situation. Although many growers consider carrying strawberry plants over from one season to another, 2013 looks to be a very poor year for this. If possible, all strawberry plants should be destroyed after this season's harvest is completed, to avoid potential carry-over of SMYEV and SMoV. *Leaving potentially infected plants in the field this summer risks virus spread into next years' crop.* Fields in matted-row production should be monitored for potential virus incidence as well. Southern Region strawberry research and extension folks are meeting with national experts and Canadian representatives in late March to plan methods to avoid a repeat of this past fall.