# Small Fruit News

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## Inside this issue:



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## Optimize strawberry fertility with plant tissue testing

*Kristin Hicks, Agronomic Services, NCDA&CS*

In order to optimize growth, fruit quality and economic return, commercial strawberry production requires intensive and precise fertilization throughout the season. In high-value crops like strawberry, using a combined strategy of pre-season soil testing and in-season plant tissue analysis is an inexpensive and highly effective approach to optimize both strawberry yield and quality. Plant tissue testing measures nutrient levels in the leaflets and compares them to established target concentrations for healthy strawberries (Table 1). This analysis can reveal nutrient deficiencies and imbalances within the plant and allow growers to adjust fertility in response to changing crop needs. Plant tissue analysis in strawberry should include nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), and boron (B). In North Carolina, the most commonly encountered nutrient deficiencies in June-bearing strawberries are N, S, Mg and B.

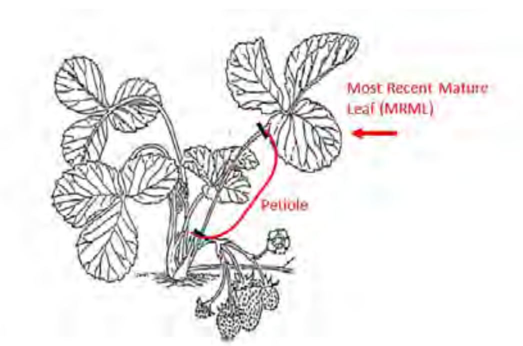


*Figure 1. Illustration of strawberry physiology with most recent mature leaf and petiole labeled.*

**Nitrogen and Nitrate-nitrogen.** Of the 11 essential nutrients, nitrogen is needed in the highest amount, is the biggest driver of yield, and is most frequently found below sufficiency. In North Carolina, of the >4000 June-bearing strawberry tissue samples submitted to NCDA&CS for analysis from 2010-2021, 44% were below the critical concentration of 3.0 % N. Because of the importance of a steady supply of nitrogen in strawberry production, analysis of nitrate-nitrogen ($NO_3$-N) in the petioles is also recommended. Petiole $NO_3$-N levels represent a snapshot of N moving from the soil into the plant, are a better predictor of N needs than leaf tissue N, and should serve as the basis for weekly nitrogen rate determinations. The optimum amount of petiole $NO_3$-N changes over the 12-week season; the target concentration is low at first bloom as the plants are emerging from winter dormancy but quickly reaches maximum demand in weeks two to four. As heavy fruiting begins, the target $NO_3$-N begin to decrease in order to prevent harmful effects of excess N on fruit quality (Table 2).

*Figure 2. Approximate location of the most recent mature leaf in strawberry.*

**Sulfur and Nitrogen: Sulfur ratio.** In addition, elevated N can create an imbalance with S in plant metabolism. Monitoring the nitrogen to sulfur ratio (N:S) is an essential component of fertility management in strawberry. When N:S is greater than 18:1, it can lead to poor utilization of either or both N and S, even when tissue levels of these nutrients are sufficient. In North Carolina, 33% of strawberry samples had N:S ratios greater than 18:1 and 11% were below the critical concentration of 0.15 % S. Excessively high N:S or low S can be easily corrected with an injection of 1-2 lb S per acre. Common fertilizers used are Epsom salts (magnesium sulfate) (13% S) and potassium sulfate (18% S).

**Magnesium.** Over the same sample period, 7% of strawberry tissue samples were below the critical concentration of 0.25 % Mg. Deficient Mg causes yellowing between the veins of the older mature leaves and then progressing to the leaf edges. Epsom salts, $MgSO_4$ (10% Mg), is often the fertilizer of choice because it also supplies S and moderates the N:S ratio. Injections of 7-10 lb Epsom salts per acre per week is generally sufficient to adequately supply both Mg and S throughout the production season.

**Boron.** Essential to good quality fruit, boron deficiency causes many symptoms, but among the most obvious are deformed berries, asymmetrical leaves, and stubby roots. In North Carolina, 8% of strawberry samples were below the critical concentration of 22 ppm B. If B was not applied pre-planting, a one-time application of 0.125 lb B per acre with the first or second fertigation is advisable. Any additional B application should be based solely on tissue analysis. Common B fertilizers include borax (11% B) and Solubor (20.5% B). In managing B fertility, of equal or greater importance than preventing B deficiency is avoiding B toxicity. In fact, B has been shown to be much more likely to cause crop loss through over-application than under-application. In strawberry, B toxicity presents as scorching of the leaf edges and is difficult to mitigate at this point. Growers should be very careful to apply only the recommended amount of B as the line between B sufficiency and B toxicity is very narrow.

**How to collect a tissue sample.** For routine in-season monitoring, plant tissue analysis should start when spring growth begins and continue every 1-2 weeks throughout blooming and fruiting stages. Plant tissue analysis is also useful If plants are showing signs of poor growth or health; these diagnostic samples can be collected at any growth stage and should include both samples of unhealthy and of healthy plants for comparison. Nutrient concentrations within the plant vary depending on the growth stage and on the plant part. Improperly collected tissue samples can produce unreliable results and lead to incorrect interpretations.

To collect a tissue sample from strawberry, select most recently mature, trifoliate leaves (MRMLs). These leaves are full-sized and green and consist of one petiole (leaf stalk) with three leaflets (Fig. 1). MRMLs are usually located three to five leaves back from the growing point and are neither newly emerging from the crown nor laying on the plastic (Fig. 2). When MRMLs are being collected, it is very important to detach the petiole from the leaflets immediately. This action halts nutrient transfer between the two plant parts and allows the two plant parts to be analyzed separately (Fig. 3).

Each sample should include leaves and petioles from 20 to 25 locations within a uniform area. For example, the plant material in a single sample should be the same variety, growing on the same soil type, at the same growth stage and having the same management history. When submitting tissue samples, be sure to include fertilization history and environmental conditions. In order to receive the correct interpretation, it is particularly important to accurately report the growth stage (Bloom or Fruit) and the number of weeks since first bloom.

Table 1. Plant tissue nutrient sufficiency ranges for strawberry*.

| Nutrient | Sufficiency Range |
|---|---|
| N (%) | 3.0–4.0 |
| P (%) | 0.2–0.4 |
| K (%) | 1.1–2.5 |
| Ca (%) | 0.5–1.5 |
| Mg (%) | 0.25–0.45 |
| S (%) | 0.15–0.4 |
| Fe (ppm) | 50–300 |
| Mn (ppm) | 30–300 |
| Zn (ppm) | 15–60 |
| Cu (ppm) | 3–15 |
| B (ppm) | 25–50 |

Table 2. Petiole nitrat ($NO_3$-N) target ranges strawberry from week of 1st bloo

| Week | Low |
|---|---|
| 1 | 250 |
| 2–3 | 2500 |
| 4 | 2000 |
| 5–8 | 1700 |
| 9 | 900 |
| 10 | 900 |
| 11 | 600 |
| 12+ | 450 |

- A pictorial guide to collecting and submitting strawberry tissue samples is available online at http://www.ncagr.gov/agronomi/Tissue/sb01.htm.
- * Campbell CR, Miner GS. 2000. Strawberry, annual hill culture. In: Campbell CR, editor.
- Reference sufficiency ranges for plant analysis in the southern region of the United States. Raleigh (NC): NC Dept of Agriculture & Consumer Services. Southern Cooperative Series Bulletin 394: www.ncagr.gov/agronomi/saaesd/scsb394.pdf

## A Closer Look: Microclimates and Disease Risk at the Canopy-Level

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Plasticulture growers in production areas outside Florida and California, such as the coastal plain or piedmont areas of the eastern US, typically use lightweight spun bound or nonwoven row covers to promote floral bud initiation (degree-day accumulation) in late fall, as well as for frost or freeze protection in spring. Growers in colder climates, such as the Appalachians or the Midwest, use row covers to protect their strawberry crop over longer periods, from December into March, as well as during cold snaps throughout flowering. Current IPM tools are typically not designed to monitor environmental variables at the canopy-level. Understanding environmental conditions within plant canopies, with or without row covers, is valuable for risk management throughout the production period.

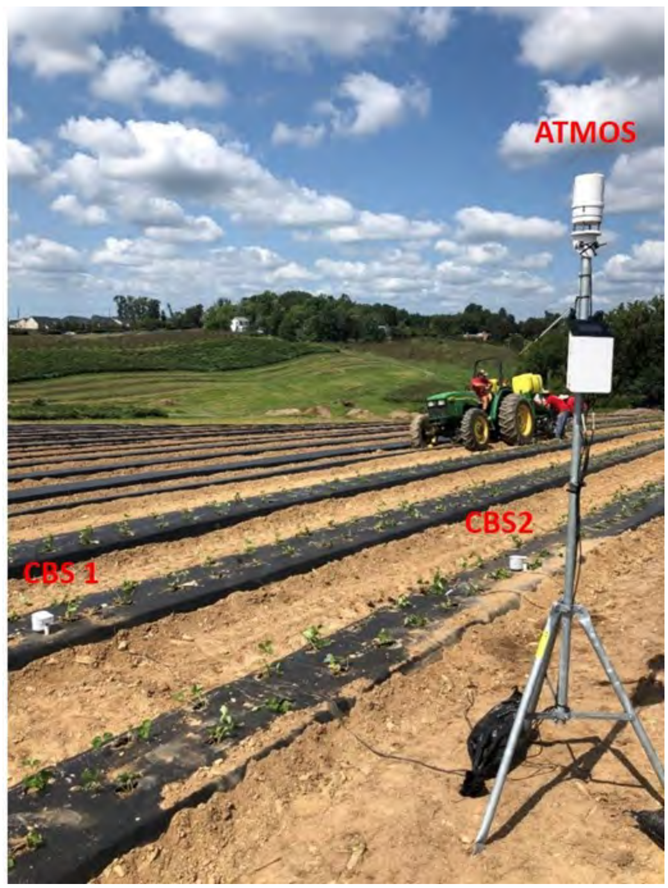


*Figure 1. Sensor placements at one site: CBS 1 (non-edge row); CBS 2 (edge row); and ATMOS*

During the 2019/20 and 2020/21 strawberry growing seasons, canopy-based sensor stations with multiple environmental sensors (Meter Group Inc., Pullman, WA) were installed at four farms in Maryland and Virginia. Five-minute resolution temperature and leaf wetness duration data were uploaded from these stations and informed the disease models previously developed for anthracnose fruit rot (AFR) and Botrytis fruit rot (BFR), which were incorporated into the cloud-based AgZoom software (Verdu, Spain). Real-time summary risk data for each model were provided via the AgZoom app. A two-year evaluation of this microclimate-based disease forecasting system was conducted in each location. Fungicide treatments were arranged in a randomized complete block design, and applications were based on three strategies: (1) predictive data from canopy-based sensors (CBS), (2) predictive data from sensors on an on-farm weather station (ATMOS 41 sensors) installed at the side of each field at 6 ft height), and (3) grower standard (GS) sprays. GS plots were sprayed every 7 to 10 days, depending on weather conditions. For the ATMOS and the CBS treatments, fungicide applications were independently guided by the risk determined from each disease model output, starting at bloom. AFR and BFR incidence and marketable fruit yield were determined every week. The main goals of this study were to understand the differences among environmental variable inputs and increased model precision due to sensor placement (within the canopy - CBS and 6 ft above the canopy - ATMOS; Fig. 1) and to validate the canopy-based disease risk models for timing fungicide applications to control AFR and BFR.

*Temperature.* The use of floating row covers significantly increased air temperatures in the strawberry canopy (CBS) compared to those in the weather stations (the ATMOS sensors, 6 ft above the canopy). Differences in daily temperatures between CBS and ATMOS sensors were greatest during the 'ripening' period (spring/summer), with canopy temperatures being warmer. Across the four sites with the 'spring covered' and 'winter covered' periods, the difference in temperature between canopy-based CBS sensors and weather station ATMOS sensors was larger during the 'spring covered' than the 'winter covered' period. Sensors under row covers reported higher average daily temperatures compared to non-covered sensors during the 'fall-covered' period. Furthermore, strawberry canopies appeared to be warmer during the day than at night time, compared to temperatures in the weather stations (ATMOS). Similarly, row covers increased canopy temperatures more during the day than at night time.

*Leaf wetness*. In general, leaf wetness duration tended to be longer in the strawberry canopy compared to the weather stations. Among the canopy-level sensors, non-edge rows tended to be wetter compared to edge-rows. Interestingly, the covered plot, regardless of sensor placement on edge or non-edge rows, was drier than the non-covered plot during the fall, at one and only site, where two adjacent plots were included to determine fall cover effects. However, this trend was not noted in the following year, when the covered sensor on the edge row had statistically lower wetness duration than the covered sensor on the non-edge row or non-covered sensors.

*Infection risk and disease management implications.* The predicted infection risk for AFR and BFR tended to be lower based on the weather station ATMOS sensors 6 feet above the strawberry canopies compared to the CBS sensors within the strawberry canopies, leading to more predicted infection events from weather data from within the canopies. These infection events triggered more fungicide applications for the CBS treatment than the ATMOS treatment, yet both treatments resulted in fewer fungicide applications than the GS treatment. Differences in AFR and BFR incidence were observed at two sites in 2019/20 and 2020/21 seasons, where the GS and CBS treatments had the least average disease incidence. While the row cover did not greatly affect predicted AFR or BFR risk during the 'fall covered' period, sensors placed on non-edge rows predicted more infection days than the edge-row or ATMOS. Although disease is unlikely to occur early in the growing season, conducive conditions may or may not increase pathogen loads latently present in plants during the fall that could affect disease severity later on in the spring. No differences were observed between treatments in marketable yield, presumably due to generally lower than normal disease pressure in both years.

In conclusion, leaf wetness varied significantly between measurements made outside the strawberry canopy (ATMOS) and measurements made within the canopy (CBS), affecting disease model predictions. While row covers increased temperature significantly, its effect on leaf wetness duration is less clear. The enhanced sensitivity of disease predications from CBS (especially non-edge row placement) may benefit cultivars with high disease susceptibility.

**References**:

Bulger M.A., M.A. Ellis, and L.V., Madden. 1987. Influence of temperature and wetness duration on infection of strawberry flowers by *Botrytis cinerea* and disease incidence of fruit originating from infected flowers. Phytopathology 77:1225-1230.

Hochmuth, G.J., S.J. Locascio, S.R. Kostewicz and F.G. Martin. 1993. Irrigation method and rowcover use for strawberry freeze protection. Journal of the American Society for Horticultural Science 118(5): 575-579.

Poling, E.B. 1993. Strawberry plasticulture in North Carolina: II. preplant, planting, and postplant considerations for growing 'Chandler' strawberry on black plastic mulch. HortTechnology 3(4): 383-393.

Wilson L.L., L.V. Madden and M.A. Ellis. 1990. Influence of temperature and wetness duration on infection of immature and mature strawberry fruit by *Colletotrichum acutatum*. Phytopathology 80:111-116.

## Infrequent Pests: Wireworms in Strawberry

Aaron Cato, University of Arkansas

Wireworms are an uncommon, soil-dwelling pest that feed on seeds and developing seedlings, as well as the roots and underground stems of plants. While uncommon, wireworms can be a serious pest of many seeded annual crops and especially of root and tuber crops such as sweet potato. Most berry growers probably aren't too familiar with wireworms or other soil-dwelling insect pests as most of our small fruits are transplanted with sizeable root balls and are perennial. However, 2021 was a weird year we found out that these small soil-dwelling larvae happen to love strawberries as much as we do.

### What's a wireworm?

Wireworms (Figure 1) are soil dwelling larvae of click beetles that almost exclusively feed under the soil-line. It's not uncommon to see wireworm adults feeding on or around strawberries or other crops, but they don't cause appreciable damage of any kind that will affect profitability. Wireworm larvae are brown, smooth beetle larvae that vary from ½ to 1½ inches in length when fully grown. Wireworm larvae live 2-6 years in the soil where they prefer to feed on seeds and developing seedlings, as well as the roots and underground stems of grasses.

*Figure 1. Click beetle (left) and wireworm (right). Photos by Marlin Rice (Left) and Ric Bessin (Left)*

Wireworm larvae sporadically cause appreciable damage to many different crops. This damage presents in the form of stand loss in seeded crops, as wireworm feeding deteriorates seeds and small plants. Damage is most common in grass crops, especially where grass crops are grown many years in a row. Additionally, any crop that follows sod, corn, or sorghum are at a heightened wireworm risk. This risk is obviously highest in seeded crops and the risk will decrease as transplant and root ball size increases.

### Why are we talking about strawberry?

Reading the info above I'm really not making a case for wireworms to be an issue in strawberry, and I think that's why most people reading this probably haven't had to deal with it. The issue with wireworms and most other insects (especially those that dwell in the soil) is that we end up with bad years where we find out they feed on more than we give them credit for. This is exactly what happened in our strawberry plots in 2021. As can be seen in Figure 2, wireworms will feed on strawberry fruit, and we incurred significant losses that would have warranted insecticide applications. Although these insects generally feed below ground, we observed larvae chewing through the plastic to get to ripe strawberries. In every case these larvae were feeding on fruit that were laying directly on the plastic, which suggests that they were sensing the location of ripe fruit through the plastic. In no instance did we observe any larvae searching for fruit, they were either inside of fruit feeding or still under berries in the soil (Figure 2 and 3).

*Figure 2. Wireworms feeding on strawberry fruit. Photos taken in Kibler, AR by Alden Hotz.*

### Why were they an issue?

Predicting insect pests is a hefty task in normal years, but we think we understand enough about wireworm biology to hazard an educated guess on why we saw so much damage. First, wireworms prefer grass crops and you should always expect increased numbers in the soil after crops like corn, sorghum, or an area previously in sod. A sorghum sudan summer cover crop was planted on this ground within the last two years. Second, wireworms move up and down in the soil profile depending on moisture. During harvest we experienced many rains and couldn't get the row middles drained properly, as exhibited with the standing water visible in Figure 2. It is possible that a high water table was enough to force wireworms up the raised beds, while not hurting the strawberry plants. Finally, there are likely more factors in play here than the previous two mentioned. We usually see years where soil pests are worse than others and it can be hard to predict. In all likelihood these conditions may not line up for you unless you are coming in behind a grass crop and get the perfect weather. In other words, it would be incredibly difficult to predict the issue we observed.

**How would you manage wireworm in strawberry?**

The first question when considering management of wireworms is whether it is necessary for you. In 2021 we lost significant amounts of strawberry in our plots, but this situation was unique and I suspect most people will never encounter issues, nor should they look to use preventive insecticides. However, if this begins to become a problem on your farm, it may be worth checking out the risk factors mentioned above.

Controlling wireworms requires forethought and isn't achievable during harvest. Cultural practices can be used to prevent most issues from occurring. Try not to go directly from sod or large grasses into strawberry, and be sure to practice some heavy tillage if you are. Wireworms can stick around a few years after a grass crop, but numbers are generally significantly higher the year after the grass crop was present. Drip applications of Imidacloprid containing products are going to offer the best control but have a 14-day phi. The timing of the application would need to be after the plants are off and growing, but 14 days before the first picking is planned.

*Figure 3. Wireworms coming through black plastic to feed on ripe strawberry fruit. Photo taken in Kibler, AR by Alden Hotz.*

## Spittlebugs in strawberry

Douglas G. Pfeiffer, Dept. of Entomology, Virginia Tech

Meadow spittlebug is an insect that most people are familiar with, even those not involved with berry production. The masses of white, frothy spittle-like material are commonly seen on meadow grasses and other plants. If you pull apart the froth, a green nymph is usually found feeding within.

Spittlebugs or froghoppers, are in the family Cercopidae (sometimes considered Aphrophoridae), are superficially similar to the leafhopper family Cicadellidae, to which they are related. However, the adults are more squat in appearance, giving rise to the name froghopper. They are further differentiated by the presence of course spurs on the hind tibia, compared with smaller spines of leafhoppers.

Adults are about a quarter inch long (5-7 mm), and are highly variable in color, ranging from yellowish brown to almost black. Adults are active jumpers, aided by backward-pointing spines on the legs; these provide traction by digging into plant surface tissue (Goetzke et al. 2019 ). These spines are hardened by incorporation of zinc into the cuticle, and leave tiny wounds in the leaf surface after jumping.

The life history was nicely summarized by Weaver and King (1954). Winter is spent in the egg stage; eggs hatch in April at Ohio latitudes, earlier farther south. There are five nymphal instars or developmental stages. Five to eight weeks are needed for nymphal development. Lower developmental threshold of 2.8° C (37° F) (Zajac et al. 1989). All nymphal development occurs within spittle mass. The foam is produced shortly after feeding starts – structures near the anus mix air bubbles into the liquid waste. In addition to protection from desiccation, the foam is thought to give some protection against predators, but some predators have adapted to this. While all development occurs with a foam mass, the insect may move around and start new feeding sites. Adult females develop eggs in August, and will lay eggs until killed by frost. Adults mate during August and September. Lay eggs low on plant (usually lower 4 inches), allowing them to use stubble. Females glue eggs into place at cracks and grooves near plant leaf sheathes. There are about 7 (1-30) eggs per mass. Eggs may be attacked by egg parasites, including mymarid and eulophid wasps.

Spittlebugs feed on xylem sap – the composition of spittle approximates that of this sap (Ponder et al. 2002), and has been used to help study xylem sap composition.

In most natural settings, spittlebugs are just a curiosity. But spittlebugs can rise to economic concern in strawberry. Spittle masses can be found on strawberry plants, where the nymphs feed. When numerous, the feeding nymphs can stunt plants and cause a reduction in yield and number of berries in the crop. Zajac and Wilson (1984) determined an action threshold of 2 nymphs per 0.1 $m^2$. That level is well below normal field levels at times, (10-20/0.1$^2$) in that study, so this insect bears watching, especially if there were large numbers of adults in the previous fall.

There is another potential impact of meadow spittlebug. While the most important vectors of *Xylella fastidiosa*, the agent causing Pierce's disease in grape, are sharpshooters (xylem-feeding leafhoppers), meadow spittlebug can also serve in this role. Spittlebugs are considered to be key vectors in Europe, where it has been associated with a decline of olive trees in Italy (Moussa et al. 2016, Bodino et al. 2021).

Because control recommendations may vary from state to state, consult local recommendations for populations of meadow spittlebugs that warrant control.

Fig. 1. Froghopper adult – Stan Gilliam via BugGuide

Fig. 2. Eric Matthews via BugGuide

## References

**Bodino, N., V. Cavalieri, C. Dongiovanni, A. Simonetto, M. A. Saladini, E. Plazio, G. Gilioli, G. Molinatto, M. Saponari, and D. Bosco. 2021.** Dispersal of *Philaenus spumarius* (Hemiptera: Aphrophoridae), a vector of *Xylella fastidiosa*, in olive grove and meadow agroecosystems. Environ. Entomol. 50: 267–279.

**Cornara, D., A. Sicard, A. R. Zeilinger, F. Porcelli, A. H. Purcell, and R. P. P. Almeida. 2016.** Transmission of *Xylella fastidiosa* to grapevine by the meadow spittlebug. Phytopathology 106.

**Cornara, D., M. Marra, M. Morente, E. Garzo, A. Moreno, M. Saponari, and A. Fereres. 2020.** Feeding behavior in relation to spittlebug transmission of *Xylella fastidiosa*. J. Pest Sci. 93: 1197–1213.

**Goetzke, H. H., J. G. Pattrick, and W. Federle. 2019** Froghoppers jump from smooth plant surfaces by piercing them with sharp spines. PNAS 116: 3012-3017

**Moussa, I. E. B., V. Mazzoni, F. Valentini, T. Yaseen, D. Lorusso, S. Speranza, M. Digiaro, L. Varvaro, R. Krugner, and A. M. D'Onghia. 2016.** Seasonal fluctuations of sap-feeding insect species infected by *Xylella fastidiosa* in Apulian olive groves of southern Italy. J. Econ. Entomol. 109: 1512-1518.

**Ponder, K. L., R. J. Watson, M. Malone, and J. Pritchard. 2002.** Mineral content of excreta from the spittlebug *Philaenus spumarius* closely matches that of xylem sap. New Phytol. 153: 237-241.

**Weaver, C. R., and D. R. King. 1954.** Meadow spittlebug. Ohio Agric. Exp. Stn. Res. Bull. 741. 99 p.

**Zajac, M. A., and M. C. Wilson. 1984.** The effects of nymphal feeding by the meadow spittlebug, *Philaenus spumarius* (L.) on strawberry yield and quality. Crop Protect. 3: 167-175.

**Zajac, M. A., F. R. Hall, and M. C. Wilson. 1989.** Heat unit model for the development of meadow spittlebug (Homoptera: Cercopidae) on strawberry. Environ. Entomol. 18: 347-350.

## Survey and management of soilborne diseases in Strawberry in Arkansas

Alejandro Rojas, Dept of Plant Pathology, University of Arkansas

Strawberry is one the most widely cultivated fruits in the US and it is a major berry crop in Arkansas, with at least 30 growers around the state, or in the nearby states. Soil infestation by plant pathogens in strawberry fields are amongst the most limiting diseases in this production system. The methyl bromide transition program has reduced the number of tools to manage soil borne diseases. Other practices such as plasticulture have been used to promote other aspects of the crop such as yield and weed management; however, these practices could not have an effect on soilborne pathogens. In Arkansas, the production system is based on annual plants aiming to rotate crops to avoid pathogen build -up and manage other pests. However, growers have limited areas for production that reduces the options for rotation. Having this in mind, it was important to characterize what potential fungal and oomycetes (water molds) pathogens were prevalent in growers' fields in the region. The identification of potential problems in soil could help to establish strategies to reduce impact of those soilborne pathogens.

One of the problems that growers faced with strawberries and soilborne diseases is the difficulty to address the symptoms and relate those to a specific pathogen, since most of the symptoms are often wilt, root rot, crown rot and plant death. Among the pathogens causing these symptoms, there are four common pathogens causing damage on strawberries. *Phytophthora cactorum* and *P. fragariae* (water molds) causing crown rot and root rot; *Rhizoctonia solani* causing black root rot; *Macrophomina phaseolina* causing a charcoal rot, and *Fusarium oxysporum* causing wilting (Maas 1998). To establish the prevalence of soilborne pathogens in Arkansas and nearby regions, plant and soil samples from strawberry fields were submitted by growers or collected and processed for the isolation of pathogens.

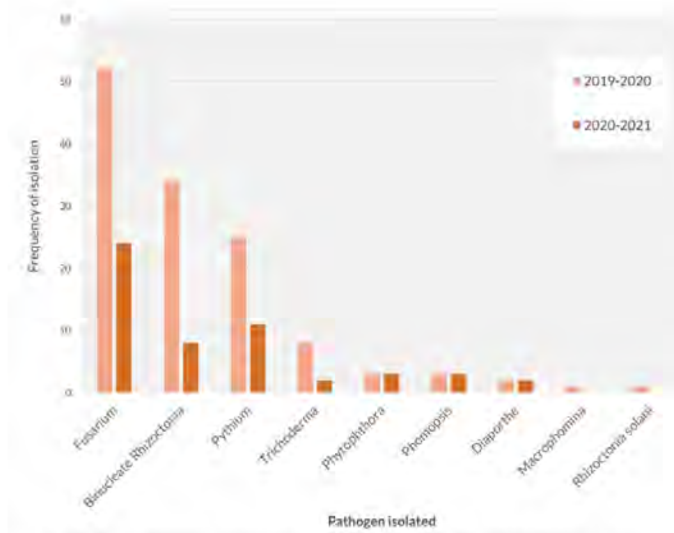


**Figure 1.** Frequency of isolation of fungal and oomycete pathogens in samples collected in 2020 and 2021 in Arkansas and nearby regions.

Throughout 2019-2020, composite soil samples and plants were taken from 20 strawberry farms around Arkansas and neighboring states. From plant tissue, isolations were done on Potato Dextrose Agar (PDA) and Corn Meal Agar (CMA-PARP) and

**Figure 2.** Progressive root rot causing "rat tail" appearance on

soil samples were processed for DNA extraction were analyzed for quantity and variety of fungal and oomycete pathogens. In 2019-2020, eighteen submissions were processed and in 2021-22, ten samples were processed (Figure 1). If isolated from plant tissue, crown, runners and roots were assessed. For soil samples, we relied on isolation by baiting (Spurlock et al. 2015). From the results, *Fusarium* is widely prevalent in samples in both years, followed by binucleate *Rhizoctonia* and *Pythium.* Most of these pathogens are widely present, especially *Fusarium,* which is a common soil inhabitant, however, it is important to clarify that not all *Fusarium* could be pathogenic. While *Rhizoctonia* and *Pythium* are more likely to cause disease in seedlings and growing plants. These pathogens are typically called "root nibblers" (Figure 2), and their prevalence and incidence get worse due to multiple years of production in the same bed. It is also common to have these pathogens causing disease problems as complex.

Diagnostics from these samples often requires isolation like it was done for the survey, and diagnosis based of symptoms could be difficult. Samples could be submitted to the [Arkansas Plant Health Clinic] to get a more accurate diagnosis. We also implemented molecular diagnostics, similar to the ones used during the pandemic, however we are aiming to detect *Phytophthora* from the soil samples and also have an idea of how prevalent it could be on soils in Arkansas (Miles et al. 2017). *Phytophthora* could be a damaging pathogen causing root rot but also affecting fruit quality. From isolations, we were able to recover less than five isolates, but using the molecular diagnostics in soil, all soil samples were below the detection threshold, which means that at least in 2020 and 2021, *Phytophthora* was not prevalent in the fields, however that could change over time.

In addition, a research plot was established in at Vegetable station (Kibler, Arkansas) in collaboration with Dr. McWhirt and Dr. Cato. Three plots with strawberry cv. Chandler were planted in September 2020 and soil samples were collected at different stages to determine levels of soil microbial communities and to evaluate impact of management practices used by growers in the region. Plots received three different management strategies using chemigation: Promax+ Zap, Ridomil, and untreated (No fungicide). In terms of disease, plants were scored for crown and root rot using severity scale 0-3 (0 = healthy root/crown tissue and 4 = severe root and crown rot). Overall, there are not strong differences across treatments, however, Ridomil Gold (ai. mefenoxam) had a greater number of plants with healthy roots and crowns. The trial is being conducted again this season and more information will be available about prevalence of soilborne pathogens under the different management strategies. Isolation from the plant samples had the usual suspects: *Fusarium, Macrophomina, Pythium* and *Rhizoctonia*. All pathogens were consistent across treatments.

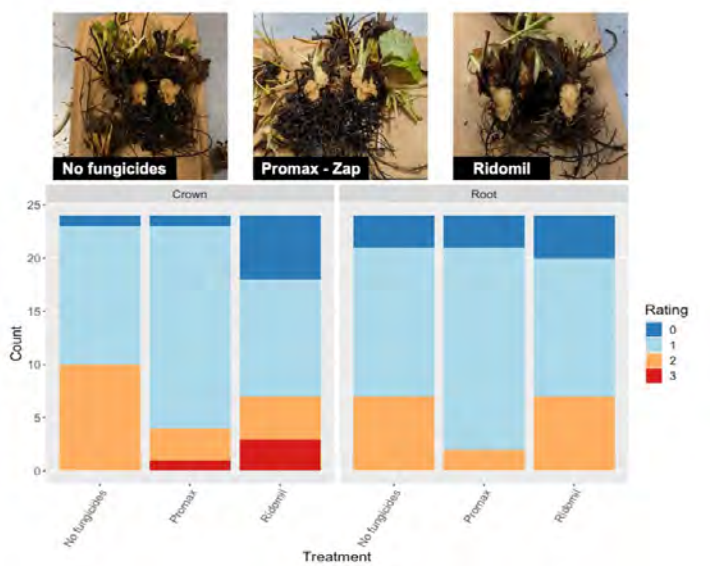


**Figure 3.** Disease ratings for strawberry chemigation trial in

One of the issues in Arkansas production system is the use of transplants, and plugs could be an entry point or carrier for pathogens that are not present in a field. Therefore, pre-planting management is important to reduce chances of disease, by using pre-plant dips or selecting tolerant varieties. Other strategies to reduce impact of diseases is the selection of fields or using beds to avoid low lying and poorly drained soils, as well as the crop rotation to avoid build up. The use of organic matter to improve soil texture is another strategy, but the most effective way to improve the overall soil health is the use of cover crops that will improve microbial activity and increase organic matter. It is also important to consider the application and timing of fungicide sapplications, since those could help to control pathogens, but they could also affect beneficial microbes, reducing chances of nontarget effects.

## References

Maas, J. L. 1998. *Compendium of Strawberry Diseases, Second Edition*. The American Phytopathological Society. Available at: https://apsjournals.apsnet.org/doi/10.1094/9780890546178.

Miles, T. D., Martin, F. N., P, R. G., Bilodeau, G. J., and Coffey, M. D. 2017. Systematic Development of Phytophthora Species-Specific Mitochondrial Diagnostic Markers for Economically Important Members of the Genus. Plant Disease. 101:1162–1170.

Spurlock, T. N., Rothrock, C. S., and Monfort, W. S. 2015. Evaluation of Methods to Quantify Populations of Rhizoctonia in Soil. Plant Disease. 99:836–841.

## Anthracnose Fruit and Crown Rot Management on Strawberry

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Anthracnose is one of the most destructive diseases of strawberry affecting fruit growers in the southeastern United States. Although all parts (crowns, runners, petioles, blossoms, fruits) of the strawberry plant can be affected by the disease, the most obvious symptoms are expressed from crown and fruit infections. Crown rot due to crown infection manifests as wilting of the whole plant (Fig. 1) and can result in a total loss depending on the plant stage when infection takes place. Fruit can be infected at the green or ripening stage but the most conspicuous symptoms such as black sunken lesions (Fig. 2) appear on ripening or fully ripened berries. Anthracnose crown rot (ACR) is a high temperature -loving disease and is mostly a problem in the southeastern United States where warm, moist conditions and abundant rainfall favor the growth and rapid dissemination of the pathogen. However, anthracnose fruit rot (AFR) can be a problem anywhere strawberries are grown.

*Fig.1. Scattered plant wilting due to anthracnose crown rot in fruiting field*

*Causal Agent, Spread of the Disease, and Diagnostics*

Fungal pathogens belonging to the *Colletotrichum gloeosporioides* and *C. acutatum* species complexes cause ACR and AFR, respectively, with some minor exceptions. Although inoculum sources for plants in fruiting fields can be diverse, non-symptomatic infected (quiescent or latent) planting stock is one of the most important sources of inoculum. Thus, the use of "disease-free transplants" is the first and most effective method for controlling anthracnose in the fruit production field. Due to the vegetative propagation of strawberries, infection at any stage in the propagation nursery, plug production facility, or fruiting field can pose a risk, although symptom expression on foliage is rare unless the infection level is very high. This infection biology poses a challenge to growers due to a lack of knowledge about the plant's health and whether they would need to take any preventative measures to manage the disease in their fields.

Diagnostic evaluation of propagation materials for latent infection from representative samples can aid in decision-making for disease prevention and management. While fruit growers expect to secure disease-free plants, it is often difficult for suppliers to ensure truly healthy plants for the same reason mentioned above. Research on developing a sensitive and cost-effective latent infection diagnostic method is in progress.

Until a standard protocol for this purpose is in place, information from plant nurseries and visual observation of plants can help growers make appropriate management decisions. Laboratories at state land-grant universities may be able to, for a fee, provide an assessment of plant infection.

*Disease Management*

From our experience, if the pathogen is latently present in a large proportion of plants at the pre-bloom stage, a fungicide program starting from 10% bloom can save the crop from severe losses due to AFR. A list of effective products can be found in the strawberry IPM guide, https://smallfruits.org/files/2022/01/2022-Strawberry-IPM-Guide.pdf. The spray interval should be dependent on the presence or absence of fungi on foliage and prevailing weather conditions during fruit development and ripening. Although strobilurins or QoI fungicides (FRAC 11) have been among the most effective against anthracnose, they are also highly vulnerable to fungal populations developing resistance to them. These products should only be used as directed in terms of consecutive sprays allowed and the total amount used in a crop year. It is also very important to communicate with plant suppliers about whether any of these products have been used in the nursery or plug production cycle, to avoid excessive applications of the same chemistry. Also, in a situation of control failure, the best option is to rotate the fungicide mode of action. For example, if Pristine fails to provide optimum control, Merivon should not be the alternative as both products have active ingredients from the same FRAC groups (7+11). In this case, Switch (FRAC 9+12) or a multi-site activity product like Captan or Thiram could be considered as an alternative. These products at the same time should provide good gray mold suppression. In most cases, ACR symptoms showing up during fall or early spring suggest a need for a fungicide program. However, detection of the pathogen on transplants may indicate the need for a fungicide dip and subsequent initiation of a spray program within a month of planting. It is extremely important to determine whether crown rot and plant wilting are due to ACR or Phytophthora crown rot by sending samples to a diagnostic lab, as different products are used to manage these two diseases.

Fig. 2. Black sunken lesions on fruit indicating anthracnose fruit rot

Photo credit: Mahfuz Rahman

## Southern Sensation Seedless: A New Table Grape for the Mid-South

Justin Scheiner, Associate Professor and Extension Viticulture Specialist, Department of Horticultural Sciences, Texas A&M University

*Mature Southern Sensation Seedless clusters on spur pruned vines.*

In 2021, the University of Arkansas System Division of Agriculture and Texas A&M University cooperatively released a new table grape, Southern Sensation Seedless. What makes this grape special is that after thirty-four years of trialing in central and southeastern Texas, areas with extreme pressure from Pierce's Disease (*Xylella fastidiosa*), no Pierce's Disease (PD) symptoms have been observed and vines have remained productive for over twenty years when other tables grapes under trial (Flame seedless, Blush seedless, and Beauty seedless) died from apparent PD. To date, it represents one of very few table grapes available with tolerance to PD.

Southern Sensation Seedless was initially selected in 1973 by Dr. Jim Moore at the University of Arkansas Fruit Research Station in Clarksville, Arkansas where it was evaluated sixteen fruiting seasons. However, it was eventually discarded after vines froze to the ground in 1985 and 1996 after experiencing temperatures of 5 to 12°F. In central Texas, trunk and cordon injury was also observed after temperatures dropped to 9°F so Southern Sensation Seedless is only recommended for the mid-South (USDA cold hardiness zone 7b or warmer), and not the upper South.

PD tolerance may be Southern Sensation's most valuable characteristic, but it also has attractive clusters and very good fruit quality. Clusters are large averaging 302 grams in Arkansas and 159 to 725 grams in Texas trials. Clusters are well filled to tightly filled with limited berry cracking observed in Arkansas (3 out of 15 years) and no cracking observed in Texas. In these trials, Southern Sensation Seedless berries ranged in size from 1.97 to 2.30 grams and had small, unnoticeable seed remnants. The overall fruit quality of Southern Sensation Seedless is ranked high and in Somerville, Texas (120 miles from the Gulf Coast) researchers were able to successfully hang and harvest fruit over about a month-long period. No formal evaluations of fungal disease resistance have been made, but in 2020, vines in Somerville maintained a healthier canopy than Blanc Du Bois in neighboring rows after a period of intense downy mildew pressure.

In both Arkansas and Texas, Southern Sensation Seedless has had good vigor on its own roots. In Somerville, Texas Southern Sensation grafted onto 1103P is less vigorous than Blanc Du Bois on the same rootstock, but own-rooted vines appear to have higher vigor than own-rooted Victoria Red. Vines have a semi-erect growth habit and may be successfully trained upright or downward.

Southern Sensation Seedless is recommended as a fresh-fruit cultivar for on-farm and local market sales in U.S. Department of Agriculture (USDA) hardiness zones 7b or warmer. It will be patented and plants are available from Double A Vineyards (https://doubleavineyards.com/). More information on Southern Sensation Seedless is available through HortScience. https://journals.ashs.org/hortsci/view/journals/hortsci/57/2/article-p345.xml

*Second leaf Southern Sensation Seedless vines trained to a Watson Training System.*

**Next issue of the Small Fruit News: July 2022**

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