**Annual Meeting notes for Multistate Project NE1839: Development and Evaluation of Broccoli Adapted to the Eastern US.**

**Meeting date**: 9 January 2020

**Attendees**: Lincoln Zotarelli, Thomas Björkman, Christy Hoepting, Steven Sargent, Mark Hutton, Jeanine Davis, Margaret Bloomquist, Gordon Johnson, Phillip Williams, Ashley Edwards, André da Silva, Joara Candian, Morgan Stone and Matt Horry (representing Brian Ward), Matt Cutulle, Jill Eccleston.

**Unable to attend**: Brian Ward, Phillip Griffiths, Carl Sams, James Myers.

**Introductions**: The meeting began with a round of introductions. In addition to SCRI-funded Eastern Broccoli personnel, the group included Gordon Johnson (University of Delaware) and Steve Sargent (University of Florida), both of whom have signed on to the Multistate Project.

**Agenda additions**: Swede midge, Alternaria, brown bead, post-harvest. Lincoln Zotarelli moved to accept, Mark Hutton seconded, additions approved.

**Minutes from 2019**: Lincoln moved to approve, Mark Hutton seconded, minutes approved.

**Leaders for 2020**: Lincoln Zotarelli exits, Christy Hoepting advances to Chairperson, Brian Ward is new Vice-Chair. André da Silva was nominated and approved to be incoming Secretary. Secretary must post minutes of meeting to NIMSS[[1]](#footnote-1) website within 60 days.

**Site selection for 2021 meeting**: Savannah, GA on 7 Jan. 2021; the group could fly into Jacksonville on 5 Jan. 2021 (Tuesday), tour Hastings area on Wednesday (see trials, two big operations, postharvest cooling equipment, wrapping machine), then drive to Savannah the same night, in time for the multistate meeting on Thursday.

**Local Arrangements** (André da Silva): group will meet for dinner at Treylor Park (suggested by Thomas Björkman) at 6:30 pm this evening.

**Administrative Advisor Report**: As Jan Nyrop was not present, Mark Hutton provided a NIFA[[2]](#footnote-2) update.

* Some NIMSS website items that were not working last year are now fixed.
* NERA[[3]](#footnote-3) is collecting information that will suggest how to restructure and improve NIFA, which has been relocated to Kansas City. Much of the staff that handled grant awards and management is gone, and the National Program Leadership has been decimated. NIFA Leadership Director Scott Angel asks that post docs, faculty, etc., apply for positions, but housing stock availability in Kansas City is uncertain.

**Research Presentations**:

Thomas Björkman circulated a draft 2019 Yield trial report to use as a basis for discussion. An error was noted in the summary for North Carolina; it will be corrected in final version.

**SITE REPORTS**

**FLORIDA**

***Lincoln Zotarelli (Hastings Trial leader)*.**

Quality trial plantings are in progress.

1. The first planting was transplanted 30 October 2019. Some stand loss occurred due to the development of *Cercospora* leaf spot on transplants in the greenhouse following excess irrigation in very warm weather. Ratings began 7 January 2020.
2. The second planting was transplanted on 5 December; good stand, looks good.
3. Entries for the third planting were sown in the greenhouse on 2 January.

The Hastings Yield trial was direct seeded (with a Monosem precision planter) to match the practice of area growers. For the trial they plant 4 60-foot rows, 4 reps, 40” bed center to bed center, double rows 8” apart. Seed quality doesn’t seem to be an issue this year.

Weed control: UF weed scientist Peter Ditmar is looking at crop safety of weed control products. There is a state-by-state effort to standardize the label of a popular herbicide along the East Coast. In Florida, they would like to use it for direct seeding.

Acreage*:* Florida has about 2000 acres of broccoli around Hastings, and a miniscule amount in Immokalee, where tomatoes and melons dominate. Broccoli has been produced in the Hastings area for at least the past 10 years.

***Steve Sargent (University of Florida Postharvest)***. Postharvest quality considerations for broccoli include maintaining crown firmness and preventing yellowing. An MS student conducted broccoli quality assessments at harvest and in storage and compared slush ice and forced air cooling. Forced air did not lead to a huge moisture loss. Steve now has results that could help convince buyers to move out of slush ice, which has a number of issues (food safety, melting water hazards, etc.). He is also testing 1-MCP on broccoli.

Iceless shipments can run into problems with cold chain temperature management: produce is exposed to fluctuating temperatures as it moves to different areas. Ice moderates those temperature changes.

* Jeanine noted that there is currently a move to go to unwrapped broccoli.
* Steve: an iceless option for unwrapped broccoli is the pallet shroud.

Can breeders select for better storage ability? Broccoli is especially sensitive to changes in temperature. In a 2013 study with 15 different hybrids, Thomas found a nearly two-fold difference in respiration rates between some of them. There is variation, but it could correlate with flower bud size (didn’t test) – not clear if breeders could select for it.

Steve also reported on results from Carl Sams, who has been studying flavor. He is finding new compounds that are present in small quantities but have a big impact on flavor.

***Phil Williams (Immokalee Trial leader)***. Phil is conducting Yield trials at the UF Southwest Research and Education Center (transplanted 17 December) and on the land of a grower who did not producing broccoli previously but is already interested in continuing. Transplants will be delivered to the grower on 21 January. Both trials are on conventional, black plastic-covered double row beds with 2 drip tapes, 8”-10” spacing between plants, 36” between beds.

Who else direct seeds besides Hastings? Maine growers do; NC growers used to.

Water and nutrient management:

* Immokalee area growers are moving away from seepage irrigation because it takes more water, plus there is serious oversight/red tape.
* In South Carolina, fertilizer is incorporated.
* Lincoln incorporates and uses transplant drip tape for Hastings Quality trial plots; his Yield trial uses seepage irrigation.
* Hastings growers grade with tile drainage. Costs $3000–$4000/acre, lasts 35 years.
* Other options for irrigation are overhead and sub-surface drip.

**GEORGIA *– André da Silva, Trial leader*.**

2019 Tifton Yield Trial:

* The weather went from a bit cold to hot.
* Main problems in GA trial were rough heads and heads that were not firm enough. He did not see purpling, but others did.
* His grower is one of the best in the area.

*Fungicide trial*: Alternaria resistance to Quadris was a concern. André did not see a lot of disease in his 2019 trial, but others did, so he conducted a trial that rotated Bravo-Switch-Endura. This rotation had 20% instance of Alternaria in the head, vs 45% in the control.

Factors that may impact disease incidence:

* Planting dates: Spring starts out too cold, then gets warmer later. Black rot arrives towards the end but stays in the leaves. In the fall, it is warmer at planting; the disease appears earlier in the season, so it has time to get to the head.
* Weather cycles: warm temperatures followed by rain followed by cold temperatures increase the incidence of both black rot and Alternaria. The diseases affect marketable yield but not total yield.
* André suspects overhead irrigation may increase disease – growers don’t fine-tune.

Yield reductions are also evident in crops grown on old plastic. Growers install plastic and use if for 3 to 4 seasons in the fall and spring. First, they grow solanaceous crops (tomatoes, peppers), so broccoli is the second or third crop on plastic each year. Yields drop going from first to third crop due to soil compaction and a decrease in water. Can get a $4000 yield reduction on older plastic, but it is cheaper for growers to accept the reduced yield than to install new plastic.

*Acreage*: The area has about 8000 acres in cabbage, 2000 acres in broccoli.

**MAINE – *Mark Hutton, Trial leader***

2019 was a bad year for trials. Problems:

* Bad potting media: used mix leftover from previous season to grow the transplants. They watered it once and it never dried out – went anaerobic. Lost 75% of broccoli, melons, tomatoes, and peppers. Anybody using organic compost-based media had the same problem.
* Weather: June in Monmouth was cool and wet, while July and August were hot and dry with no rain. Aroostook County had a fairly normal year. Growers there irrigate, so lack of rain is not a problem, but late plantings can be stopped by cold October weather/snow.

*Total acreage*: 5000 to 6000 acres. Total Brassica acreage didn’t change but may be shifting to more cauliflower.

The earliest growers put transplants in the ground in April. They prep fields and lay plastic in the fall, transplant in April, and harvest in May/June.

Growers in Maine are already working with seed companies on big evaluation trials. We can’t show them anything commercial that they haven’t already seen. [But they don’t trial public hybrids.]

*Swede midge* arrived this year. Small organic growers suffered the most, lost 30 to 40 acres of broccoli in 2019. Organic treatments aren’t effective. Some may stop growing broccoli. Highmoor Farm has 5 acres of broccoli and does not spray. They do have pheromone traps out, and the midge has not shown up in them yet. Not a problem for the big conventional growers.

*Alternaria*: not a problem for Maine trials this year.

Discussion questions:

* Mark Hutton asked if we should introduce cauliflower evaluations in the future.
* Matt Horry asked if any growers in Maine use high tunnels. Mark H: just for transplants. Some grow sprouting broccoli for overwintering in high tunnels.

**Delaware** –*Gordon Johnson, University of Delaware*.

Gordon was invited to come to this meeting following a presentation he gave at ASHS.

He started trials in Delaware because a grower (10-200 acres) wanted to produce broccoli crowns. Cauliflower and brussels sprouts are also of interest.

Available recommendations were for fall only (October to early December harvest), when disease and pest pressures are heavy. They wanted to test high density plantings and late spring production. Initially got some information from Georgia.

He conducted a series of trials in springs and falls of 2017 and 2018. The earliest trial was encouraging, but later ones had significant problems -early heat in Spring 2018, and diseases in the fall.

Lessons:

* Good thing he ran more than one trial; first did not reveal challenges.
* High density is not an option there – need air movement to reduce disease pressure.

Gordon has a state specialty crop grant for on-farm trials with the grower who wants to expand. Would like to see late May production and fall production into December.

For the Multistate project, adding Delaware site is good opportunity to try new things to tackle challenges: it is on the coast and hit with many issues (disease, pests – loopers, diamondback moth (DBM) can be problems.) We also have a coastal site in Charleston.

Delaware has an entomologist studying DBM and a weed scientist looking at herbicides. Also switching to white plastic mulch in the fall.

*Black rot*:

* They never saw it in the past, but high density and heavy rains contribute. They see it mainly in the summer, not the spring. May try heat-treated seeds.
* High density plantings plus high humidity in the field make the spread easier in DE.
* Other locations:
  + Mark Farnham thinks black rot is in the environment and creeps in at random scenarios. He sees it in the summer in Charleston, not in the spring and fall. He doesn’t think it is generally a serious problem, which may be why there is not much work on it.
  + Mark Hutton sees black rot in Maine.
  + Christy Hoepting thinks black rot issues in NY are mainly from seed. Cabbage has good tolerance. Weeds can harbor it.
* Extending the season makes it more of a problem.

**NEW YORK** – ***Christy Hoepting, Trial leader***

Broccoli in NY is fickle – growers think they’ve got it, then it crashes.

*2019 NY Yield trial*

* New grower hosted the trial this year, on land close to Lake Ontario.
* 2019 trial looked a lot better than the 2018 one.
* The grower adopted the new fungicide spraying program for his crop, but he did not use it in Christy’s trial, so rot appeared, especially in the standard.

*Managing Alternaria*:

* Quadris alone is losing effectiveness. A possible new Alternaria species in the Tifton area shows resistance, and new resistant strains are appearing in the mid-Atlantic.
* The old spray program in NY of Bravo and Quadris cost $44; new program with Bravo, 2 applications of Switch, Priaxor, and Endura for 5 weeks costs $250. (Switch is the most expensive, $70/application.) It’s challenging to put together a program that does not overuse the most effective materials. The new program starts with a bit of Bravo to keep disease out of lower canopy. When canopy fills in, apply Switch once/week for 2 weeks, then Priaxor, then Endura.

Grower north of Albion, close to Lake Ontario, invested in several hundred acres of broccoli. The land was previously used for apples. Proximity to the lake keeps it cooler in the summer and delays freeze.

Discussion: do (pesticide) chemicals break down in heat? Half-life can be shorter.

**NORTH CAROLINA** – ***Jeanine Davis and Margaret Bloomquist, Trial leaders***

*Broccoli production in North Carolina*:

* Eastern NC has coastal production.
* A large operation near VA border has 1000 acres of cabbage, broccoli, greens and an excellent post-harvest facility.
* Mountain area could fill June production window. But should they fight to invest in ice if industry is moving away from it? A big distributor is expanding and has interest in that window, but their growers must have slush ice.
* More small growers in the areas are producing broccoli, and more farms are reporting that they grow it.

*NC Yield trials*

* The Yield trial in Old Fort Yield trial (warmer side of the mountain) could start earlier. They were happy with how it held. The grower is adding acreage.
* The Mills River Yield trial has surprisingly low yields, but it is on different programs, e.g., in rotation with celery
* Hoping to hold a field day at a Yield trial site this year.

*Disease management*:

* The third Quality trial planting in Waynesville usually gets hit the worst with disease, probably because it builds up from earlier plantings. They will review Christy’s fungicide program.
* Growers in the area are all going to white on black plastic, which Jeanine promoted. (Ironically, their two Yield trial growers still use black plastic.)

**SOUTH CAROLINA *– Brian Ward, with assistance from Matt Horry and Morgan Stone***

*Quality trial*: first planting okay; heat hit came on late in the second planting, resulting in lost and rough heads. The third planting was hit with rainfall and wind from Hurricane Dorian – took the plastic off plots.

*Yield trial*:

* The commercial standard did fairly well but was not as uniform as the top public and commercial entries.
* Grower increased spraying activity due to past insect problems and Alternaria.
* Everything looked better than it had the past 2 years, but rain and temperature cycles slow things down, which makes managing labor difficult. Grower has decreased broccoli acreage, but not significantly.
* Brassica following Solanaceous crops is a popular rotation in SC.

Broccoli can be risky crop on the coast for weather-related reasons. Growers in the middle of the state experiment with it, but they can make more on other crops. Big growers like it because it lets them keep labor; having other popular crops gives them the leverage to get buyers to take the broccoli.

**VIRGINIA (Ashley Edwards)**

* 2019 Yield Trial was transplanted 20 June and harvested 16 August – 12 September. Trial had to be checked every 2 days or else crowns would get loose. At 2400 ft. elevation, the heat wasn’t high, but the humidity was.
* She saw reductions in yields 2 years in a row due to bacterial soft rot. Crop stays wet from dew at night, which makes it worse. Rough head was the biggest problem, and rot (bad season). Also saw brown bead, plus one hybrid had bottom ring of big yellow beads (only see when crown is turned over).
* Alternaria wasn’t the worst disease problem; it was mainly rots from water
* She works with 5 broccoli growers, all within 40 miles of each other. Smallest ones have 30-40 acres. A big grower “below the mountain” harvests in May, good crop.
* Late summer is not usually broccoli season for her growers. Cabbage can work, but by then everyone is in pumpkin mode. Her farm finishes summer squash at that time. One grower has a broccoli – tomato – cucumber rotation. Another grows 8 acres near NC line in early summer.
* Some possible changes in 2020:
  + Trial will move earlier to harvest in late June into second week of July.
  + May harvest crowns at 4”. Growers take crowns while they are small, sacrificing yield to keep quality. If head is left to make size, you can lose it in one day.
  + Plant spacing has been about 10”, 3 row “beds”. If she goes with smaller heads, may decrease spacing

**PATHOLOGY**

**Alternaria**:

* Bhabesh Dutta at the University of Georgia is studying a new species/strain. He can only receive DNA samples, does not have permit for infected plant material or fungal cultures. Chris Smart at Cornell has a permit and will accept diseased plant tissue.
* There are probably 2 species. One of them is new and has been found in NY and GA. Virginia is seeing something different: resistance to Quadris in a different strain of the known species of Alternaria.
* An SCRI proposal for funding further investigations is under development.
* Alternaria that is restricted to broccoli leaves is not a problem; only affects marketability when it reaches the crown.

Discussion:

* Do we spray pre-emptively to protect, or wait until symptoms appear?
* This is a good opportunity to create a model to predict risk based on rainfall, temperature, and humidity.
* If the right temperature/moisture conditions occurred, could release warning. In Georgia currently, they just advise Extension agents of the risk, but could develop a system to let growers know directly – grant potential?
* Should trial leaders be more proactive about controlling disease? For an on-farm trial, it is the grower’s decision.

**Brown bead**: could be caused by many different things, and appearance varies. Sometimes cause is something local in the environment, sometimes it’s genetic.

* Is it a type of tip burn? Calcium water disorder – calcium all goes to leaves not to developing crown.
* Tarnished plant bug feeding
* Boron deficiency is another possible cause.
* Sunburn/sunscald is possible; makes for purple color.
* Has different manifestations: scattered yellow buds that turn into bigger patches and eventually turn brown; buds that just turn brown (no yellow), dry tip-burn like. Sometimes it starts in the center and goes out, other times it is more patchy. Individual buds can turn brown, shrivel up. Buds at tip may be ready to open, ones at bottom abort. Sometimes buds have premature senescence. Alternaria in the crown also causes patches of yellow/brown but that is different.
* Does CMS contribute? CMS lines don’t have healthy anthers, so buds may develop differently. Could compare same hybrid using CMS or not.
* Is there the potential for ethylene effects in the field? Test 1-MCP in field?
* Should we have a sub-category? BB paler, BB scattered; or just ‘mild/severe’.

**Swede midge**.

* Yolanda Chen of the University of Vermont is working on it. Her former student Elisabeth Hodgdon is now an Entomology Extension Specialist in NY. More swede midge resources can be found on the swede midge information center website at <http://web.entomology.cornell.edu/shelton/swede-midge/>.
* It is manageable in conventional systems, but organic and smaller growers without enough land for crop rotations are especially vulnerable.
* Have to crash the population, either by rotating or by achieving 90% control.
* For organic growers, rotation is really all they can do. Organic farms with fields secluded by trees wouldn’t have economic damage if they could take 1 year out of rotation, or possibly if they waited to plant until after the first generation emerged.
* Red Russian kale is one of their most preferred hosts (but they don’t like Winterbor so much).
* Christy and Mark H. may try a tarping experiment to see if that strategy could work.
* Pheromone disruption is another strategy being studied.

**Broccoli breeding – Mark Farnham**

* Most conventional broccoli needs to be vernalized below 22 or 23°C. More of an issue in warmer southern regions than in the north. Temperatures above 30°C cause problems like bracting, distorted crown shape, discoloration.
* The most negative effects occur if high temperatures happen as plants are shifting from vegetative to reproductive control (usually about 3 weeks before harvest).
* In South Carolina, temperatures as low as 22 or 23°C don’t occur beyond May in the spring/summer. In the early 1990’s, Mark looked at 70+ entries and found only 5 to 7 that were worth working with.
* One of the first USVL lines out that effort was tolerant but extremely rapid. Didn’t require vernalization. Performed the same in summer or fall. Need an inbred that performs WELL in summer and fall.
* How can we push if they are only 40 days? How/when do you side dress? Matt Horry will ask the grower about fertility.
* Griff’s approach is to bring in good traits from other Brassicas. Results for those will take a while longer – won’t be here before the EBP ends. One new broccoli with jagged leaves makes a good baby green; a vertical farming company is interested.
* Jim Myers breeds for processing and florets. His lines tend to purple easily.
* Floret market has changed; it was mostly frozen florets from Mexico, now fresh pack florets are popular – higher value?
* Mark thinks hybrids specialized to slot are what is needed.
* Public breeders can handle small scale seed increases but need seed company for larger increase, and for finding material that is widely adapted.

**Floretting**: How did this go in Quality trials? Is the technique (2 cuts, check center floret diameter and blonding) getting the information we want?

* It adds a time but is not too difficult.
* Food service companies, schools, and institutions use a lot of them. Large bags seem to hold well.
* Machines have the same throughput as people but cost $10,000.

**Postharvest – Steve Sargent showed presented some information**

* Grower uses a harvest mule train. Harvesters set broccoli gently on a soft surface, then it gets processed and repacked into RPC or waxed containers.
* The grower has a slush ice-making trailer that goes to Florida in the winter, north in the summer. Slush ice gets augured into bins.
* Automated system puts bunches into bags.
* Broccoli is cooled at least an hour after harvest.
* Steve compared slush ice, forced air, and hydrocooling. Hydrocooling was ad hoc with grower’s slurry water since they didn’t have a hydrocooler.
* Forced air cooler: create a tunnel in big refrigerated room by stacking 2 lengths of pallets and putting a tarp over the alley between them. A fan pulls warm air out and cooler air through. Air comes in through holes in the boxes (boxes must have proper sized holes in sides); boxes on the outside cool the fastest.
* They measured change in temperature of broccoli with a probe inserted 2” into stalk. Used “7/8 cooling time” metric: how long it takes to get to 2°C, which indicates remove of 7/8 of field heat. Getting broccoli to 2°C took 25 minutes with hydrocooling; 87 minutes with forced air. With slush ice, broccoli did not reach 7/8 point even after 2.5 hours. As ice melts, air barrier slows heat transfer.
* For forced air cooling, growers sometimes leave pallets in cooling set-up for 3 to 4 hours. This is a management problem: need 90 to 94% humidity so the broccoli won’t dry out, but the room doesn’t have that.
* Vacuum cooling also has the problem that it could dry out the broccoli.
* Straight ice can freeze the product (slurry doesn’t).
* How much would it cost for each method/product? That information is tough to get. If you ask how much energy it takes, they don’t know. (Steve might be able to get the info from the big grower near him.)
* Dry room for storing vs wet room for broccoli at 36-38°F.
* Once they ship, it is with mixed pallets. Put iced on the bottom, other items above.

**Eastern Broccoli Project final years:**

* Overall metric for broccoli project: $100 million farm-gate value for eastern broccoli. Comparing 2017 with 2012 Ag Census results, a conservative estimate of the value in 2017 was $90 million – so we will likely make the goal.
* Press releases through respective universities are encouraged. Administrators like to see them, they get attention, and people call. Good to have some information out there before applying for grants so reviewers are familiar with issues.
* The Eastern Broccoli Project will be done after August 2021; no-cost extension is NOT an option. Need to make sure NIFA and Cornell accounting have the absolute last dates for spending, then go as late as you can.
* Now is a good time to think about local sources of funding to supplement entry fees for the Multistate project after SCRI funding ends.
* An independently funded Economic Development Grant in the Hudson Valley will look more at market channels. It is closely aligned with what we are doing.
* Thomas has a collaboration going with a researcher whose research focus is how the final form of the sepal is determined. They are trying to get some money. It is a good follow up to this project.

**How to keep the momentum going**

* Gordon Johnson could have the funded Delaware grower add a Yield trial site.
* Matt Cutulle: would it be worth pursuing an OREI in connection with this?
  + Need new varieties. There is a large demand for local organic broccoli but many factors are limiting: bugs, disease, nutrition. Seed productions are another limitation.
* The multistate group can add different crops; which make sense? Would have to be same season, also enough markets in the East so seed companies would think it worthwhile.

**How do you use momentum to add value for future years?**

Spinoffs? Cooling trials?

* NC group would like some forced-air cooling plans. Need plywood, fans. If market will accept iceless, there would be more opportunities for that area.
* Microcooling development opportunity.
* Steve will send out Extension bulletin for small growers. Organic production is similar but uses different sanitizer.

**Other topics**:

* Should there be meetings throughout the year? Trial site leader meetings are useful.
* Matt Cutulle asked if there was data on speed of germination related to transplant size. Time from germination to ideal transplant size. Competitiveness with weeds? Seed treated with herbicide? Initial seedling growth is more a matter of seed quality than genetics.
* NC wants a fall trial planted in August, away from other plantings to show good season.
* VA impact: cooling, plus how long hybrids lasts in postharvest storage. Need to hold longer.

1. National Information Management & Support System, <https://www.nimss.org> [↑](#footnote-ref-1)
2. National Institute of Food and Agriculture [↑](#footnote-ref-2)
3. Northeastern Regional Association of State Agricultural Experiment Station Directors [↑](#footnote-ref-3)