Enabling Agricultural Research and Innovation (EARI)
Accelerating Agricultural Innovation through Demonstration (Element 2)

Final Report- EARI16-029

1. *Project title and number*:
Project A: Late Blight (LB) Resistant Tomato Cultivar Demonstration
Project B: Greenhouse/Tunnel Tomato Production Monitoring for Improved Profitability
Project EARI16-029

2. *Project leader and collaborators*:
Claude Berthélémé from the New Brunswick Department of Agriculture, Aquaculture and Fisheries (NBDAAF) is the project lead. He is the Provincial Organic and Vegetable Specialist. Tara Scott from the Atlantic Canadian Organic Regional Network (ACORN), Michael Tesfaendrias (Provincial Plant Pathologist) and Venessa Allain (Crop Development Officer) from the NBDAAF collaborated.

3. *Summary:*

This demonstration project allowed several NB vegetable growers an opportunity to grow in their fields and evaluate eleven LB resistant tomato cultivars and one control cultivar. Through this project, the NBDAAF staff also monitored irrigation, fertilization program, inside and outside temperatures and yields of six greenhouse and tunnel tomato production sites. Furthermore, this project also allowed the applicant to hire an experienced greenhouse production specialist who visited eight NB farms in mid-season. The consultant presented his observations and recommendations during the ACORN 2016 conference held in Moncton.

Five growers from across the province grew the LB resistant cultivars (field conditions) and many of them have provided their feedback for each of the eleven tomato cultivars by completing a crop assessment survey. Although no late blight was reported at any of the sites, valuable information on the agronomic and fruit quality of the selected cultivars, was collect by project lead and collaborators. Based on the crop assessment surveys and several recently published documents, only a few of the LB resistant cultivars selected may be of interest to NB vegetable producers: Mountain Magic, Defiant, Mountain Merit and Plum Regal. Jasper, a very small cherry type tomato, could have been part of the list because of its great flavour and high level of resistance to the US-23 genotype of late blight; however, in our field conditions this cultivar yielded poorly, its fruit was prone to splitting and its fruit was very slow to harvest due to its small size.

Six greenhouse and tunnel tomato growers were selected for the greenhouse monitoring component of the project: Strawberry Hill Farm, Rainbow Harvest Acres, Jemseg River Farm, Codiac Organic and ferme ALVA Farm. NBDAAF staff installed tensiometers and temperature data loggers to monitor soil moisture and indoor/outdoor

air temperature. NBDAAF staff also conducted soil and plant tissue sampling to monitor the fertilization program of each farm through the season.

Although tensiometers were installed and used to monitor soil moisture, few of the growers relied on them to manage their irrigation because many sites involved poorly structured, compacted new soils and shallow water tables.

Regarding fertilization, although the basic soil tests taken prior to planting indicated a relatively high level of fertility at all sites, none of the greenhouse soil tests (Saturated Media Extract) from the farms showed sufficient available potassium and only one farm's tissue samples indicated sufficient potassium. Furthermore, only two farm's greenhouse (SME) soil tests indicated a sufficient nitrate level through the season. Soil and tissue test reports suggest that most growers need to apply additional nitrogen and potassium at the beginning and during the season.

On several occasions during the season, the temperature in the greenhouses and tunnels at most sites reached the high critical level for tomato production of 35°C indicating the need for improved ventilation. Also, sites that did not use supplemental heat in their structures, had inside night and early morning temperatures regularly below the low critical level for tomato production of 15°C. The two growers who used supplemental heating were able to maintain their greenhouse temperatures above the 15°C.

4. *Introduction:*

During the last 10 years, few vegetable research and demonstration projects have been conducted in New Brunswick, with the exception of the work carried out by AAFC's Sénateur Hervé J. Michaud Farm in Bouctouche. The vegetable sector has evolved greatly over the past 30 years. Fewer producers are now involved in production and many of them have scaled down as wholesaling produce has not been very profitable for growers.

Although the overall acreage of vegetables grown in the province has diminished since the 80's, many new small scale operations have been established. These operations are involved with direct marketing and are benefiting from the renewed interest shown by consumers for locally produced fruit and vegetables. As a result, many of them are involved in season extension activities. Off-season prices associated with early and late season crops and the need to stretch the growing season to capture new markets are driving the interest for season extension.

Late Blight disease caused by *Phytophthora infestans*, is a devastating disease that affect tomato and potato plants, often causing serious economic losses. There are various tomato cultivars that are resistant to late blight; however, many producers who grow field tomatoes are suggesting that the late blight resistant tomato cultivars lack productivity and flavor.

5. *Project Objective(s):*

Provide five NB vegetable growers with an opportunity to grow and evaluate eleven late blight resistant tomato cultivars (field production).

Monitor the tomato production of six greenhouse and tunnel producers (including irrigation, watering practices, fertilization program, inside/outside temperatures of the infrastructure, and crop yield).

Hire an out-of-province greenhouse specialist to visit and provide recommendations to eight NB greenhouse vegetable growers.

6. *Project Deliverable(s):*

The eleven LB resistant tomato cultivar transplants were grown and delivered to five NB vegetable collaborating farms in early June, 2016. The producers grew and evaluated the tomato cultivars for late blight and incidence of other diseases, and assessed agronomic and fruit quality parameters. Although all sites were monitored, only the main demonstration site (Strawberry Hill Farm) was selected for the yield assessment of the cultivars through the entire season.

Six tomato producers were selected for the greenhouse monitoring component of the project. NBDAAF staff monitored irrigation, fertilization program and inside/outside temperatures. Growers were asked to keep track of the yield from the 15 reference tomato plants that were supplied.

7. *Project details/methodologies*:

Late Blight Resistant Tomato Cultivar Demonstration: The five producers grew the LB resistant cultivars in their fields using their typical production practices. Growers received 10-15 plants per cultivar and filled in the crop assessment sheets so the project lead could report all the relevant information. It is important to note that the weekly yield data from the main demonstration site was collected. At the main demonstration site, the producer grew the tomato plants organically through black plastic mulch in a single row. Granulated chicken manure was applied to the rows and incorporated lightly into the soil prior to the installation of the plastic mulch and prior to planting. No drip irrigation system was installed. The plants were supported by 8 ft rebars and a “sting and weave” system. The plants were pruned twice in early season and all the indeterminate cultivars were de-headed prior to the end of the season. No fungicides were used on the main demonstration site.

Greenhouse Tomato Production Monitoring: At each site, two tensiometers and two thermocouples (temperature data loggers) were installed to monitor irrigation and inside/outside air temperatures. Soil fertility was assessed prior to planting time with one Basic Soil Test and during the season with four Greenhouse Soil Tests (Saturated Media Extract, SME) and four Plant Tissue Tests. Tomato growers were asked to weigh the fruit from 15 plants that were given to them at the beginning of the season. All 15 tomato plants were used as the reference cultivar for participating growers. The “Sakura”, a cherry type tomato, was the reference cultivar.

The LB resistant cultivar transplants and the “Sakura” transplants used in this demonstration were grown by Strawberry Hill Farm.

8. Results and discussion:

Late Blight Resistant Tomato Cultivar Demonstration: No late blight incidence was reported at any of the trial sites; however, valuable information on the agronomic and fruit quality of the selected cultivars was collected. Based on the crop assessment surveys and several recently published documents, only a few of the LB resistant cultivars selected could be of interest to NB vegetable producers: Mountain Magic, Mountain Merit, Defiant and Plum Regal. Jasper, a very small cherry type could have been part of the list because of its high level of resistance to US-23 and great flavour; however, under our field conditions this cultivar yielded poorly, its fruit was prone to splitting and its fruit was very slow to harvest (4 min/lb) due to the small size of fruit.

Large and medium beef type: The three cultivars, Mountain Merit, Defiant (best yielding in 2016 on one site), and Plum Regal (Salsa type) have recently showed moderate to excellent resistance to the most predominant *Phytophthora infestans* strain in NB, US-23. Some references suggest that Brandy Wine does not have any resistance to the US-23 strain. Under New Brunswick conditions, both Brandy Wine and Pruden's Purple (heirloom cultivars) were highly sensitive to early blight and sensitive to powdery mildew and leaf mould. The data collected from one non-replicated site showed that Defiant was the highest yielding large to medium size tomato cultivar with a yield of 5.8 kg/plant.

Cherries: Jasper was one of the top tasting cultivar (5/5 rating); however, most growers will not be growing it in the future because it is a very small cherry and tends to crack under field growing conditions. Also, growers find this indeterminate and very small fruited cultivar very slow to pick when grown in the field with minimal pruning and with "string and weave system" as the fruit is difficult to find. Cherry Bomb was also a top tasting cherry cultivar (5/5 rating); however, based on other reports, its resistance to late blight is questionable. Mountain Magic, a large cherry type, did very well in the taste testing (4/5 rating).
The same references also suggest that Golden Sweet, Red Pearl, Juliet and Brandy Wine do not have any resistance to the most recent strains (e.g.US-23). The 2016 data collected showed that Juliette, Mountain Magic and Cherry Bomb were the highest yielding cherry tomato cultivars with 3.3, 2.5 and 2.4 kg/plant of fruit respectively.

Data collected during the season are reported in the Annex A and B, Tables 1, 2 and 3.

Greenhouse Tomato Production Monitoring: Six greenhouse and tunnel tomato growers were selected for the greenhouse monitoring component of the project: Strawberry Hill Farm, Rainbow Harvest Acres, Jemseg River Farm, Codiac Organic and ferme ALVA Farm. NBDAAF staff installed tensiometers and temperature data loggers to monitor soil moisture and indoor and outdoor air temperature. NBDAAF staff also conducted soil and plant tissue sampling to monitor the fertilization program of each farm through the season.

Irrigation: Based on irregular tensiometer readings and observations, it was quickly determined that the tensiometers used to monitor soil moisture were not effective at many of the sites because several sites involved poorly structured, new soils and shallow water tables. Since tensiometer readings were not coherent, the instruments were monitored occasionally; however, no data was collected. Irrigation was therefore very difficult to manage early in the season on several sites as these soils became saturated with water early in the season. It is interesting to note that in 2016, the majority of the participating growers had good irrigation system design and good watering practices (2 to 4 drip lines and multiple watering cycles between mid-morning to mid-afternoon). Watering was generally done between 10:00am to 3:00pm.

Fertilization: Although the basic soil tests taken prior to planting indicated a relatively high level of fertility at all sites, none of the greenhouse soil tests (Saturated Media Extract) from the farms showed sufficient available potassium and only one farm's tissue samples indicated sufficient potassium. Furthermore, only two of the farm's greenhouse soil tests indicated a sufficient nitrate level. Soil and tissue test reports suggest that most growers need to apply additional nitrogen and potassium at the beginning and during the season. Growers participating in the project, tended to underestimate the tomato plant's need for nitrogen and potassium. Four of the soils monitored showed low magnesium availability (SME tests), although the magnesium levels in the tissues met or were near the sufficiency level. Calcium in the foliage was always in the sufficiency range but it was often below the sufficiency range in the greenhouse soil test. For a second season, all greenhouse soil tests and many of the tissue tests indicated low levels of phosphorus, although no phosphorus deficiencies were observed on the crop. This observation was not surprising to the project consultant who works closely with other organic growers. The soluble salts found in the soils varied significantly during the season. In some cases, the salinity increased and in other cases it decreased over time. Four of the six sites had soil pH above the desired level of 7 (see Annex A, Tables 4, 5 and 6).

Temperature: On several occasions during the season, the temperature in the greenhouses and tunnels at most sites reached the critical high level for tomato production of 35° C, indicating the need for improved ventilation. Also, sites that did not use supplemental heat in their structures, had inside night and early morning temperatures regularly below the critical low level for tomato production of 15°C. The two growers who used supplemental heating were able to maintain their greenhouse temperatures above the 15°C through simple automation with thermostats and heating systems (see Annex A, Charts 1, 2 and 3).

Yield: Five of the six farms provided yield data to the project lead. Yield for the reference cherry type tomato cultivars "Sakura" varied from 19.1 kg/m^2 to 3.3 kg/m^2 (19.1, 9.7, 4.7, 3.4, and 3.3 kg/m^2). These yields are relatively low compared to the high yield from high tech year around organic greenhouse production units that can produce 40 kg/m^2 over a longer production season. It should be noted that only two of the six farms use some supplemental heating which allowed them to harvest fruit for a longer

period (90 to 110 days). Furthermore, the low plant densities used by some of the farms also had a significant impact on crop yield.

The hired greenhouse consultant visited eight greenhouse/tunnel operations, provided individual recommendations to the growers and presented his findings and recommendations at the ACORN conference. The following aspects of greenhouse tomato production needs to be reviewed by growers: 1) row spacing, plant spacing and crop densities, 2) Improved pollination, 3) improved natural ventilation, 4) transplant production, 5) grafting, 6) selection of true greenhouse cultivars, 7) irrigation management, 8) plant and fruit pruning, 9) trellising, 10) plant fertilization and 11) crop protection, including predators and parasitoids. Notes taken during farm visits are available in the Annex B.

9. *Conclusions and important things learned in 2015-2016:*

Coloured Sweet Pepper Cultivars (2015)

2015 Coloured Sweet Pepper Demonstration: According to the comments provided by the growers on the crop assessment surveys, the productivity of the coloured sweet peppers grown on the eight farms was extremely variable. The surveys also indicated that the following six cultivars appear to be the most interesting for NB vegetable producers who sell locally: Triora, Carmen, Catriona, Cupid, Doe Hill and Red Wing. Two informal group tasting events found the first 5 cultivars listed above to be the most flavourful (Annex A). It should be noted that some of the growers (direct marketers) preferred the medium sized fruits over the large fruits because of the higher unit cost associated with the large fruits. Many growers sold the small pepper cultivars in mixtures and by containers instead of by weight. It is possible to successfully grow coloured sweet peppers under NB conditions by selecting early to mid-season cultivars and by growing them in greenhouses and tunnels which allow for earlier ripening, extended season and less bacterial disease pressure (reduced leaf wetness). Collaborators and industry consultants agree that it is extremely important to grow robust and healthy transplants to obtain high yield. The pepper assessment summary sheet provides a detailed description of the ten (10) cultivars grown. Since the productivity of the pepper cultivars was extremely variable between sites, growers should conduct cultivar trials under their own growing conditions and practices to determine which ones are better adapted to their operation.

Grafted Tomato Plants (2015):

Based on the results of the 2015 project, most grafted tomato plants (treatments) grown in minimally heated greenhouses and unheated tunnels allowed for increased yield. It is generally recognized that growers who produce tomatoes in heated greenhouses or tunnels and in the soil with little or no crop rotation options should consider grafting their plants on disease resistant and vigorous rootstock. This is particularly true when soil-borne diseases have been identified. However, a number of recent studies from Quebec clearly show that grafting tomato plants will delay fruit production. Consequently, tomato grafting is more beneficial to greenhouse/tunnel growers who extend their season with supplemental heat. To mitigate the delayed

harvest, growers are encouraged to manage their grafted indeterminate tomato crop on two heads and with intensive pruning (especially the small fruited cultivars). De-suckering and pruning will re-balance the crop from an excessively vegetative mode to a fruit setting mode (regenerative mode). It should; however, be noted that some varieties do not perform well when they are pruned heavily. Also, grafted tomato plants may not be suitable for growers looking for tomatoes for the early market.

Since grafted tomato plants generally provide increased plant vigour and vegetative growth, improved management and more pruning will be required. For this reason, novice growers may want to consider improving their tomato production skills before considering grafted tomato plants. However, some industry experts think differently, suggesting that the improved rootstock may offer more benefits when the crop is grown in less than adequate conditions (i.e. fertility, water and temperature stress). To make full use of a vigorous rootstock and for economic reasons, the scion (top part of the transplant and cultivar grown for its fruit) is often grown with two heads or leads. The scions should also be managed so they are not in contact with the soil to prevent them from developing roots. The roots from the scion do not have the soil-borne disease resistance that is offered by the selected rootstock. Furthermore, the suckers from the rootstock should not be allowed to grow as they are generally not productive and their fruit of lower quality. Growers who make use of grafted tomato plants may need to adjust their irrigation practices and fertilization program.

Late Blight Resistant Tomato Cultivars (2016):

In 2016, late blight (LB) was reported in only one tomato field (personal communication); however, no LB was observed at any of the demonstration sites. Late blight resistant cultivars may be very useful to tomato producers who grow their crops in the field. Growers need to pay particular attention to the cultivars that have shown a high level of resistant to the *P. infestans* strain US-23 as it is the most prevalent strain in the province. Growers who sell direct to consumer must also be aware that some of the LB resistant cultivars lack flavor. Taste evaluation is therefore highly recommended. Since the productivity of the cultivars was variable between sites and management practices, growers should conduct cultivar trials under their own growing conditions and practices to determine which ones are the best adapted to their operation. Based on the crop assessment surveys and several recently published documents, only a few of the LB resistant cultivars selected are of interest to NB vegetable producers: Mountain Magic (large red cherry), Mountain Merit (medium to large round red), Defiant (medium round red) and Plum Regal (medium elongated red).

Other interesting references:

http://articles.extension.org/pages/72678/late-blight-management-in-tomato-with-resistant-varieties
http://vegetablemdonline.ppath.cornell.edu/NewsArticles/Tomatoes-LB-Resistant2013.html
http://www2.gnb.ca/content/dam/gnb/Departments/10/pdf/Agriculture/Brochure_LateBlightPotatoTomato_inHome%20Garden.pdf
http://www.hortcouncil.ca/wp-content/uploads/2016/02/Late_Blight_of_Potato_CHC_E.pdf

Greenhouse Tomato Production Monitoring (2015 and 2016):

Many greenhouse tomato growers have improved their irrigation system design and watering practices. The system should include at least 2 drip lines and preferably 3 to 4 lines per bed for organic production. Higher numbers of drip lines allow for uniform watering of the entire bed width. Drip line emitter spacing should not be too far apart (less than 12 inches apart). To reduce evaporation and stimulate mineralization of the organic fertilizers applied on the surface of the soil, black or white on black plastic mulch should be used. The use of white on black plastic (non-buried) is of particular benefit to organic growers who need to lift their plastic mulch in order to apply dry organic fertilizers during the season. Without any type of plastic or mulch, limited mineralization of the organic matter and organic fertilizers will occur at the surface of the soil because the conditions are too dry to support soil biological activity. Based on the observations made during the summer of 2015 and 2016, diversified vegetable growers tend to under-irrigate their crop (watering is not frequent enough). To compensate for irregular watering, some growers will often over-irrigate (leaving the irrigation on for excessively long periods of time). Growers need to be more consistent in the watering frequencies and length of watering cycles. When the tomato plants are producing ripened fruit and when the conditions are sunny and hot, multiple short watering cycles should be used and overall water volume increased. Watering should be done between mid-morning and mid-afternoon. A period of soil dryness (aeration) is needed after the watering cycles. The period of aeration should occur during late day and night time. This encourages soil biological activity and optimal root growth. Tensiometers are valuable soil moisture monitoring tools that are used to manage the watering practices; however, for them to be useful, the irrigation system must be well designed to ensure uniform watering. Novice greenhouse operators should use tensiometers.

The fertilizers or amendments should be applied to the entire bed width to encourage optimal root development. Placing organic fertilizers in the plant hole before planting is not a recommended practice. Some references suggest that organic and conventional tomato growers should apply at least ½ of the nitrogen fertility to the soil prior to planting. Other references suggest multiple applications of fertilizers during the season are required. The organic fertilizers or amendments used prior to planting must be incorporated lightly into the soil. Since only 2 of 6 farm sites had adequate nitrogen levels in the soil and plants during the entire season, growers will need to add nitrogen fertilizers during the season on top of the beds or through the drip irrigation system. Organic growers may want to use several sources of nitrogen to ensure a more consistent and longer lasting release of nitrogen. High yielding organic greenhouse operations in Québec often use weekly applications of fertilizers. Under NB's current growing practices, most growers should consider a monthly application (at planting, 30 days later and 60 days later). Low levels of soil and plant tissue phosphorus are often reported in organic tomato production. Since none of the crops have shown any phosphorus deficiencies in 2015 and 2016, no corrections were required on any of the sites. In general, growers tend to underestimate the tomato plant's need for potassium. Potassium should be applied prior to planting and during the season. According to plant tissue analysis, during 2015 and 2016, eight of the ten sites should have added some potassium rich fertilizers during the season. The project demonstrated the usefulness of

doing some basic soil tests prior to planting, in-season greenhouse soil tests and in-season tissue tests to monitor the fertilization program. According to the greenhouse consultant, greenhouse soil tests should be taken regularly and tissue testing done only when nutritional deficiencies are suspected. A greenhouse soil sampling protocol will need to be developed. Although it was suggested that the first cm of soil should not be part of the soil samples, during the 2015 and 2016 seasons, the entire soil profile (0 to 150 cm) was collected for analysis. It was also suggested that in the future, beefsteak type tomatoes should be monitored instead of cherry types, as the beefsteak types are more productive and have higher requirements. Beefsteak types tend to show nutritional deficiencies before the cherry types do.

On several occasions, the temperature in the tomato greenhouses and tunnels at most sites reached the critical level of 35°C during the season. Growers who use season extension infrastructure need to better monitor inside temperatures and ventilate their structures before the temperature reaches excessively high levels. Horizontal air-flow (HAF) fans may be used to circulate the inside air and to eliminate hot spots. The warm air should be exhausted out of the structure through natural ventilation or forced air ventilation. Greenhouse and tunnel tomato plants will benefit from improved mid-day ventilation to reduce indoor temperature. Greenhouse tomato plants can withstand short periods of high temperature provided the irrigation is adequate and night temperature is back in the optimal range. Small tunnels and basic hoophouses are often not designed and equipped for optimal ventilation. Growers who have greenhouses that are insulated with double layers of plastic should consider supplemental heat to keep the greenhouse temperature above the critical level of 15°C. Adding heat in early and late season should allow for higher fruit yield. It will also allow growers to optimize the benefit of the grafted plants which should be more productive over a longer period of time. For tomato production, it is best to keep the ambient temperature between 17°C and 25°C. The productivity of the tomato plants is jeopardized when the ambient temperature is outside the critical temperature levels. Adding early morning heat and/or ventilation would also reduce the relative humidity (RH) in the tunnels. This RH is responsible for morning condensation on the plants and higher incidence of disease. Heating systems can be automated, to reduce workload. If automated, the control systems should be wired to thermostats, weather stations and heating and ventilation systems. Besides the critical mimimum/maximum temperature levels discussed above, controls should also consider the 24 hour average temperature. With supplemental heat, growers are also able to readjust or steer “direct” plants that are not well balanced (vegetative vs regenerative). Several temperature related strategies can be used to steer the crop growth.

Row spacing, plant spacing and plant density needs to be reviewed by many of the growers. To achieve optimal yields, higher plant densities are generally required. Typically, growers tend to have narrow row spacing and wide plant spacing. In many instances, it would be best to increase row spacing and add more plants into the row. Crops produced with twin-heads can be used to increase plant density. Tomato crops can be grown in a single row in a V-Shape (one plant or head to the right, the next one to the left) with two supporting metal wires (approx. 60 + cm apart) or can be grown in double “staggered” rows. Double rows (staggered planting) can be used but this

planting option is not well suited if a grower is planning to use plastic mulch and apply multiple applications of dry fertilizers during the season. To keep the soil surface moist for improved mineralization, it is best to cover the entire bed width with the plastic mulch.

True greenhouse tomato cultivars should be used in these season extension structures to maximize yield. Greenhouse pedigreed cultivars are bred for disease resistance and yield. Leaf mould and powdery mildew are two common greenhouse tomato diseases that will reduce plant health, vigour and yield. Growers need to select their cultivars for such resistance.

Since tomato plants need to be well pollinated to produce quality and high numbers of fruit, growers will need to make sure natural pollinators can reach the flowers. If the number of pollinators is low, growers will need to pollinate their plants manually. Growers can shake or vibrate the strings or top wires during the middle of the day. For large structures such as multi bay high tunnels or gutter connect greenhouses, growers need to rely on purchased bumble bees.

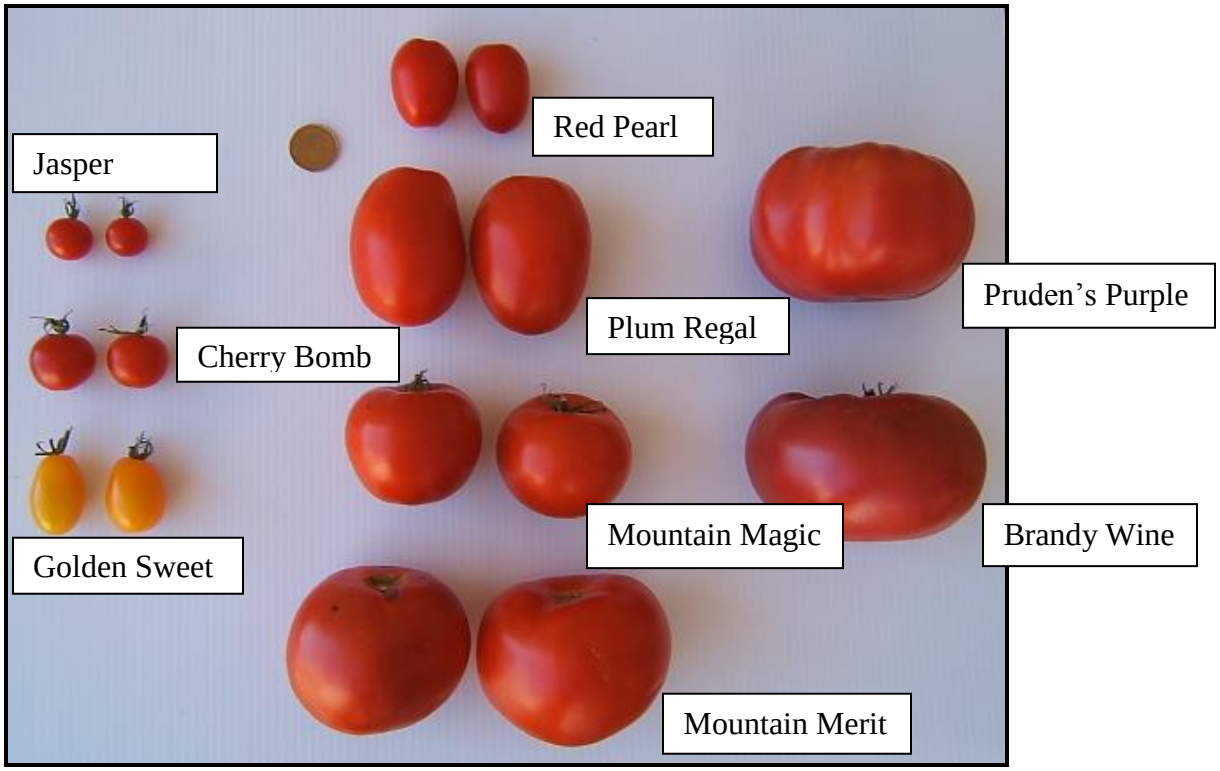
Given the limited experience that NB greenhouse vegetables growers have, there is a need for them to hire out of province expertise. Large as well as small growers in Quebec continue to rely on paid private consultants.

10. Required next steps – The results and observations over the course of the season suggest that further greenhouse vegetable projects are required. Growers need to improve their irrigation system designs, watering practices and fertilization programs. Growers should also purchase several crop production aids (e.i. better suited irrigation equipment, white on black plastic mulch, tensiometers, temperature monitoring, alarm devices and automated systems) as well as continue to invest in soil and tissue testing. The project lead and the partners are considering applying for additional funds in 2017-18. The application will be developed and submitted in April 2017 to the Developing Business Skills Program.

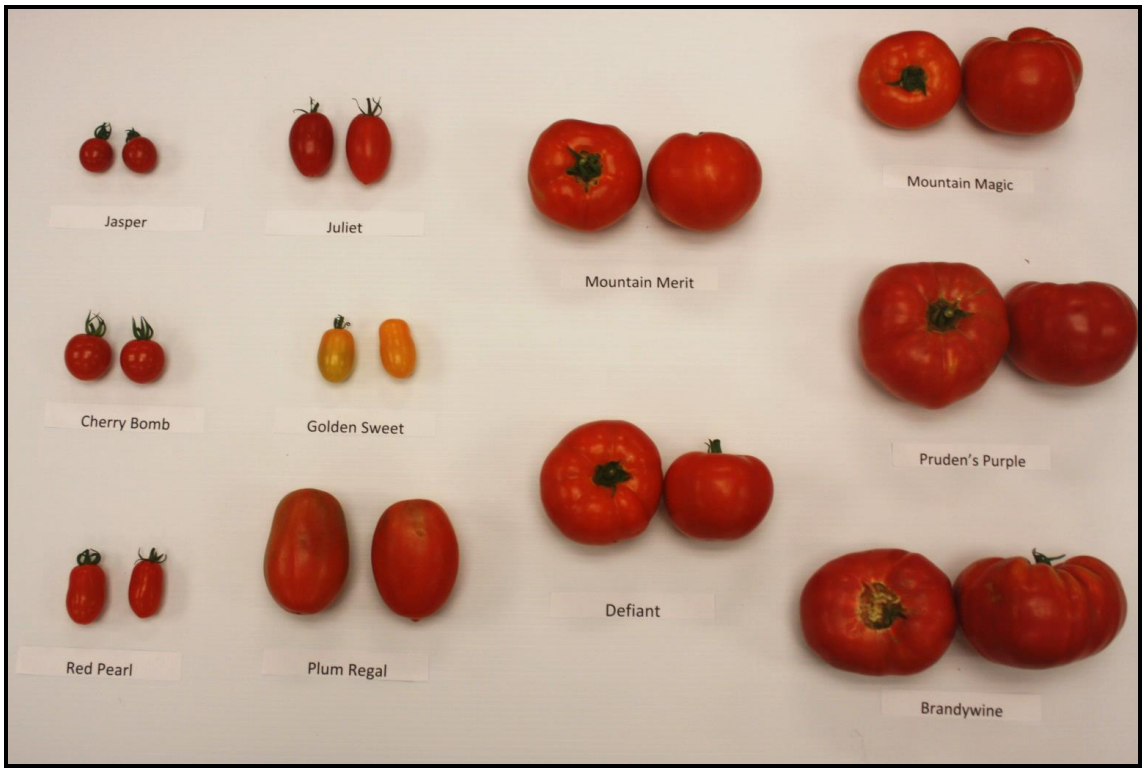
11. *Communication*: The project lead, collaborators and project consultant will be presenting the results of the project at the ACORN conference (November 2017), at the NBSCIA Meeting as well as during the upcoming NBDAAF Crop Update. The report, presentations and notes will be available on-line via the ACORN website.

Acknowledgements:
Thank you to the following project collaborators: Strawberry Hill Farm, Rainbow Harvest Acres Farm, Jemseg River Farm, Slocum Fresh Produce Farm, Codiac Organic Ltd, Windy Hill Farm, Ferme Vienneau, Ferme Alva Farm, Ferme Maurifils and Micheal Tesfaendrias (NBDAAF), Benjamin Slaney (summer student), Venessa Allain (NBAAF) and Philippe-Antoine Taillon (ClimaxConseils).

Annex A



Missing from top the image: Joliette and Defiant



Annex B

Description of late blight (LB) resistant tomato cultivars selected.

Data below was collected from seed catalogues and various papers including;
http://articles.extension.org/pages/72678/late-blight-management-in-tomato-with-resistant-varieties

Important notes about late blight resistance: There are five major resistance genes responsible for late blight resistance of tomatoes (Ph-1, Ph-2, Ph-3, Ph-4 and Ph-5) and at least 24 genotypes or stains of *Phytophthora infestans*, the pathogen responsible for late blight. Unfortunately, a major gene may not offer resistance to all genotypes of the disease. The genotypes found in Eastern Canada are: US-8, US-23, US-22 and US-24; and the most prevalent genotype currently found in New Brunswick is US-23.

Defiant: Determinate, 70 days to maturity after seed germination, mid-size slicer has high resistance to late blight (LB) and intermediate resistance to early blight combined with great flavor. The 6-8 oz., globe-shaped fruit are smooth and medium-firm with good texture. Deep red internal and external color. High-yielding, medium-sized plants are widely adaptable. Defiant was traditionally bred to inherit the Ph-2 and Ph-3 major genes for late blight (*Phytophthora*) resistance. High resistance to fusarium wilt races 1, 2, late blight, and verticillium wilt; and intermediate resistance to early blight. Very good resistance to US-11, US-23 and US-24. Similar resistance expected with US-17 and US-22.

Mountain Merit: Determinate, 75 days (other sources: 69 days after transplant, 75 days after planting in the US), medium-large fruit (8-10 oz.), red slicer with an excellent disease package to keep it healthy in the field. Larger than Defiant PHR, though flavor is not quite as good. Mountain Merit has one of the best disease packages around for a variety of field conditions. High resistance to fusarium wilt races 0-2, late blight, nematodes, and tomato spotted wilt virus. Very good resistance to US-23 and US-24. Similar resistance expected with US-11, US-17, and US-22

Plum Regal: Determinate, 75 days (Other sources: 68 days after transplant, 80 days after planting in the US), great for sauces and salsa. Fruit (3-4 oz.). This hybrid has a bright red interior and exterior that is superior in flavour. It also has a great texture with good crack resistance. With its great disease resistance package it stays healthy in the garden, making it a great choice for home gardeners and organic growers. It has resistance to late blight, Verticillium and Fusarium wilt, early blight and tomato spotted wilt virus. Good but variable resistance to US-23; sometimes ineffective. Very good resistance against US-11 and US-17. Observed effective for US-22 when occurring naturally, but ineffective when inoculated (lab); also ineffective for US-24 (lab).

Red Pearl: Indeterminate, 58 days, tender and nearly seedless, with intermediate resistance to late blight. Fruits weigh 15-20 gm, and have good flavor and a meaty texture. Resists cracking and stores well on and off the vine. Tall and healthy plants, high resistance to fusarium wilt races 1, 2, and intermediate resistance to late blight. Ineffective for US-23, US-24 and intermediate resistance to US-22.

Jasper: Indeterminate, 60 days. Round and small deep red cherry (7-10 gm), fruits are crack resistant, borne on small trusses, and store on the plant well. According to seed provider, this cultivar is resists cracking and rot; however, some cracking was observed in the 2016 LB demonstration sites in NB. The texture is pleasantly chewy, flavor is sweet and rich. Plants are extra vigorous and tall, staying healthy for a long picking period. Intermediate resistance to early blight, septoria leaf spot, *Fusarium* races 1 and 2, and late blight. Very good resistance to US-23.

Mountain Magic: Indeterminate, 66 days, large red cherry tomato has exceptional sweet flavour, crack resistance and vigorous foliage. Always the healthiest looking plants in our trials. Indeterminate, good yields, cluster forming and easy to pick. Its firm texture gives it a long shelf life. Resistance to late blight, fusarium and verticillium wilt. Maturity of 70-80 days (other source). Very good resistance to US-11, US-17, and US-23; also effective to US-22, US-23, and US-24 in lab.

Juliet: Indeterminate, 60 days. A larger sister variety of Santa, deep red, shiny fruits avg. 2-2 1/4" L x 1 3/8-1 1/2" W, weighing 1.5-2 oz. Typically 12-18 fruits per cluster. Delicious, rich tomato flavor for salads, great salsa, and fresh pasta sauce. Good crack resistance, vine storage, and shelf life. High resistance to late blight; and intermediate resistance to early blight. Ineffective for US-23, intermediate resistance to US-17 and US-22. Some suppression of fruit symptoms with US-8 and US-11. Ineffective for US-22, US-23, and US-24 in lab.

Golden Sweet F1: Indeterminate, 60 days, firm, 15-20 gm., deep yellow fruits grow in long clusters on tall, healthy plants. The best-eating yellow grape with mild, sweet flavor. According to the seed provider this cultivar is resists cracking; however, significant cracking was observed in the 2016 LB demonstration sites in NB, especially in early season. High resistance to fusarium wilt.

Cherry Bomb: Indeterminate, 64 days. Red field cherry, perfect for the organic grower who needs strong late blight protection. Vigorous plants produce high yields of uniform, vivid red fruits with ideal cherry size (15-20 gm for harvest and snacking). Classic cherry tomato flavor - firm, sweet, and well-balanced. Unique calyx makes an attractive display when left attached to fruit. High resistance to late blight.

Pruden's Purple: Indeterminate, 67-72 days. Large to very large (many over 1 lb.) fruits are flattened and smooth (except for shoulder ribbing on some), and resist cracking. Vivid dark pink skin with crimson flesh. Medium tall, potato-leaf plants. Organically grown. Good resistance to US-23, moderate resistance to US-24 and US-17. Some suppression of foliar symptoms, not fruit, with US-8 and US-11. Resistance to US-22, US-23 and US-24 (lab).

Brandy Wine: Indeterminate, 78-82 days. We describe Brandywine's luscious flavor as "very rich, loud, and distinctively spicy." The large fruits, often over 1 lb., have a deep pink skin and smooth red flesh. The medium-tall, potato-leaf plant is best staked or caged. Ineffective for US-23 and US-24, and moderate resistance to US-17.

Table 1. EARI-16-029 Project- 2016 NBDAAF/ACORN Late Blight Resistant Tomato Cultivars - Crop Assessment Survey

Agronomic performance in field grown conditions (Poor = 1, Good = 5)

Cultivars	Maturity	Abundance of Leaves (1-5)	Crop Vigour (1-5)	Yield Potential* (1-5)	Marketable Fruit (1-5)	Ease of Picking (1-5)	Post-Harvest shelf life (1-5)	Diseases or disorders: Powdery mildew (PM), leaf mould (LM), white mould (WM), late blight (LB), cracking, green shoulders, deficiencies,	Comments from collaborators (4 sites): *No late blight was reported on all of the demonstration sites.*
Defiant (Det. Medium)	Mid-season	4.0	3.7	5	4	4	4	Some LM at one site. Heavy PM at one site	Some green shoulders (sun scald) on exposed fruit jn mid-season at a few sites. Top yielding cultivar at SHFarm. One collaborator found it lacked vigour. *(Effective for US-23)***
Mountain Merit (Det. Medium to Large)	Very Late	3.8	3.8	4	4	4	4	Sensitive to PM and LM. Some leaf rolling on two sites.	Easy to pick compared to other beefsteak cultivars. Tallest determinate cultivar. One collaborator reported high crop vigour. *(Effective for US-23)***
Plum Regal (Det. Salsa)	Late	4.3	4.3	4	4	4	4	Sensitive to PM and LM	Fruits remain firm but with some shrivelling. Although a short determinate, it should be well staked or trellised to keep fruit off the ground. *(Good but variable resistance to US-23) ***
Red Pearl (Indet. Cherry)	Early	4.0	4.0	3	5	4.5	4-5 remains firm	Very healthy. Very little PM at one site.	A cluster can be picked with one hand. Excellent post-harvest shelf-life (fruit remains firm and not shrivelled). *(Ineffective for P. infestans strain US-23)***
Jasper (Indet. Cherry)	Very Early	4.3	4.7	2	3	3.5	2-3 because of post-harvest cracking	Very healthy. Significant cracks prior to picking and post-harvest. Moderate PM at one site.	Due to small fruit size, it is hard to pick and requires a lot more fruit to fill a box. Very slow to pick (4 minutes/lbs on one site). Prone to splitting, may help if peduncle is kept on fruit. Need frequent picking to reduce cracking (over-ripening). Lowest yielding at SHFarm. *(Effective for US-23)***
Mountain Magic (Indet. Cherry)	Late	4.3	4.7	3	5	4-4.5	4 some shrivelling	Very healthy. No PM.	Slow to produce its first fruit compared to cherry types and medium size fruit. One collaborator reported higher yield. *(Effective for US-23)***
Juliet (Indet. Cherry)	Mid-season	4.3	4.3	4	5	4	3 some shrivelling	Some LM on one site. No PM.	Cultivar with average to high vigour. Easy to pick. Very good shelf-life for one collaborator. *(Ineffective for P. infestans strain US-23)***
Golden Sweet (Indet. Cherry)	Early	4.7	4.7	3	2-4	3	3-4 significant cracking on most sites	Significant cracking early in season at all sites but one. No PM.	Very prone to cracking, should harvest early and frequently to avoid excessive cracking. Less cracking in mid to late season. No cracking reported on the well irrigated site (top pick for that grower). One collaborator suggests it is very easy to pick. *(May not be resistant to LB)***
Cherry Bomb (Indet. Cherry)	Early to mid-season	5.0	5.0	3	5	3.5	3-4 some cracks	Some cracking in early season	Great looking fruit and vigourous plant (sometimes difficult to pick because of its height and vigour. Should be well pruned, staked and/or trellised. *(Reported to be resistant to P.infestans)***
Pruden's Purple (Indet. Beefsteak)	Late	4.3	3.7	5	2-4	2-5	2 because of splitting	Very sensitive to early blight. Sensitive to PM and LM. More sensitive to diseases than Brandy Wine and all other cultivars. Magnesium deficiencies observed on one site.	Some consumers may not appreciate the heirloom look of this cultivar. Can be picked quickly (15 seconds/lb on one site) but sometimes hard to pick when the fruit is caught between strings. Better yielding than Brandy Wine. Marketability may be difficult with some clients. *(Reported to be resistant to P.infestans strain US-23)***
Brandy Wine (Indet. Beefsteak)	Very Late	4.0	4.0	5	2-4	2-5	2 because of splitting	Very sensitive to early blight. Sensitive to PM and LM. Magnesium deficiencies observed on one site.	Some consumers may not appreciate the heirloom look of this cultivar. Can be picked quickly but sometimes hard to pick when the fruit is caught between strings. Marketability may be difficult with some clients. *(Ineffective for P. infestans strain US-23)***
Sakura (Indet. Cherry)No LB Resistance	Very Early	3.7	3.7	4	5	5	3-4 some shrivelling	Very little disease during the season. Some early blight at the end of season. No PM.	Very easy to pick due to low abundance of leaves. Resistant to cracking. Very productive and adapted to tunnels and greenhouses. Great yielding cherry tomato. *(Not resistant to late blight)***

*Yield potential based on 2016 Strawberry Hill Farm (SHF) fruit yield. Plants were grown in one single row with 15 plants per cultivar. Fruit from all plants were harvested weekly until Sept 29.

** Data from seed catalogues and other papers.

Table 2. EARI-16-029 Project- 2016 NBDAAF/ACORN Late Blight Resistant Tomato Cultivars - Crop Assessment Survey

Fruit quality in field grown conditions (Poor = 1, Good = 5)

Cultivar	Fruit diameter and length (cm)	Fruit shape (ribbed, round, elongated, flat, ...)	Uniformity of fruit	External texture (very soft, soft, firm, very firm)	Internal texture (very juicy, juicy, pasty, firm, very firm)	Depth of stem scar (deep, average, shallow)	External appearance (1-5)	General taste* (1-5)	Description of fruit taste (bland, sweet, acidic, balanced acidic/sweet/, sour, fruity/floral aroma)	Comments from collaborators (4 sites):
Defiant (Det. Slicer)	7	Medium round beefsteak	4	Very firm	Firm, juicy	Shallow	4	1.5	Bland, mild acidity, slight sweetness	Has great appearance and should sell well, but the taste is very bland. The fruit is very firm. One collaborator found its external appearance was very nice.
Mountain Merit (Det. Slicer)	8 - 9	Medium to large round beefsteak	3	Firm	Firm, very juicy	Shallow	3	2	Bland, slight acidity, good flavor	Good appearance, but the taste is very bland. One collaborator found its external appearance was very nice. Top tasting for one collaborator.
Plum Regal (Det. Cherry)	6 x 9	Large elongated cherry	2	Very firm	Very firm, dry and pasty	Shallow	3	1	Bland, low acidity, little flavour	Good appearance, but the taste is very bland. It is a processing tomato. One collaborator found its external appearance was very nice.
Red Pearl (Indet. Cherry)	2.5 x 4	Small elongated, ribbed cherry	4	Very firm-firm	Firm, dry	Shallow	3.5	2.5	Bland, low acidity, little flavor	Not very tasty for a cherry tomato.
Jasper (Indet. Cherry)	2	Very small round cherry	4.5	Soft	Juicy	Shallow	4.5	5	Well balanced with unique taste, good flavour	Unique taste always scored in top 3 in group tasting events. Visually appealing and easy to eat. By far the smallest of the cherries in test.
Mountain Magic (Indet. Cherry)	5 - 7	Large round cherry	4	Firm	Firm, juicy	Shallow	4.5	4	Not much flavour	Larger than a usual cherry, looks great, and tastes good. Well appreciated medium size fruit during tasting events.
Juliet (Indet. Cherry)	3.5 x 6	Medium elongated cherry	3	Very firm	Firm, dry and pasty	Deep	3.5	2.5	Bland, poor flavour	Similar taste to Red Pearl, but is bigger in size.
Golden Sweet (Indet. Cherry)	2.5 x 4.5	Medium elongated cherry	3	Firm	Juicy, pasty	Shallow	4	2.5	Sweet, low acidity, floral	Does not have a very distinguished flavour but its shape, size and yellow colour are appealing. Top tasting cultivar for one collaborator.
Cherry Bomb (Indet. Cherry)	2.5	Small round cherry	5	Soft-Firm	Juicy	Shallow	4	5	Sweet, very good flavour, good balance	Very good taste, average size cherry and great appearance. Always scored in top 3 in group taste tests.
Pruden's Purple (Indet. Beefsteak)	10 - 14	Large flat ribbed, lumpy beefsteak	2	Very soft	Juicy, pasty	Deep	2-4	2	Well balanced, very good flavour, refreshing	Appealing to heirloom connoisseurs but needs to be harvested at an early ripening stage to avoid excessive cracking. Pruden's Purple yielded better than Brandy Wine at the main demonstration site.
Brandy Wine (Indet. Beefsteak)	11 - 15	Large flat ribbed, lumpy beefsteak	2	Very soft	Very juicy, pasty	Deep	2-4	3	Well balanced, mild flavour, bit sweet	Appealing to heirloom connoisseurs but needs to be harvested at an early ripening stage to avoid excessive cracking. Brandy Wine always scored higher than Pruden's Purple in the tasting events. Brandy Wine fruit is a bit larger than Pruden's Purple.
Sakura (Indet. Cherry) Not LB Resistant	3.5	Small to medium round cherry	5	Soft-Firm	Juicy	Shallow	4	5	Well balanced acidic/sweet, great flavour	Very good taste, great appearance, on the bigger side for a cherry. Although not LB resistant, Sakura always scored in top 3 in group tasting events.

*General Taste is based on three group tasting events and collaborators comments.

Det: Determinate type cultivars are smaller and bushier plants, and the plants stop to grow when the fruit sets on the end of their stems. Determinate types are often earlier and produce ripened fruit all at once.

Indet: Indeterminate type cultivars produce fruit over a longer period and are generally grown in heated greenhouses.

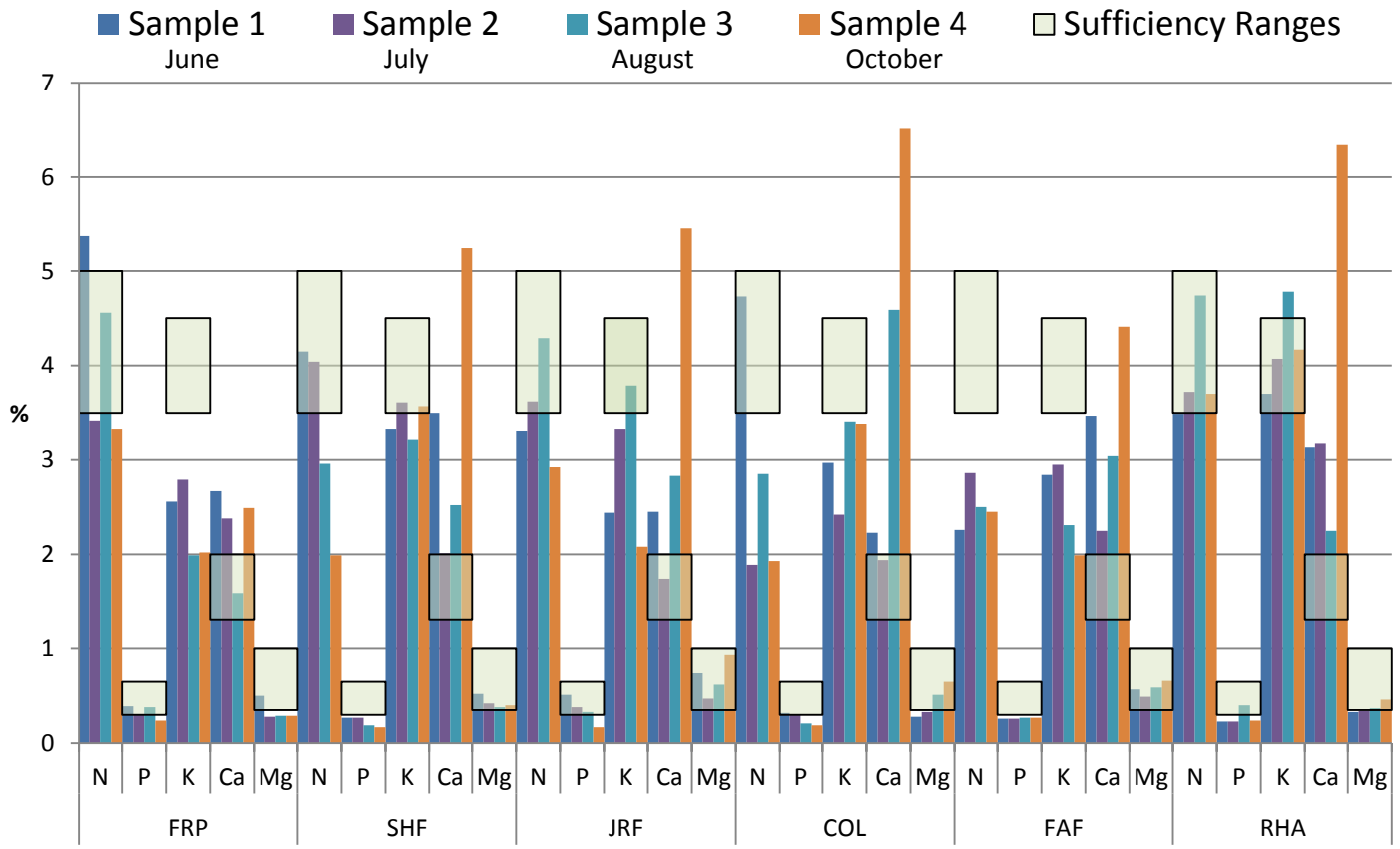
Table 3. Marketable yields obtained from the late blight resistant tomato cultivars at Strawberry Hill Farm in 2016

	Marketable Yield[2]
Cultivars	**kg/plant**
Defiant	5.8
Pruden's Purple	4.7
Brandy Wine	4.3
Plum Regal	4.1
Sakura[1]	4.0
Mountain Merit	3.8
Julliet	3.3
Mountain Magic	2.5
Cherry Bomb	2.4
Golden Sweet	2.1
Red Pearl	2.0
Jasper	1.6

1 Sakura is a large size cherry tomato cultivar used as control (not reported to be resistant to late blight).

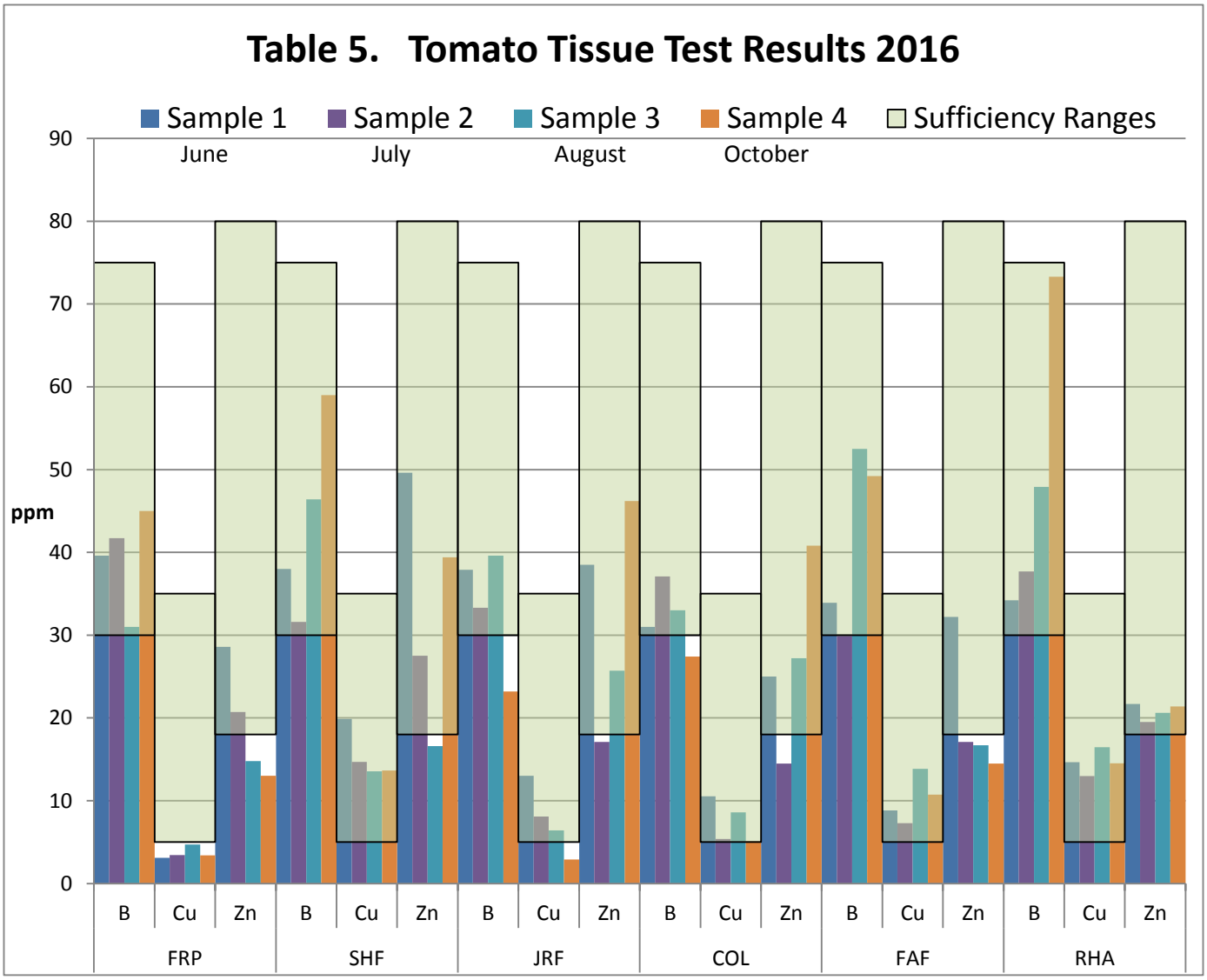
2 Marketable fruit yield from Strawberry Hill Farm's 2016 tomato harvest. Plants were grown in one single row with 15 plants per cultivar (plots were not replicated). Fruit from all plants were harvested weekly until Sept 29. The crop was grown in black plastic, with no drip irrigation. Granulated chicken manure was applied to the rows and lightly incorporated into the soil prior to the placement of plastic mulch. The crop was pruned twice in early season to remove first suckers and all indeterminate cultivars were de-headed before the end of the season. The crop was supported with 8 ft rebar (6 ft above ground) and baler twine (twine and weave system). No fungicides were used at any time during the season. No late blight was reported on this site.

Table 4. Tomato Tissue Test Results 2016

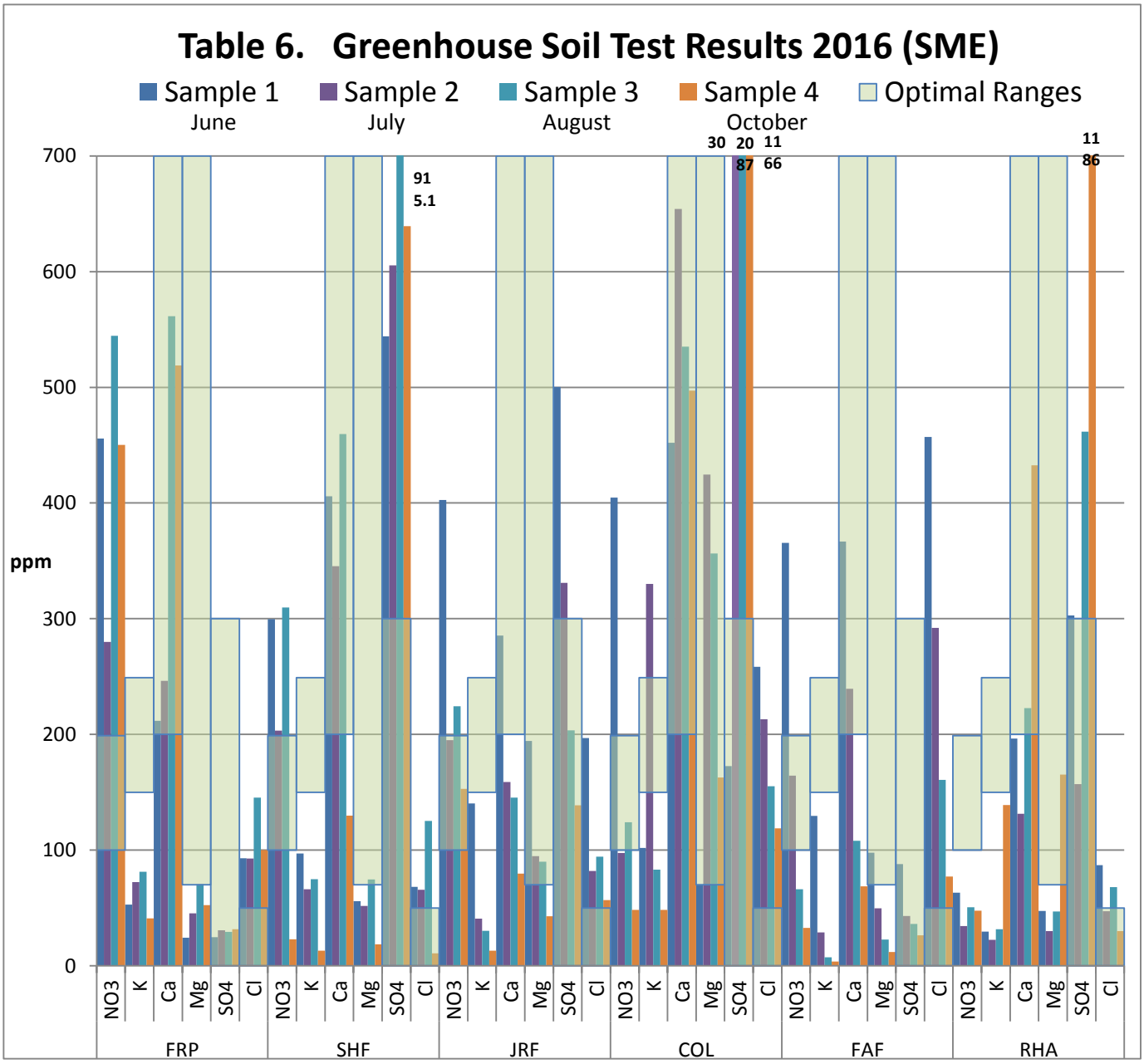


Nutrients applied and available to crop for each farm (N-P-K kg/ha):
FRP: 134-28-45
SHF: 263-(90-225)-187
JRF: 150-(15-785)-(75-845)
COL: 86-74-91
FAF: (106-128)-(80-138)-(162-292)
RHA: 102-116-180

Table 5. Tomato Tissue Test Results 2016

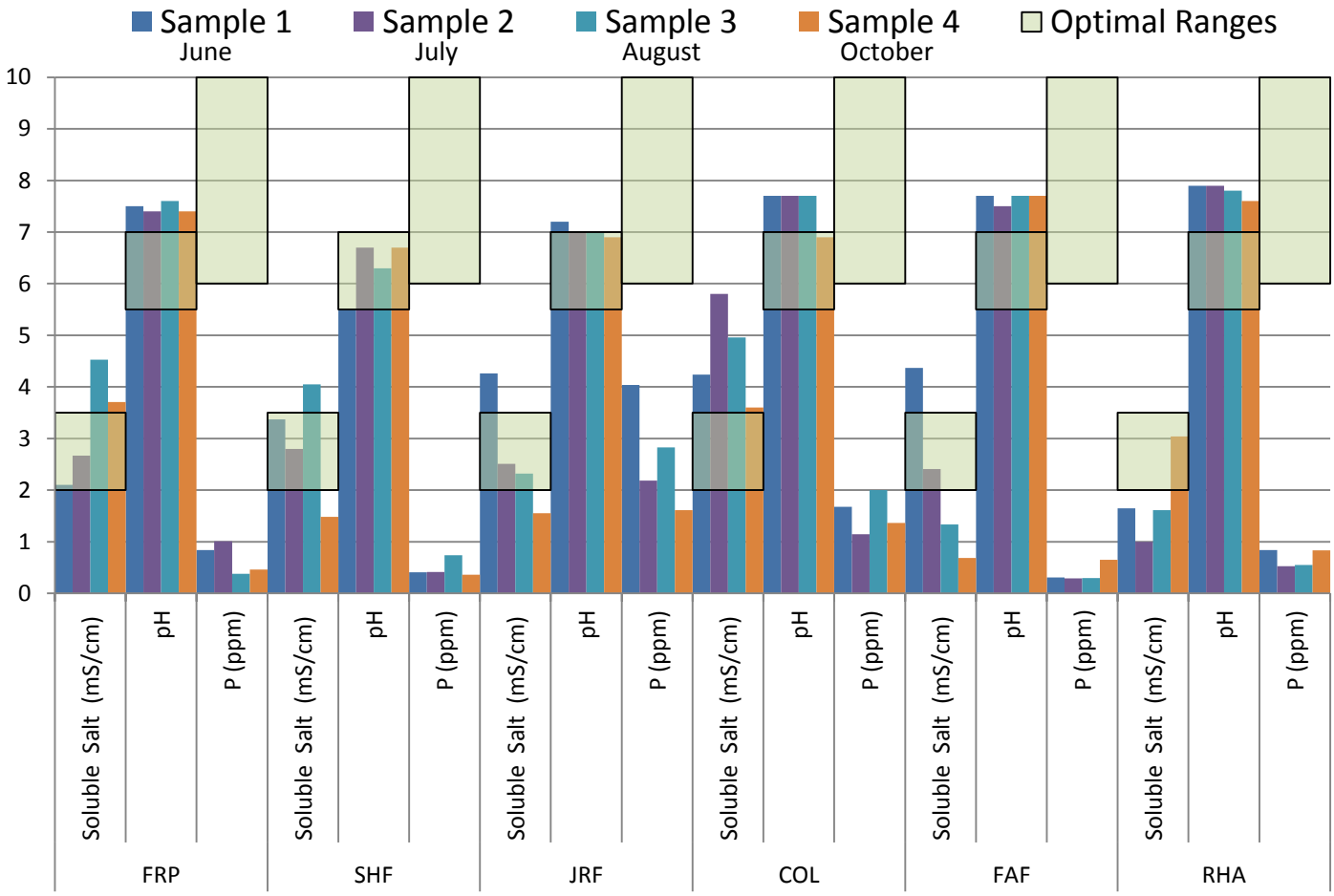


Nutrients applied and available to crop for each farm (N-P-K kg/ha):
FRP: 134-28-45
SHF: 263-(90-225)-187
JRF: 150-(15-785)-(75-845)
COL: 86-74-91
FAF: (106-128)-(80-138)-(162-292)
RHA: 102-116-180



Nutrients applied and available to crop for each farm (N-P-K kg/ha):
FRP: 134-28-45
SHF: 263-(90-225)-187
JRF: 150-(15-785)-(75-845)
COL: 86-74-91
FAF: (106-128)-(80-138)-(162-292)
RHA: 102-116-180

Table 7. Greenhouse Soil Test Results 2016 (SME)



Nutrients applied and available to crop for each farm (N-P-K kg/ha):
FRP: 134-28-45
SHF: 263-(90-225)-187
JRF: 150-(15-785)-(75-845)
COL: 86-74-91
FAF: (106-128)-(80-138)-(162-292)
RHA: 102-116-180

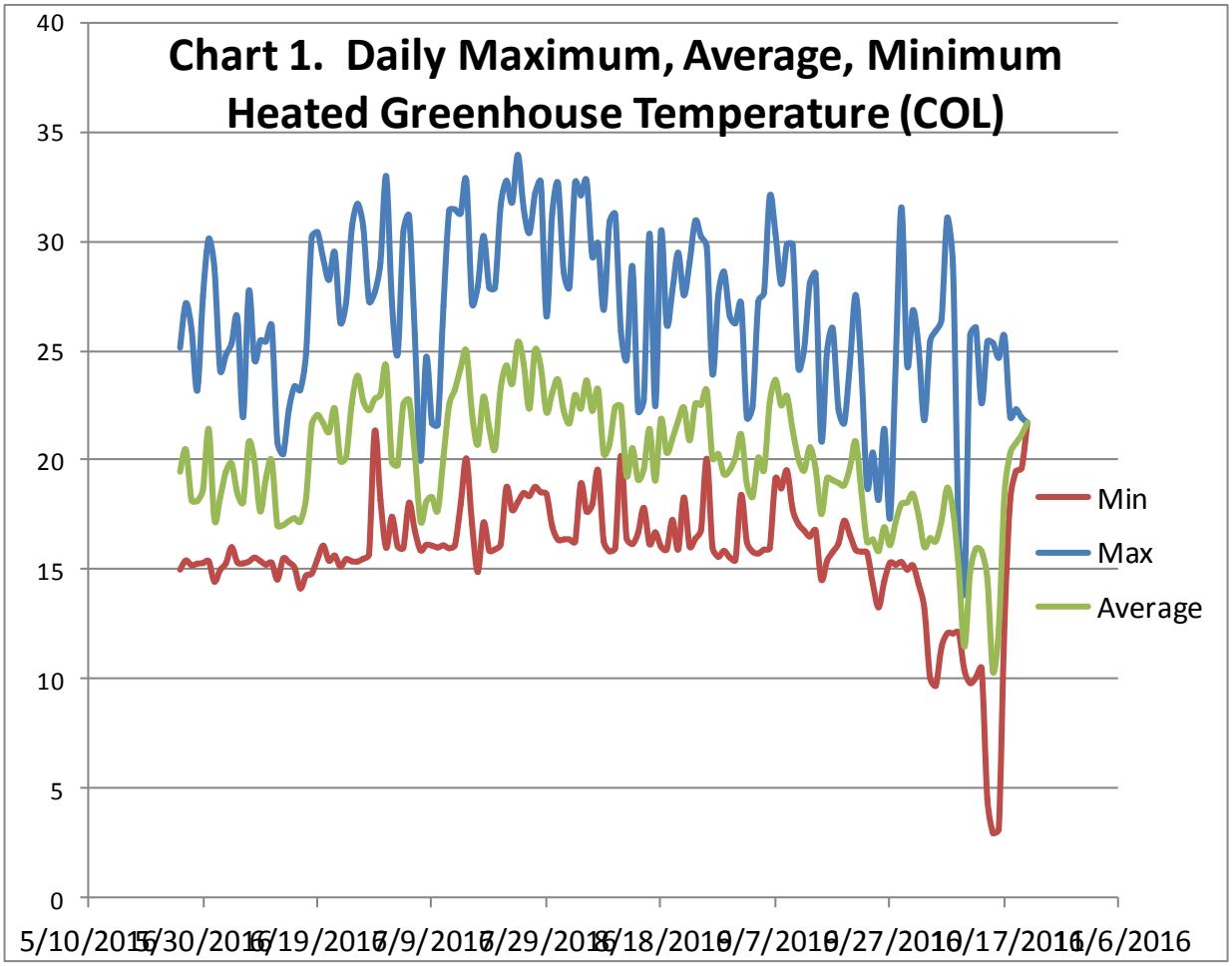


Chart 1. Daily Maximum, Average, Minimum Heated Greenhouse Temperature (COL)
40
35
30
25
20
15
10
5
0
5/10/2016
5/30/2016
6/19/2016
7/9/2016
7/29/2016
8/18/2016
9/7/2016
9/27/2016
10/17/2016
11/6/2016
Min
Max
Average

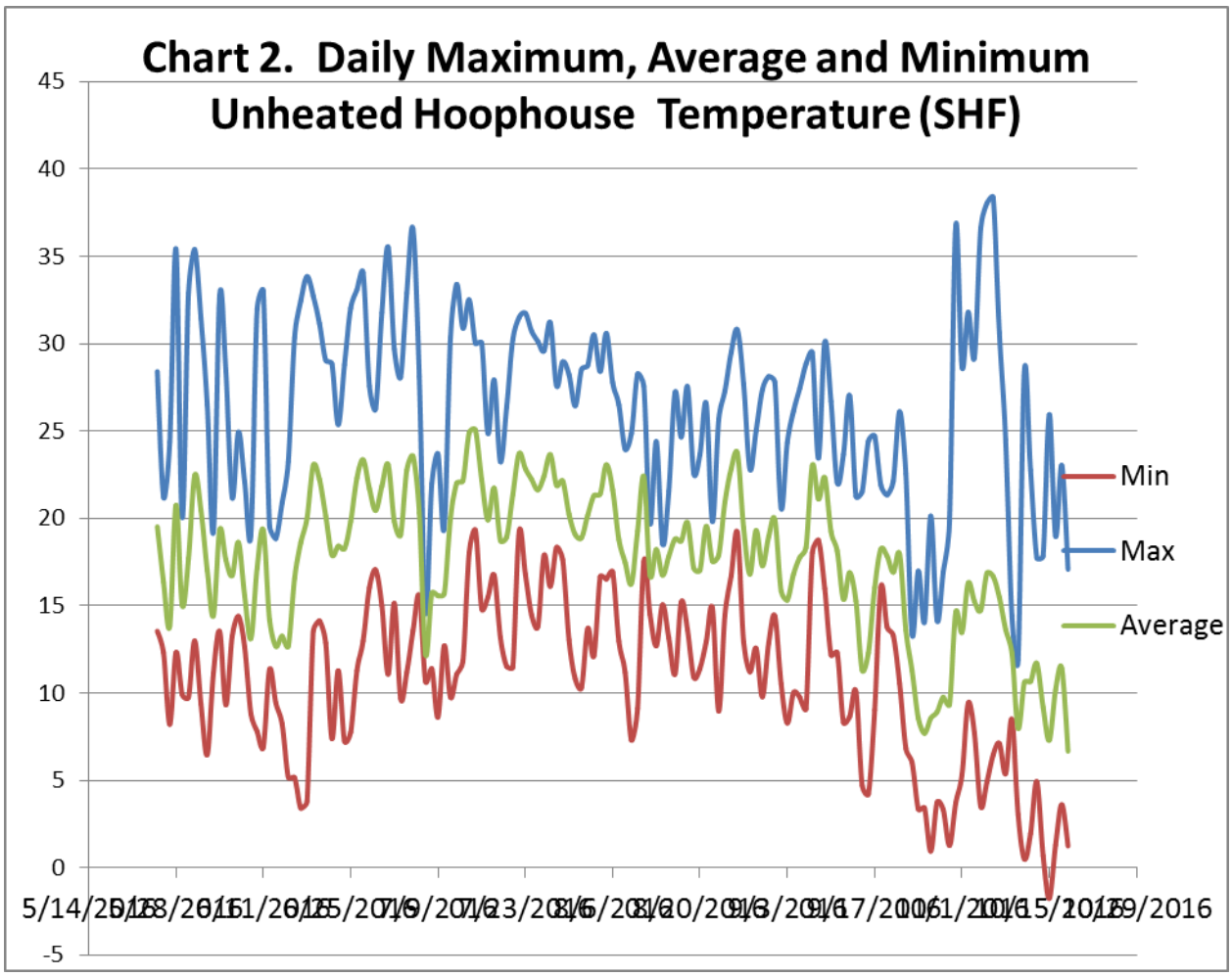


Chart 2. Daily Maximum, Average and Minimum
Unheated Hoophouse Temperature (SHF)
45
40
35
30
25
20
15
10
5
0
-5
Min
Max
Average
5/14/2016
5/28/2016
6/11/2016
6/25/2016
7/9/2016
7/23/2016
8/6/2016
8/20/2016
9/3/2016
9/17/2016
10/1/2016
10/15/2016
10/29/2016

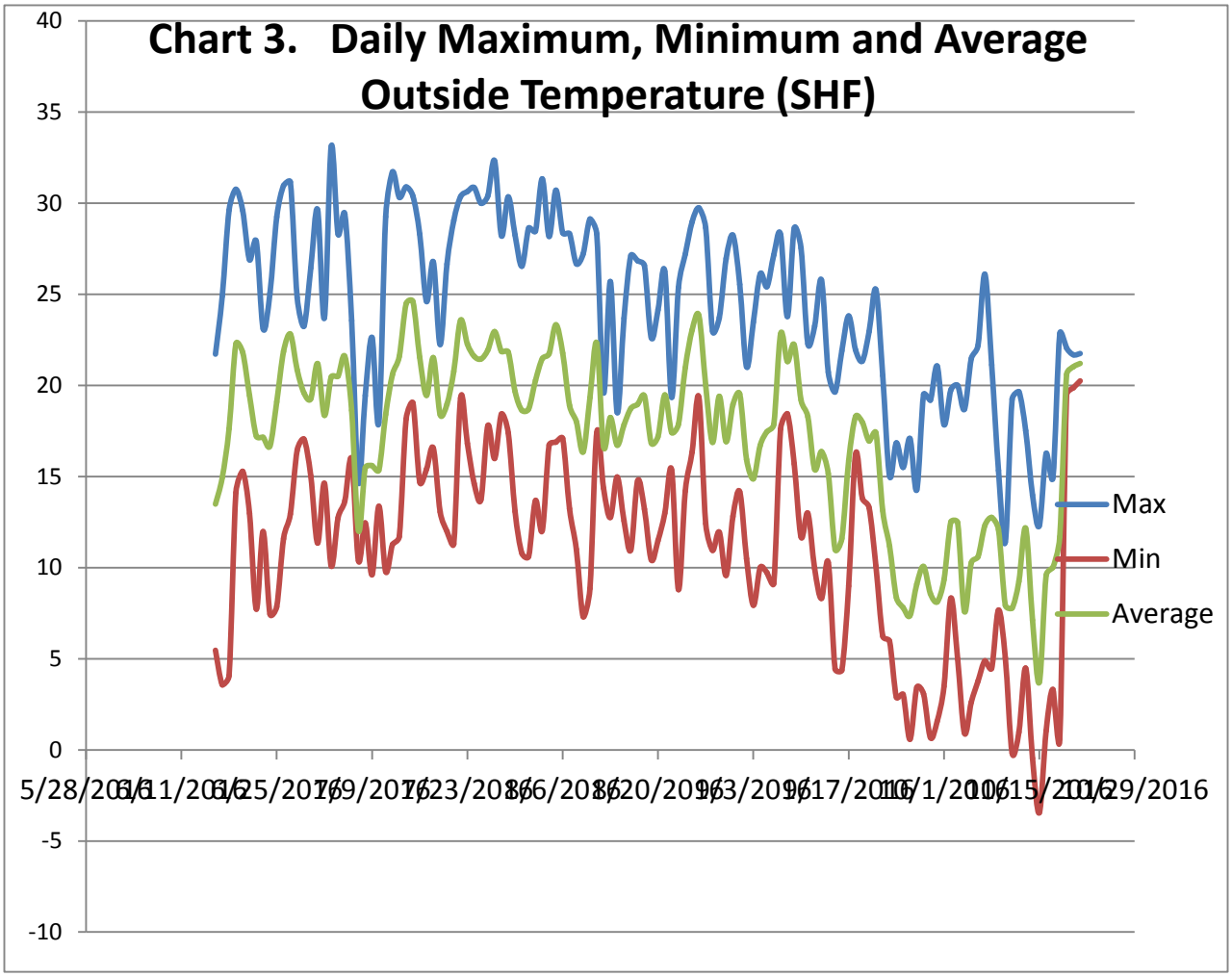


Chart 3. Daily Maximum, Minimum and Average Outside Temperature (SHF)
40
35
30
25
20
15
10
5
0
-5
-10
5/28/2016
6/11/2016
6/25/2016
7/9/2016
7/23/2016
8/6/2016
8/20/2016
9/3/2016
9/17/2016
10/1/2016
10/15/2016
10/29/2016
Max
Min
Average

Annex B

Notes taken during NB Greenhouse Consultations
July 26-29, 2016

These notes are not intended to be recommendations to growers; they are simply a summary of the information that was discussed during the greenhouse visits. Care must be taken before growers apply any of the information contained in this document. Furthermore, it is the grower's responsibility to follow all pest control product labels. Also, organic growers must make sure the products they intend to use meet the Canadian Organic Standards and that their use is allowed by their organic certification agency.

- Better pollination:
  Avoid excessively cold and hot conditions. Ideal temperature: 16 to 25°C.
  Non-pollinated cluster will have few fruit and irregular size fruit.
  Bumble bees may be useful. Growers may want to vibrate or shake the top wires and string between noon and 2:00pm. Good pollination ensures good fruit size and uniformity.

- Basic tomato, pepper and cucumber plant pruning information:
  Keep 3 to 4 tomatoes per clusters (beef type only), and prune the others early as heavy clusters are hard on the crop. The crop will have a difficult time to balance itself (lack of vigor at the top of the plant). Bottom leaf pruning can be done up to 2nd unpicked fruit cluster. The unhealthy and diseased bottom leaves should be removed and disposed of appropriately. Some of those leaves can become a burden to the plant as the energy and nutrients may be diverted towards the leaves instead of towards the growing point and fruit development.
  When grown on strings large English cucumber plants need to be pruned. Bottom suckers should be removed and every second fruit or blossom should be removed. Always leave a few suckers at the top of the plants, in case the tarnished plant bugs damage and destroy the growing point. Later, one of the young suckers can be kept and used as a new growing point. If all suckers are removed and the growing point is destroyed, the plant will never recover.
  For medium size cucumber varieties, leave one fruit at every node.
  For Lebanese cucumber (small fruit) varieties, leave up to two fruit at every node.

- Some of the pepper varieties are more productive than others. Basic pepper pruning would include the removal of all flowers or fruits below the 1st branching. Weaker varieties that have a large fruit at the branching point often are unable to support more fruit production or development. These plants will provide one large king fruit but few other fruits. Quebec growers are producing more lunch type peppers instead of large globe peppers. Many growers in Quebec use rebars and strings to weave and support the plants to avoid lodging.

- Tomato plant density and row spacing:
  Row spacing of 1.6 m is often used (between row centers).
  Simple rows are easier to manage than staggered rows if growers plan to add organic fertilizers. Tomatoes are strung in a V-shape with two top metal wires. The distance between the top wires of approx. 60 + cm and the distance between the top wires in the alley is approx. 1 meter at 3 m of height.
  2-3 plants/m2 for beef steak type tomato plants
  2.5-3.5 plants/m2 for cluster types
  Up to 3-5 plants/m2 for cherry types
  Ideal densities will depend on grower experience and greenhouse technology.

- Microscopic sulfur: Sulfur and Milstop are good control options to control powdery mildew. No additives should be used with MilStop. Typically, sulfur is applied with water (750g/1000 liters). Some Quebec growers use higher rates of sulfur. Some Quebec growers will apply the sulfur dry with dusters (gas powered or with Chapin type dusters). This dry application is an off label use. Tomatoes can take a lot of sulfur but other crops are sensitive. Cucumbers are sensitive so no dry sulfur should be used on cucumbers. Bartlett Microscopic sulfur is OK for organic. Make sure you know how to apply the powder as the static charge of the material and applicator can cause explosions. Make sure the applicator's ground line or chain is used on the dusters. Cherry type tomatoes are more sensitive to the powdery mildew (PM). Favorita is very sensitive. Sulfur also controls spider mites and other diseases. Microscopic sulfur in water can also be mixed with Epsom salt. The Epsom salt will make sure no dry deposits accumulate at the tip and bottom of leaves and fruits. 20-30 g of Epsom salt per liter of water can be used.

- Spider mites and predators for cucumber production. If predators or parasitoids are used to suppress the spider mite population, misting will be required. The misting will increase humidity and will help lower mite pressure and encourage biologicals. The misting is not to wet the plants but rather to increase the humidity in the air. Sulfur can suppress mite populations. Some organic growers in Quebec use "Greenspray" oil to suppress the aphid population. The oil is typically used before the predator and parasitoids are released.

- New cultivars:
  1) Toronjina: highly resistant and vibrant orange cherry type tomato.
  http://www.enzazaden.com/binaries/tomato%20brochure%202012_english_lr_tcm13-18709.pdf
  2) Sweet Treats: pink cherry type (a little larger than cocktail, good against leaf mould),
  http://www.sakatavegetables.com/_ccLib/attachments/pages/SweetTreatsBrochure.pdf
  3) Makari (pink cultivar, a good substitute for Tomimaru Mucho),
  4) Chesapeake pepper plants have smaller fruit (very nice fruit).
  Very early, smooth, blocky fruit that changes color from dark green to red rapidly. This variety can support a king fruit and many other fruits. Same can be said about Carmen.
  5) Emerite is a very interesting pole bean. Stays tender. 53 days. Medium green completely stringless long filet bean. Pod averages 20 cm, very straight and smooth with excellent bean flavor.
  6) Romano is another pole bean but it is not as nice looking for the market.

- Basic irrigation information:
  At least three irrigation lines should be used. White over black plastic is useful to reduce evaporation and encourage surface mineralization. Growers should always avoid heavy watering events. It is much better to use multiple short cycles per day. Never water before 10:00am and after 2:00pm. During harvest, when conditions are sunny and hot, up to 4 liters/m2 of water may be needed for tomato production.

- Anti-condensation (AC) plastic: Always use AC greenhouse plastic for single and double layer plastic for greenhouses and tunnels.

- Natural ventilation and insect exclusion screens: Unless you plan to grow cucumbers, exclusion nets or screens are generally not needed. If growers want exclusion screens, they should not select fine screens as they will restrict air movement and cause excessive heating. The screen should only exclude larger insect such as cucumber beetles and tarnished plant bugs. For proper natural venting with roll-up sides, the roll-up opening must be at least 25% of the greenhouse width (ie. a 32 foot wide greenhouse should have at least 8 ft of unobstructed roll-up side opening). Insect exclusion netting often restricts the natural air movement and can cause excessive heating.

- Greenhouse controller systems: igrow by Link4. Temperature sensors in greenhouses should be at the height of the top clusters.

- The scion part of the grafted plants should not be allowed to set root as the disease resistance of root stock will be lost.

- It is possible and easier to pinch above the 2nd true leaf to obtain two uniform heads (plant stressing). Pinching should ensure a 1st cluster after 6-7 leaves instead of 8 to 11 leaves without pinching. This allows earlier harvest.

- Productivity and profitability: In general, growers need to do a better job keeping track of yield. Yield information is critical to determine profitability and for the development of adequate crop fertilization plan. To obtain high yields, growers need to fertilize the tomato crop at higher rates.

- In Quebec, the organic greenhouse tomato seedlings are grown in 6 in. pots (seedlings are approximately 7 weeks old at planting, when they have up to 1 flower cluster). If seedlings are more mature, watering will be extremely important. The conventional tomato seedlings are grown in 4 in. pots.