NCCC-212 Report for 2020-21 for the Cornell University Agricultural Experiment Station, Ithaca, NY and the New York State Agricultural Experiment Station, Geneva, NY.

Submitted by Marvin Pritts (CUAES) and Courtney Weber (NYSAES)

Strawberry

Development of Berry Varieties for Protected Agriculture Production in Cold Climates 2019-22. C. Weber, Cornell University-NYSAES, Geneva, NY
Objective 1
Dissemination of results: Reports to NYS Dept. of Agriculture and Markets. Patent publication.
Plans for next reporting period: Continued evaluation of selections for production characteristics.

Development of strawberry varieties adapted to the full potential NY production season from early June to December by integrating the breeding of strawberry with production in protected agriculture systems. Hybridized strawberry genotypes with the potential to produce new varieties adapted to protected agriculture systems. Approximately 30 populations of strawberry and raspberry were evaluated. Potential parent genotypes were grown in the greenhouse to produce flowers for hybridization. Pollen was collected and flowers emasculated to make hybridizations. Fruit from hybridizations was grown and seed collected from mature fruit. Seeds were scarified and stratified in the fall of 2019 and sown in the winter of 2019-20 to grow plants for field for evaluation. Plants were transplanted to the field under low tunnels in late May 2020. Plants were evaluated for field performance and fruit quality aspects in fall 2020 (day-neutral) and spring 2021 (short-day). Hybrid seedlings were evaluated for fruit size and eating quality, fruit color, yield potential, disease tolerance and adaptation to NY climate conditions. Superiorly performing genotypes (11 day-neutral; 64 short-day) were selected for propagation for further evaluation.

Weber, Courtney A. 2020. Strawberry plant named 'Dickens'. United States Plant Patent #32,535P2. **Filed August 1, 2019.**
https://patents.google.com/patent/USPP32535P2/en?oq=uspp32535p2

Alternative planting systems for cold climate strawberry plasticulture.
C. Weber, Cornell University-NYSAES, Geneva, NY
Objective 2

Dissemination of results: Publication in open access refereed journal.
Plans for next reporting period: Project completed.

Weber, C.A. 2021. Strawberry Crown Plugs Provide Flexibility and Improved Performance in Cold Climate Plasticulture Production. Agronomy 11:1635. https://doi.org/10.3390/agronomy11081635. Published online August 17, 2021. Open access.

Weber, C.A. 2021. Performance of Strawberry Varieties Developed for Perennial Matted-Row Production in Annual Plasticulture in a Cold Climate Region. Agronomy 11 (7):1407 https://doi.org/10.3390/agronomy11071407. Published online July 14, 2021. Open access.

Extend the growing season and improve quality of berry crops in New York
M. Pritts, Cornell University-CUAES, Ithaca, NY
Objective 2
Dissemination of results: Presentation at ASHS conference. Publication in refereed journal.
Plans for next reporting period: Continued evaluation of row coverings.

Row coverings. Day neutral strawberries are occupying a growing niche in colder regions where short-day cultivars traditionally predominate. These cultivars, coupled with low tunnels covered with plastic films, allow the season to be extended from a few weeks to several months. Considerable research has been targeted at identifying the optimal plastic tunnel film by comparing those with varying degrees of UV and IR blocking additives, and/or light diffusing properties. Differences among these films has been marginal.

We compared standard polyethylene films to alternative coverings. One set of coverings was woven fabrics with reflective strips at various densities (greenhouse-grade shade cloth), providing a range of shading (70, 60 and 50% light transmission) under them. Another film (Cascade Light Technologies) was impregnated with luminescent formulations of optically-active substances that shift the light spectrum into photosynthetically-active wavelengths. These six coverings and a control were evaluated in black plastic-covered raised beds using two types of plants: 'Albion' bare-root plants established in early May and 'Albion' bare-root plants established in 10 cm pots in late February in a heated greenhouse then transplanted into the raised beds in early May (early starts).

The early start plants produced significantly more yield (77%) over the growing season than bare-root plants set directly into the field. Furthermore, the early starts were more responsive to the coverings. Plants covered with reflective shade fabric experienced cooler temperatures and were more productive than plants under standard plastic film. Also, early start plants under the Cascade film were more productive, despite relatively warm temperatures in that treatment. Bare-root transplants did not respond strongly to the various coverings. The lack of response may be due to the need for the plants to become

sufficiently large before responding to the films. If true, this may account for the small differences among standard films in field-planted day neutrals. Early starts are much more productive than bare-root 'Albion' plants planted in early May, especially when grown under what appear to be more favorable temperature conditions.

https://ashs.confex.com/ashs/2021/meetingapp.cgi/Paper/35708

Crop protection. Although growing strawberries under low tunnels is increasing in popularity across the northeastern United States, little is known of how they impact the presence of natural enemies and pollinators that provide key ecosystem services on strawberry. We employed passive (fruit collections, sticky cards and pitfall traps) and direct (direct observations, leaf brushing and fruit bagging) monitoring over 2–3 growing seasons to compare the abundance and impact of beneficial insects and mites on strawberry grown under low tunnels versus the open field. Three different low tunnel plastics ranging in UV-selectivity were included to determine any effect of UV exclusion on natural enemy and pollinator presence. Plant yield and fruit marketability was higher under low tunnels compared to the open field for two of three years observed. The abundance of predators, and to a lesser extent parasitoids, was similar or higher under low tunnels compared to the open field. However, catch on sticky cards revealed lower densities of parasitoids under tunnels. There was some evidence that UV-selecting plastics resulted in poorly pollinated fruit compared to UV-transmitting and open-field treatments. However, there was no difference in pollinator presence among treatments, so the mechanisms causing the plastic effect are unclear. Overall, we conclude that growing strawberries under low tunnels, regardless of UV selectively, can support higher and more marketable yield in some years while likely having neutral to positive impacts on beneficial predators, parasitoids and pollinators.

Willman, S., M. Pritts and G. Loeb. 2021. The effect of plastic low tunnels on natural enemies and pollinators in New York strawberry. Crop Protection: **https://doi.org/10.1016/j.cropro.2021.105820**

The Influence of Cultural Management Practices on Strawberry Yield, Flavor and Quality 2018-21. M. Pritts, Cornell University-CUAES, Ithaca, NY

Objective 3

Dissemination of results: Publication in refereed journal.

Plans for next reporting period:

In a parallel study, Day neutral strawberries (*Fragaria* x *ananassa* Duch.) produce fruit over several months, even in climates with cold winters. Air temperatures during these long fruiting periods can range from near freezing to close to 40 ˚C. We divided fruit development into four developmental stages and divided the typical air temperature range during the growing season into four non-overlapping intervals from 7 to 32 ˚C. We sampled fruit from a day neutral strawberry planting approximately once a week from July to Nov., calculated the number of hours that individual fruits were exposed to a particular temperature interval during each of the four developmental stages, then correlated this number with the soluble solids content (SSC) of the harvested fruit.

We found that warm air temperature exposure (16 - 23 ˚C) early in fruit development was positively correlated with final SSC at harvest, but SSC increased further when fruits were exposed to cooler air temperatures (7 - 15 ˚C) for the 15 days prior to harvest. Exposure to air temperatures above 24 ˚C at any developmental stage resulted in fruit with lower SSC. Our data provide field validation that strawberry sweetness is highest under moderately cool temperatures, and sugar content is reduced when developing fruits are exposed to hot (>24 ˚C) temperatures as fruit approach ripening. It may be possible for growers to minimize the amount of time air temperatures exceed 24 ˚C by using evaporative cooling, reflective low tunnel coverings or shade cloth to enhance the sugar content of fruit.

Osatuke, A. and M. Pritts. 2021. Sugar content in strawberry is influenced by temperature during fruit development. J. Amer. Pomol. Soc., in press.

Soil management practices to enhance flavor and quality in strawberry.
M. Pritts, Cornell University-CUAES, Ithaca, NY
Objective 2, Objective 3
Dissemination of results: Publication in refereed journals.
Plans for next reporting period: Project completed.

The majority of cultivated strawberries (*Fragaria × ananassa)* in the northern United States (US) and Canadian provinces is grown in perennial matted rows across a range of soil types and microclimates. Management practices vary in fertilization rates, intensity of pesticide use, and the source of inputs depending on grower preferences. The objective of this study was to identify environmental and management factors that influence strawberry flavor attributes across a range of production systems. The cultivar Jewel was selected for its popularity in this region and reputation for excellent flavor. 'Jewel' was sampled from regional farms and, concurrently, grown in a controlled field study with different inputs over three years.

Soluble solids content (SSC) and titratable acidity (TA) across farms was found to be positively associated with the air temperature differential during fruit ripening. In controlled field studies, yield was correlated positively with total N in the form of synthetic urea, but not with the rate of applied organic N. Despite different levels of soil carbon inputs, N rates, pesticides, and microbial supplements, the fruit quality attributes, including SSC, TA, aromatic volatile concentration and phenolics were not associated with treatment. A human sensory evaluation found no perceptible differences in flavor or aroma among contrasting treatments. Our study concludes that growers should invest in temperature management, rather than agricultural inputs, to influence SSC and TA of strawberry.

Osatuke, A. and M. Pritts. 2021. Development of quality attributes in strawberry fruit: A review. J. Amer. Pomol. Soc. 75:50-62.

Osatuke, A. and M. Pritts. 2021. Strawberry flavor is influenced by the air temperature differential during fruit development but not management practices. Agronomy 11: 606. https://doi.org/ 10.3390/agronomy11030606

Development of Best Management Practices for Berry Crops During COVID-19.
M. Pritts, Cornell University-CUAES, Ithaca, NY; et al.
Objective 4
Dissemination of results: Publication on small farms website.
Plans for next reporting period: Project completed.

Rangarajan, A., E. Bihn, M. Pritts, J. Suarez, K. Deamer, L. McDermott, B. Neal and E. Lamb. 2020. Best management practices for agritourism during the COVID-19 pandemic. https://smallfarms.cornell.edu/resources/farm-resilience/best-management-practices-for-agritourism-covid/

Rangarajan, A., E. Bihn, M. Pritts, J. Suarez, L. McDermott and E. Kibbe. 2020. Best Management Practices for U-Pick Farms During the COVID-19 Pandemic. https://smallfarms.cornell.edu/resources/farm-resilience/best-management-practices-for-u-pick-farms-during-the-covid-19-pandemic/

Revision of the Strawberry Production Guide for the Northeast and eastern Canada
University of New Hampshire with editorial assistance from Cornell (M. Pritts), Univ. of Maine (D. Handley), and Univ. of Vermont.
Objective 4

Revision of the APS Strawberry Compendium
M. Pritts, Cornell University-CUAES, Ithaca, NY; C. Weber, Cornell University-NYSAES, Geneva, NY; et al.
Objective 4

Blackberry and Raspberry

Development of Berry Varieties for Protected Agriculture Production in Cold Climates 2019-22. C. Weber, Cornell University-NYSAES, Geneva, NY
Objective 1
Dissemination of results: Establishment of grower trials. Presentations at grower workshops. Patent publication.
Plans for next reporting period: Further evaluation of selections for production characteristics.

Development of blackberry and raspberry varieties adapted full potential NY production season from June to December by integrating the breeding of raspberry and blackberry with production in protected agriculture systems. Approximately 30 populations of blackberry and raspberry are targeted. Potential parent genotypes were grown in the high

tunnels to produce flowers for hybridization. Pollen was collected and flowers were emasculated to make hybridizations. Fruit from hybridizations was grown and seed collected from mature fruit. Seeds were treated in the fall of 2020 and sown in the winter of 2020-21 to grow plants for field for evaluation. Plants were transplanted to the field in late May. Raspberries and blackberries were grown in pots in a high tunnel and in open field conditions for evaluation. Hybrid seedlings were evaluated for fruit size and eating quality, fruit color, yield potential, disease tolerance and adaptation to NY climate conditions. Floricane populations were evaluated in open field conditions due to the need to overwinter plants for flower and fruit development. Selections will be established in plots in the soil under high tunnels for further evaluations. Superiorly performing genotypes will be selected for propagation for further evaluation and trials with grower cooperators. For 2021, 28 selections were made from black raspberry germplasm, 4 floricane red raspberry and 33 primocane red raspberry.

Weber, Courtney A. 2021. Raspberry plant named 'Crimson Treasure'. United States Plant Patent #32,799P2. **Filed August 29, 2019.** https://patents.google.com/patent/USPP32799P2/en?oq=uspp32799p2

Weber, C.A. 2020. Introgression of spine-free and primocane fruiting from red raspberry (*Rubus idaeus* L.) to black raspberry (*R. occidentalis* L.). Acta Hort. 1277:17-24.

Willman, M., J.M. Bushakra, N. Bassil, C.E. Finn, M. Dossett, P. Perkins-Veazie, C.M. Bradish, G.E. Fernandez, **C. Weber**, J. Scheerens, L. Dunlap and J. Fresnedo-Ramirez. 2020. Genetic analysis of drupelet count in black raspberry (*Rubus occidentalis*). Acta Hort. 1277:65-72.

Overwintering techniques for high quality, tender raspberries.
M. Pritts, Cornell University-CUAES, Ithaca, NY
Objective 2
Dissemination of results: Publication in refereed journal.
Plans for next reporting period: Analysis of yield data and development of reports.

Fall-fruiting raspberry varieties developed in warmer climates often show significant winter damage when grown in substrate. Different treatments were tested to determine if and how best to overwinter potted plants. Multiple replicates of two raspberry cultivars were overwintered pot-in-pot inside a high tunnel; potted plants were laid over and covered by felt row cover inside a high tunnel; pots were left on top of the ground inside a high tunnel; and pots were overwintered outside. Treatments were repeated in 2020-2021. Plants were grown in the spring and primocane growth and yield was used as a measure of overwintering success. Canes grown and harvested during 2020 were overwintered in 2020-2021 using the same treatments as before, except floricanes will remain intact. Yields were measured in 2021 on both floricanes and primocanes.

Hanson, E., K. Demchak and M. Pritts. 2020. Tunnelberries: Enhancing the sustainability of berry production. Scientia 129:24-27. https://www.scientia.global/tunnelberries-enhancing-the-sustainability-of-berry-production/