PENNSYLVANIA VEGETABLE
MARKETING & RESEARCH PROGRAM

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Research Grant Pre-Proposals for 2022

Board and Committee members are asked to rate the following pre-proposals using the following system:

A – very interested in funding and in receiving a full proposal for final consideration
B – potentially interested in funding – would appreciate a full proposal for final consideration
C – very little or no interest in funding

___ 1 **Hydroponic Research Proposal**
Jonathan Rubin MPA

My farm would like to research the subcategories of *Organic/sustainable variety selection* and *Organic/sustainable nutrient management.* Specifically, we would like to research hydroponic, year- round indoor farming for specialty crops. To do this, we are requesting $15,000. We have a farm in Florida researching and working in this area. We are opening a farm in Pennsylvania and this grant would assist us in furthering our work in a new growing environment, with different challenges and a unique market. We consult frequently with the Pennsylvania Department of Agriculture and SBDC Pennsylvania. I have a Master's in Environmental Science and Policy from Columbia University, in New York City. The $15K would be used to experiment new crops, design new equipment, and test different sustainable growing methods.
$15,000

___ 2 **Multifunctional Sprayable Biodegradable Film Formulations for Organic Farming**
Sibel Irmak, Meetpal Kukal and Suat Irmak, Department of Agricultural and Biological Engineering, Pennsylvania State University

Organic vegetable production systems in PA and beyond can significantly benefit from innovative addressal of issues in soil management, weed suppression, and soil health. The immediate access of PA farms to local renewable materials presents a potential sustainable solution for these agricultural challenges. Biodegradable and sprayable mulch films made from sustainable and renewable natural sources can enhance agricultural profitability via multiple pathways, especially in organic production systems. These mulch films can be tailored for specific and multifunctional benefits, such as enhancing soil health and aiding in weed suppression, by blending specific ingredients into the film formulations. For instance, protein-based mulch films can release nitrogen into the soil during the degradation process, improving nutrient availability and uptake, and potentially reducing inorganic fertilizer requirement. We propose to develop novel protein-based, degradable mulch films incorporated with biochar to provide beneficial inputs to the soil while suppressing weed growth on sweet corn production. The film formulations will be prepared using low cost, locally-abundant and non-toxic raw materials such as chicken feather protein (keratin) and biomass-derived compounds. While these innovative biofilm formulations can be applied to all vegetable and agronomic crop production systems, well-performing film formulations in this specific project will be applied in open sweet corn field plots to evaluate protection against common weed infestations and enhancing soil health, relative to conventional management. Innovative film formulations will be evaluated against OMRI-approved commercial weed control products. Comprehensive cost-benefit analyses that will be carried out will allow growers to evaluate scope and economic and environmental benefits of incorporating this management option on their farm operations.
$65,000

___ 3 **Impact of Management Practices on Soil Health Indicators in Conventional and Organic Vegetable Cropping Systems** (multiyear- Year 3)
Dr. Gladis Zinati, Director, Vegetable Systems Trial, Rodale Institute

Vegetable growers implement various tillage practices whether they farm organically or conventionally. The cropping systems and management practices play major role in building or degrading soil health over the years. The objectives of this project are to examine the chemical and biological soil health indicators in a long-term Vegetable Systems Trial (VST) at Rodale Institute over multiple years. The generous funding from Pennsylvania Vegetable Growers Association allowed us to sample soils in 2020 and soon 2021 (Years 1 and 2 out of 4-year project). The deep soil samples for year 2 will be collected in November at three depths sectioned 10 cm each (0-30 cm) and analyzed at various laboratories. The proposed project here is to continue sampling soil during the 2022 growing season (Year 3) and assessing these samples for physical, chemical nutrients (macro- and micro- and protein) and biological properties (bacterial and fungal microbial biomass). Funding from the Pennsylvania Vegetable Growers Association for this multiyear project will enhance our efforts in assisting the vegetable growers in making informative decisions with science-based knowledge on cropping management practices that build soil health, increase crop productivity, and environmentally friendly.
$8,000.00

___ 4 **Are Organic Herbicides Effective for Burndown Prior to Crop Establishment?**
Dwight Lingenfelter and John Wallace, Penn State Department of Plant Science

Weed management in organic cropping systems is extremely challenging. In most cases, it is accomplished with various tactics including tillage, cover crops, mulches, among others. Planting vegetable crops into an organic no-till system provides its own set of unique challenges and significantly reduces the number of weed control options. However, some growers are always looking for ways to make this system work. One option is to apply OMRI-approved herbicide products such as HomePlate, Axxe, or Scythe during the burndown phase prior to crop planting. However, reliable information is limited on the overall weed control effectiveness of these types of products.

We propose to evaluate these products for burndown control especially on problem weeds such as marestail. We will compare HomePlate, Axxe, Scythe, and possibly others at various use rates, spray volumes, and with certain OMRI listed adjuvants to determine their effectiveness on burndown weed control over a few-week period. As a comparison, conventional burndown herbicides such as glyphosate, paraquat, and Sharpen will be included. The study will be conducted at the Penn State research farm near Rock Springs, Centre County. Benefits to state and regional organic vegetable growers will include updated information in vegetable production guides and other educational resources on how to control weeds more effectively.
$2,000

___ 5 **Evaluating Potential Herbicide Carryover to Vegetables**
Mark VanGessel, University of Delaware; Dwight Lingenfelter, Penn State University; Lynn Sosnoskie, Cornell University

Many considerations are involved when making herbicide decisions. Most of the questions concern effectiveness, crop safety, and costs. However, crop rotation is just as important. Use of a specific herbicide may not be an option if rotational crops are not specifically mentioned. These rotational restrictions are based on herbicide residues that maybe found in the crop when planted the next season; the herbicide does not breakdown over 8 to 12 months and crop injury can occur; or there is lack of information on how the rotational crop may respond so out of an abundance of caution, the label restricts planting for at least 18 months.

In many situations, this forces farmers to use the same herbicides in their rotational crops that they use for their vegetables. This lack of herbicide options prevents the use of more effective

herbicides during the corn or soybean phase of the rotations. Since most of the weeds that infest a field were from seeds deposited the previous year, reduced control in rotational crops can mean higher weed pressure when planting vegetables. In addition it can limit the range of herbicide mode of actions being used and put additional selection pressure for herbicide resistance.

Allowing for a more diverse herbicide rotation over 2-year period can allow for an overall improvement in weed control and reduce the selection pressure for resistance. Two herbicides that can improve control of problematic weeds in the region include mesotrione and metribuzin. Mesotrione is an active ingredient in Halex GT and Lexar and is commonly used in corn. Metribuzin is labeled for soybeans and is available as a "stand alone" product or is a component of many herbicide premixes. Both mesotrione and metribuzin are effective on Amaranthus species (redroot pigweed and Palmer amaranth) and common ragweed. Not only are these weeds difficult to control, there are herbicide-resistant populations in the area. Both mesotrione and metribuzin are still effective on the resistant biotypes in this region, and these herbicides will provide a more diverse herbicide rotation over a 2-year period.

The study will be conducted over two years. Mesotrione and metribuzin will be sprayed at three herbicide rates (1X, 2X, and 4X) in 2022. Rotational crops will be planted in 2023 and evaluated for potential crop injury and final yield. Three rotational crops will be planted. Pumpkins will be grown at each site, plus two locally important crops. These trials will be conducted at the Penn State, University of Delaware, and Cornell University. These locations will provide a range of soil types and environmental conditions to evaluate crop safety.

$9,000 for 2 years - $4,500 each year

___.6 <u>Potential Herbicide Programs to Control Problem Weeds in Pumpkin</u>

Dwight Lingenfelter and John Wallace, Penn State Department of Plant Science

Weed control in pumpkins is challenging for many reasons, including the production practices of wide rows, no-till which excludes use of cultivation, long growing season, and limited number of herbicide options. These practices result in a greater reliance upon herbicides for weed control. Unfortunately, there are very few herbicides labeled for postemergence weed control in pumpkins. Since herbicides play an important role in pumpkin production, it is important that currently registered herbicides are used judiciously and new herbicides (i.e., ones with different active ingredients and modes of action than those currently labeled) are identified that fit into a pumpkin production system and provide effective weed control, minimal crop injury, and environmental safety.

We propose to evaluate preemergence and postemergence herbicide programs for control of typical annual weeds such as, giant foxtail, velvetleaf, pigweed, nightshade, ragweed and any other weed species present in the study location. In addition to evaluating weed control, we will determine effect of the herbicides on pumpkin injury and any subsequent impacts on yield. We will compare labeled standards such as Command, Curbit, and Sandea to some recently labeled products and those that could potentially receive a label for use in pumpkins such as, Dual, Reflex, Zidua, bicyclopyrone, BroadStar, Tough, and others. The study will be conducted at the Penn State research farm near Rock Springs, Centre County. Benefits to state and regional pumpkin growers will include updated information in vegetable production guides and other educational resources on how to more effectively control weeds with existing and new products and how best to integrate other effective herbicide modes of action into the program to reduce the potential for resistance.

$2,000

___ 7 **Improving Onion Center Rot Management Through More Precise Topping at Harvest**

Beth K. Gugino and Jennie D. Mazzone, Dept. of Plant Pathology and Environmental Microbiology, The Pennsylvania State University

Pennsylvania onion growers are continually challenged by bacterial disease. For over a decade, the Gugino Vegetable Pathology Program has worked to improve disease management using IPM strategies, but an elusive question remains; At what point can topping prevent bacterial disease from moving into the bulb? Bulbs with external bulb decay are odoriferous and easy to cull at harvest. Bulbs infected with the bacterial disease center rot prove much more challenging. Center rot pathogens enter natural openings or wounds in the leaves, causing bleached lesions that eventually cause the leaves to wilt, collapse, and then the pathogen progresses through the neck and into the bulb. Center rot can sometimes be identified at harvest by inspecting the onion neck after it is topped for a soft, discolored ring but this symptom can be subtle and difficult to see if plants have lodged prior to harvest. If foliar infections were identified and their progression stopped before they made it into the bulb, growers would have another tool in their toolbox for managing center rot. Through an inoculated field trial, we propose to top onions at bulb maturation, while documenting foliar lesion proximity to bulb, dry and store the onions, and then three months later evaluate bulb disease incidence postharvest. We will assess the minimum distance needed between the observed foliar symptoms and the bulb to remove the pathogen during topping and prevent the disease from progressing into the bulb. If the pathogen can be removed at harvest during topping, the proportion of infected bulbs shipped to markets will decrease. The proposed project will build upon previous research supported by PVGA/PVMRP, which determined a critical disease severity threshold to help growers determine when to harvest onions to minimize disease losses. Together, the results from these trials can be used to develop a picture tool to aid growers in deciding when to harvest based on the proximity of foliar symptoms to bulb. The results will be shared with growers through the Penn State Extension Website, Penn State Vegetable Gazette Newsletter and Mid-Atlantic Fruit and Vegetable Convention.
$3,000

___ 8 **Refining Organic Insecticide Programs to Reduce Allium Leafminer Damage to Marketable Standards.**

Teresa Rusinek & Ethan Grundberg, Regional Vegetable Specialists, Cornell Cooperative Extension

Previous trials conducted by Grundberg and Rusinek evaluating the optimization of application timing for 2 sprays of Entrust* + M-Pede have successfully identified the critical control window for Allium leafminer (ALM)--targeted insecticide applications to weeks 2-5, after confirming the onset of ALM activity in the field. However, the best sequence of 2 applications of Entrust + M-Pede have still resulted in mean ALM densities of nearly 6 per leek in fall 2019. Previous research also demonstrated the potential to combine insecticide applications with reflective plastic mulch to further reduce damage from ALM in alliums. Combining reflective mulch with 2 applications of Entrust + M-Pede still resulted in mean ALM densities of 7.7 per leek in fall 2020 while unsprayed leeks planted on reflective mulch had an average of 33.8 maggot and pupae per leek. Dr. Shelby Fleischer and Tim Elkner have demonstrated some potential for Azera (azadirachtin + pyrethrins) to reduce damage from ALM in leeks. Therefore, it is hypothesized that the addition of one application of Azera in combination with 2 applications of Entrust + M-Pede and reflective mulch may reduce ALM densities to tolerable levels for organic producers. Determining the optimal interval and sequence of a 3 spray program (i.e. 7-days vs. 10-day schedule) would provide information growers need to further reduce ALM larvae, pupa and associated decay over the prolonged duration of the fall ALM flight (up to 8 weeks). The estimated cost of the project including: salaries plus fringe, and supplies is **$12,500**.

*The Entrust Label requires rotating to another class of effective insecticides for at least one application after two consecutive applications of Group 5 insecticides (spinetoram and spinosad).

___ 9 **Evaluating OMRI-listed Herbicides in Organic Snap Bean Production**

Ethan Grundberg, Regional Vegetable Specialist, Cornell Cooperative Extension

Several newly formulated OMRI-listed herbicides have become available to organic growers since 2019, but little research has been conducted in the Northeast and Mid-Atlantic to evaluate the potential of these products to improve weed management for organic vegetable growers. Ethan Grundberg completed a preliminary trial using Axxe (BioSafe Solutions) and HomePlate (Certis) to control annual broadleaves and crabgrass in carrots in 2021. Both products showed great potential to control broadleaf weeds and some ability to reduce crabgrass biomass when multiple shielded applications were made; however, a cost comparison to mechanical cultivation remains to be completed. This proposal aims to expand the 2021 work in carrots to snap beans in 2022. The 2022 trial would be a small plot randomized complete block design using the OMRI-listed herbicide products Axxe, HomePlate, Final-San-O (Certis), and Torched (Southland Organics) at Alewife Farm in Kingston, NY. Post-emergent shielded herbicide applications would be made as needed, but no more than three times during the production cycle. Additional treatments would include a hand-weeded control, a grower's standard mechanical cultivation, and an unweeded control treatment. One weed count would be made after the final herbicide application in each plot and a final weed biomass weight would be collected prior to bean harvest. Marketable yield by plot would also be evaluated. The total estimated cost of the trial, including Cornell University indirect cost charges of 26%, is
$9,500 (or about $7,500 without direct costs).

___ 10 **Evaluating the Efficacy and Safety of Pyridate in Snap Beans**

John Wallace and Dwight Lingenfelter, Penn State, Department of Plant Science; Lynn Sosnoskie, Cornell University; Mark VanGessel, University of Delaware

Pennsylvania, Delaware, Maryland, New Jersey, and New York, combined, produce over 46,000 acres of snap beans (NASS, 2017). Because of the crop's short stature and the comparatively brief window between planting and harvest, season-long weed control is necessary to maximize snap bean yield. Many weeds of concern can emerge with the beans, resulting in significant competition for limited resources and physically impeding or contaminating harvests; consequently, postemergence (POST)-applied herbicides are valuable tools for preventing yield loss. Relatively few products are labeled for POST use in snap beans and the addition of novel active ingredients would be valuable for suppressing unwanted vegetation. Pyridate, a WSSA Group 6 herbicide (PSII-inhibitor) is registered in several counties for use in chickpeas/garbanzo beans and lentils and is being explored for use in succulent peas, suggesting members of the Fabaceae may possess a level of tolerance to the chemical. It is effective for controlling pigweeds, lambsquarters, jimsonweed and nightshades and research is needed to fully demonstrate its utility in snap beans.

The objective of this trial is to evaluate the efficacy and safety of pyridate for commercial snap bean production. We will evaluate two formulations of pyridate (Tough EC, an emulsifiable concentrate, and Lentagran WP, a wettable powder) at multiple rates and timings. Rates will be based off recommendations for garbanzo beans (0.47 to 0.94 lbs ai/A). Timings will include applications at the unifoliate and first trifoliate developmental stages, and at flowering. An untreated check and currently registered POST herbicides (e.g. Basagran, Reflex, others) will be included for comparison. This trial will be conducted at three locations, PA, NY, and DE to evaluate consistency across different environments and production practices. Results of this trial will provide required data to potentially expand the pyridate labels to include snap bean production. Results will also be shared with regional snap bean producers at 2022 and 2023 extension meetings.
$5,000

___ 11 **Precision Cultivation Using Camera Guidance Technology in Snap Bean**

John Wallace and Tosh Mazzone, Penn State University

Recent advances in cultivator technology provide novel opportunities for Pennsylvania snap bean growers to use precision cultivation to control weeds with tools such as camera-based guidance systems and finger-weeders. Camera guidance systems facilitate cultivation within snap bean rows and allow for use of flatter cultivation sweeps between rows, which minimizes soil disturbance. Finger weeders disturb soil in and around the base of crop plants with enough force to kill newly germinating weeds. Thus, camera-based guidance systems and in-row tools can improve the speed, productivity and efficacy of cultivation. We propose to establish a field research trial that will evaluate cultivation timing of in-row cultivation with finger-weeders and camera-based guidance to optimize weed control and minimize crop injury. Organic and conventional snap bean growers have limited herbicide options, so both can benefit from improved cultivation-based weed control methods. Understanding the tradeoff between weed control and crop tolerance is a significant knowledge gap that prevents use of precision cultivation in horticultural crops. Cultivation is generally more effective for early season weed control, but young snap beans may be more sensitive to mechanical injury during this time. Due to the potential for crop injury during cultivation, we plan to establish a field trial that will test the effects of in-row cultivation timing and working depth on snap bean stand and yield. Through this research we aim to optimize in-row cultivation using finger weeders to reduce crop injury while maintaining effective weed control. The results of this research will be shared with growers through Penn State Extension and regional extension meetings.
$1,250

___ 12 **Assessing the Ability of Tomato Communities to Suppress Disease in the Field**

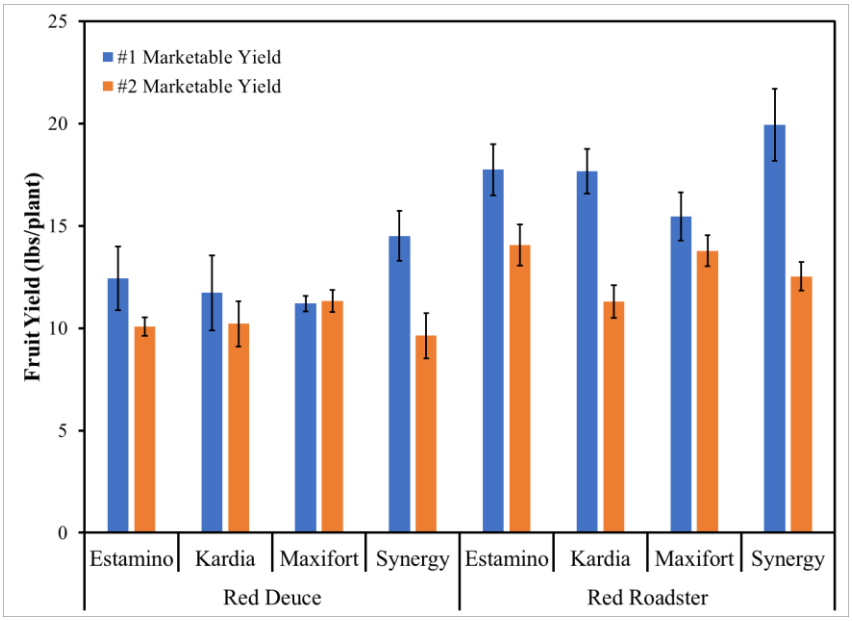
Kevin L. Hockett, Dept. of Plant Pathology and Environmental Microbiology, Pennsylvania State University

In 2019, I and my collaborators were funded through the PVMRP to attempt to develop microbial communities that were suppressive toward bacterial speck of tomato (title: *Developing microbial communities to suppress bacterial diseases of tomato*). Over the past two summers, 2019 and 2020, we have had promising results in that we observed a trend where, with repeated passaging, disease severity increased from passages 1 to ~5, followed by a steep decline in disease severity from passages ~5 onward. These results have been highly encouraging in supporting the idea that natural communities can selected to suppress bacterial speck. We were able to leverage these results to receive a Northeast Sustainable Agriculture Research and Education (NE SARE) grant. In 2021, we were funded through PVMRP for similar research into bacterial spot of tomato (title: *Expanding suppressive microbial communities to manage bacterial spot of tomato)*. Although not identical to the trend for bacterial speck, a similar trend was observed, where following passage 6, there was a noticeable decrease in disease severity, which was sustained for the remainder of the passaging. This new proposal aims to assess whether the disease suppression that we have observed in the greenhouse will translate to the field. For this work, we will either use communities that we've developed in the summer of 2021 for the field season in 2022 or we will develop new communities using the passaging approach in the spring of 2022. For this work, tomato plant starts (cv. Red Deuce) will be inoculated with disease suppressive communities in the greenhouse, prior to being transplanted into a field setting at the Penn State Rock Springs experimental farm. Once the plants have been given sufficient time to acclimate to the field (~1 week), the bacterial spot pathogen (*Xanthomonas perforans*) will be spray inoculated onto the plants. Disease symptoms will be monitored over a period of up to 3 weeks to assess average disease severity and incidence. The suppressive community treatment will be compared to a no community control. Additional treatments with commonly or commercially available products (fixed copper spray, Serenade, LifeGard) will be included for comparison as space and material is available. This work will be performed in collaboration with Dr. Beth Gugino, who will aid in setup and analysis of the experimental results.
$8,500 - $7,750 – summer student wages, $400 – seeds, pots, soil, $350 – field preparation and maintenance costs

___ 13 **Evaluation of Rootstock-Scion Interaction and Yield Performance in Fresh-Market Tomato Grown in High-Tunnel**

Timothy Elkner Penn State Extension; Andrew Blunk and Francesco Di Gioia, Department of Plant Science – The Pennsylvania State University

The increased adoption of high tunnel production systems is leading also to an increased adoption of grafted tomato plants. The rootstock selection and the rootstock-scion combination are key factors for the successful use of grafted plants. Previous studies have shown that the use of vigorous rootstocks can help overcome soilborne pest and pathogens as well as abiotic stress conditions (low and high temperatures, water stress, salinity, alkalinity). In a preliminary study conducted at SEAREC in Southeast Pennsylvania during the 2021 growing season we have observed consistent differences in terms of yield and plant growth testing eight combinations between two scions 'Red Deuce' and 'Red Roaster" and four rootstocks (Estamino, Maxifort, Kardia, and Synergy). We propose to repeat the same study and compare these grafting combinations in terms of yield, plant growth, nutrient uptake, and fruit quality. Treatments will be arranged according to a split-plot experimental design with four replications. Biometric assessments and plant tissue analyses will be performed to assess nutrient uptake. Fruit yield and quality response will be evaluated. Outreach activities will be organized to show the results of the study. Estimated funds required to cover field supply, hourly wages, and laboratory analysis:
$10,000.



Preliminary results showing final marketable fruit yield for category #1 and #2 fruit.

___ 14 **Keeping PA Vegetable Growers Profitable: Statewide Cultivar Trials**

Elsa Sánchez, Bob Pollock, Tim Elkner, Tom Butzler, and Megan Chawner - The Pennsylvania State University Department of Plant Science and Extension

Selecting which cultivar to grow is critical to successful vegetable production. When farmers grow high-yielding cultivars suited to an area, they can make a profit. However, because numerous cultivars are commercially available, it can be difficult to select the best ones. Our goal is to provide farmers with up-to-date information for successful, region-specific cultivar selection. We would like to continue our statewide effort to evaluate cultivars in central, southeastern, and southwestern Pennsylvania. We would also like to add a fourth site at The Seed Farm in eastern Pennsylvania. This fourth site will allow us to evaluate vegetables using organic methods and address the needs of organic farmers for cultivar selection. In 2008-09, with funding from the PVRMB, we have evaluated green bell peppers, winter squash, bicolor and white synergistic sweet corn, spring and fall broccoli, 15-25 lb orange, smooth-faced pumpkins,

muskmelons, and spring and fall cabbage. Regional and statewide recommendations have been disseminated through presentations and articles. Statewide recommendations also appear in the Mid-Atlantic Commercial Vegetable Production Recommendations guide.

We would like to evaluate early maturing, determinate, large, red, slicing tomatoes in 2022. In Pennsylvania, tomatoes are a top crop for vegetable farmers. Field-grown tomatoes are grown on 1,586 farms comprising 3,297 acres (Census of Agriculture, 2017). This is up from 1,720 farms growing 2,655 acres in 2012 (Census of Agriculture, 2017). Additionally, 304 growers at the 2011 Mid-Atlantic Fruit and Vegetable Convention were asked, "What specific crops should researchers focus on in order to maintain your operation's profitability and that of the Mid-Atlantic Vegetable and Fruit Industry? Tomatoes came out as the top response of 18 listed crops. Conventional farming practices will be used at the western, central, and southeastern sites and organic methods will be used at the eastern site. We are requesting $20,000 or $5,000 per site for this project. Growing tomatoes requires higher labor needs than the crops we have evaluated before. We are requesting the same amount per site as in the past; however, the number of cultivars we will evaluate in a single year will be lower to account for increased labor costs. Our plan is for this to be the beginning of a period devoted to evaluating different types of tomatoes (varying sizes and times to maturity, heirloom-hybrid crosses, high tunnel types, for example).
$20,000

___ **15. <u>Breeding Processing Tomatoes for Production in PA</u>**

Majid R. Foolad, Professor of Plant Genetics, Department of Plant Science, The Pennsylvania State University

Objective: To develop breeding lines and F_1 hybrid cultivars of processing (PROC) tomato with disease resistance and other desirable characteristics suitable for production in PA.

At Penn State, we have developed elite processing (PROC) tomato breeding lines with strong resistance to foliar diseases <u>early blight</u> (EB) and <u>late blight</u> (LB), and general resistance to other tomato diseases, including <u>bacterial</u> (e.g. we have established a comprehensive project on <u>bacterial canker resistance</u>; PhD thesis research of Jonathan Bonfiglio). The PSU PROC tomato inbred lines have also been bred for other desirable characteristics, including high yield, early maturity, superior fruit quality (e.g. firmness, high lycopene content, reduced color disorders), and adaptation to PA conditions. Most of our lines are elite and ready to be used as parents to develop F_1 hybrids for commercial evaluation/production. During the past few years, we developed a large number of PROC tomato F_1 hybrids and trialed them at Penn State research Farms, some of which were also trialed by a few tomato processing/canning companies. For example, in 2021, we trialed 21 elite PROC tomato F_1 hybrids with EB resistance and 23 PROC hybrids with EB + LB resistance, including 11 elite hybrids (which were tested in previous years) and 12 new hybrids (PSPH-20 series). We also shared some our elite F_1 hybrids with three tomato PROC/canning companies, Fermano Foods Inc., Red Gold, and Hirzel Canning, which trialed them under their production conditions. For example, Furmano trialed 14 elite PROC tomato F_1 hybrids with EB resistance (2 of which in large scale, 2000+ seed) and 23 PROC hybrids with EB + LB resistance (2 of which in large scale, 2000+ seed). All three companies would like to re-trial these and more of our hybrids in 2022. Furthermore, Furmano, identified 7 of our hybrids, which they want to trial in very large scale (3 or more acres) in 2022. We have made agreement with the University to allow this large-scale trials by Furmano in 2022, and are currently producing seed of these hybrids in Costa Rica. In 2021, we also were engaged in producing new inbred lines of PROC tomatoes, which will to be used as parental line for development of new F_1 hybrids. The **Main Objectives** of the 2022 projects include: **1)** Evaluation of a total of <u>41</u> PROC tomato F_1 hybrids with EB resistance (including 20 new hybrids developed in 2021); **2)** Evaluation of <u>56</u> PROC tomato F_1 hybrids with EB + LB resistance (including 33 new hybrids developed in 2021); **3)** Continue evaluation and development of elite inbred lines of PROC tomato with EB/LB resistance; **4)** Share and trial our PROC hybrids in collaboration with three Food Processing/canning companies; and **5)** Establish a project to identify and map genes for bacterial canker resistance to be used for breeding purposes. The last objective includes screening, evaluation, and identification of genes for resistance to tomato bacterial canker (PhD thesis research of Jonathan Bonfiglio). Currently, we are producing very

large-scale seed of our select hybrids in Costa Rica for 2022 trials by seed companies. We are also making new crosses and producing new hybrids in-house at Penn State, University Park campus. $6,000

___16. Breeding Fresh-Market Tomatoes for Production in PA

Majid R. Foolad, Professor of Plant Genetics, Department of Plant Science, The Pennsylvania State University

Objective: To develop breeding lines and F_1 hybrid cultivars of fresh-market (FM) tomato with disease resistance and other desirable characteristics suitable for production in PA.

We have developed elite fresh-market (FM) tomato breeding lines, including large (slicer), plum, cherry and grape tomatoes, with strong resistance to foliar diseases early blight (EB) and late blight (LB), and general resistance to other tomato diseases, including bacterial (e.g. we have established a comprehensive project on bacterial canker resistance; PhD thesis research of Jonathan Bonfiglio). Our inbred lines have also been bred for other desirable characteristics, including high yield, early maturity, superior fruit quality, and adaptation to PA conditions. Most of our inbred lines are elite and ready to be used as parents for developing F_1 hybrids for commercial evaluation/production. During the past several years we developed a large number of FM tomato F_1 hybrids, which were evaluated at Penn State research Farms and also trialed by several national/international seed companies and a few PA tomato growers. For example, in 2021 we evaluated 46 elite FM large-size F_1 hybrids with EB resistance, 31 elite FM large-size F_1 hybrids with EB + LB resistance, 67 grape tomato hybrids with EB and/or EB + LB resistance. We also shared seed of some of our FM F_1 hybrids with a few seed companies for trials. In 2021, we also developed 51 NEW FM large-size F_1 hybrids with EB resistance, 46 NEW FM large-size F_1 hybrids with EB + LB resistance, and 40 NEW grape tomato F_1 hybrids, which were not evaluated in 2021 but will be evaluated in 2022. In 2022, all of the tomato hybrids selected from our 2021 trials, and all the NEW hybrids developed in 2021 (produced in Costa Rica) will be trialed by us at Penn State and by several of our cooperative seed companies. The **Main Objectives** of the 2022 projects include: **1)** Evaluation of 95 FM large-size F_1 hybrids with EB resistance; **2)** Evaluation of 77 FM large-size F_1 hybrids with EB + LB resistance; **3)** Evaluation of 90 FM grape tomato hybrids with EB and/or EB + LB resistance; **4)** Continue evaluation and development of elite inbred lines of large-size FM tomatoes for future hybrid production, **5)** Continue evaluation and development of elite inbred lines of grape tomatoes for future hybrid production, and **6)** Establish a project to identify and map genes for bacterial canker resistance to be used for breeding purposes. A major focus in 2022 will be screening, evaluation, and identification of genes for resistance to bacterial canker (PhD thesis research of Jonathan Bonfiglio).

$8,000

Total Requested $180,250 for 2022