2019 - 2020
Research Proposals
for
Oregon Processed Vegetable Commission

Prepared by
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Processed Vegetable

TITLE: Monitoring Soil Moisture and Temperature Impacts on Soilborne Fusarium Diseases in Processing Vegetable Cropping Systems

YEAR INITIATED: 2019-20 **CURRENT YEAR:** 2019-20 **TERMINATING YEAR** 2021-22

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FUNDING REQUEST FOR 2019-20: $32,409

JUSTIFICATION: Sweet corn and snap bean production, amongst other vegetable crops grown in the Willamette Valley of Oregon, are impacted by soilborne diseases caused by *Fusarium* species. The decline in sweet corn yields due to Fusarium crown and stalk node rot as well as root rot in snap bean and sweet corn are well documented in the valley. The widespread presence and increasing disease pressure from *Fusarium* in the soils of western Oregon compels growers to define optimum management practices in order to minimize the impact from *Fusarium* diseases.

Soilborne diseases caused by fungi like *Fusarium* species are increasingly important. Although breeding for plant resistance to *Fusarium* species is valuable, it is not the end-all in disease management because *Fusarium* is capable of genetic adaptation for quickly overcoming plant resistance genes. Soilborne *Fusarium* propagules that survive between crops are unreachable by most chemical applications. Fungicide seed treatments provide only short periods of efficacy and cannot protect throughout the growing season for vegetable crops like sweet corn and snap bean. Soil fumigants and other soil treatments are costly, destroy beneficial soil microorganisms, and do not control *Fusarium* existing in plant debris.

Plant pathologists have informally and formally discussed the increased presence of pathogenic *Fusarium* species. The factors behind the greater yield impacts from *Fusarium* are complex and potentially have synergistic interactions. In western Oregon soils, soil temperature and moisture levels during the growing season as well as during the non-cropping months greatly affect disease pressure. It is likely that conditions occurring during winter and early spring months promote the survival and/or propagule increases of *Fusarium* species. It could be a direct effect such as periods of warmer winter temperatures that promote both weed growth and *Fusarium* reproduction on weedy hosts, or indirectly by the modulation of the breakdown of crop plant residues after harvest as well as the variation of other soilborne microflora (bacteria, actinomycetes, other fungi) that are antagonistic to pathogenic *Fusarium* species.

Little has been done in investigations on soil water and temperature effects on these Fusarium diseases in processing vegetables in western Oregon. Peachey (2005) showed that an irrigation regime that imparted drier soil conditions was associated with lower levels of root rot in sweet corn. However, Fusarium crown and stalk node rot disease severity may increase or have earlier onset in sweet corn fields under drier, hotter soil conditions. For long term success in managing fields to suppress Fusarium, we need to have enhanced information on how soil temperature and moisture affect disease levels.

HYPOTHESIS & OBJECTIVES: We hypothesize that the incidence of *Fusarium* root disease can be predicted by soil temperature and moisture levels. It may be possible to reduce *Fusarium* diseases and their associated losses in sweet corn and snap bean fields by connecting the interaction of *Fusarium* and soil environment with the physical properties of soils and cropping practices such as irrigation. The proposed investigations would aid in improving the sustainability of processing vegetable production in Oregon.

The objectives of this project are:

1. Evaluate soil conditions (temperature and moisture) as predictors of *Fusarium* incidence.
2. Evaluate *Fusarium* disease incidence and severity of crops in monitored sweet corn and snap bean fields.

PROCEDURES:
Objective 1: Evaluate soil conditions as predictors of *Fusarium* incidence.

We will continually monitor soil temperature and soil moisture through the growing season and overwinter. Each field will have four TDR-315 sensors installed in the top 6-inches of soil, and enclosed in protective PVC tubing. TDR probes will be connected to data loggers (equipment owned by Buckland's program) that will be located at recording stations within the field. Data will be downloaded at regular intervals and used to describe overall field conditions throughout the season. We anticipate being able to identify temperatures as well as duration of conditions, such as excessively dry and hot summer conditions or winter low temperatures, which may discourage the growth of *Fusarium* or promote propagule die-out. We will also complete a basic soil health assessment including soil physical, chemical and biological properties as a reference for soil moisture and temperature data.

Fusarium population levels in fields will be determined in representative soil samples collected immediately prior to sowing the crop, every two to three weeks until harvest, and then, monthly during the fall/winter until sowing the following spring. Twelve-inch soil cores will be collected in a systematic manner across each of five blocks in each commercial field site. Soil cores will be combined within each block and subsamples will be evaluated for *Fusarium* species by soil plating onto a *Fusarium*-selective medium as well as by microbiome analysis.

Objective 2: Evaluate *Fusarium* disease incidence and severity of crop plants in monitored sweet corn and snap bean fields.

Stand counts will be done in all fields at two weeks after planting. For sweet corn, rot of the mesocotyl, primary root, adventitious roots, stalk, and crown tissues will be evaluated every two to three weeks beginning at the two-leaf stage. Plants will be evaluated by digging up 10 plants from each block (50 plants per field), washing soil from the root balls of each plant, and rating for the disease incidence and severity – all in the same day. Crowns of post-silking plants will also be digitally-captured and subsequently analyzed for grayscale with ImageJ. For snap beans, root rot will be evaluated every two to three weeks beginning at the two-leaf stage. Plants will be evaluated by digging up 10 plants from each block (50 plants per field), washing soil from the root balls of each plant, and rating for the root rot severity.

ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER:
We anticipate that the data from continual soil monitoring will be the start of a database that will identify conditions under which *Fusarium* diseases will pose an increased likelihood of crop loss. We anticipate the need to continue soil and plant health monitoring over three seasons to gather data under a wide variety of environmental conditions. With these results, growers and field agronomists can adapt crop rotation, irrigation scheduling and crop disease scouting intervals as needed to minimize crop losses.

PROJECT TIMELINE: Soil monitoring equipment will be installed in grower-cooperator fields in the spring, as soon as field conditions allow. Temperature and moisture data will be recorded continually throughout the year. Soil will be sampled in late spring for full chemical, biological and physical analysis. Soil pathogen sampling and crop sampling will begin at the 2-leaf stage, after which samples will be collected every 2-3 weeks.

Activities	Year 1			
	2019-2020			
	Spring	Summer	Fall	Winter
Equipment installation				
Soil monitoring				
Soil samples				
Soil pathogen samples				
Snap bean and corn samples				

LITERATURE REVIEW: *Fusarium* species are common soil inhabitants that can infect most crop species and cause a range of symptoms and types of diseases. Fusarium wilts, root rots, and seed/seedling diseases occur world-wide, causing economically important disease outbreaks (Summerell et al., 2010). Many of the disease symptoms in important annual crops caused by *Fusarium* species lead to lodging, stunting, or death of the plants, and can also result in the accumulation of harmful mycotoxins. In this proposal, we focus on sweet corn and snap bean because of the agronomic importance of these crop species in the processing vegetable systems and the plethora of associated *Fusarium* diseases (Table 1). Many *Fusarium* species are associated with rot of corn roots, stalks, and ears. Root rot of corn has been studied in the Midwestern US for decades. A new *Fusarium* disease that became yield limiting in sweet corn, was observed on *Zea mays* in western Oregon during the 1990s (Fig. 1; (Miller and Ocamb, 2009)). This disease is incited by *F. oxysporum* var. *redolens*, which can cause Fusarium crown and stalk node rot in sweet corn, dent and silage corn (Ocamb, *unpublished*). *Fusarium solani* f. sp. *phaseoli* causes root rot in snap bean (Fig. 1; (Silbernagel and Mills, 1990)). *Fusarium* diseases are common on sweet corn and snap bean in western Oregon processing fields. Ocamb previously investigated sweet corn root rot and Fusarium crown and stalk node in western Oregon (OPVC reports 2002 through 2013) as well as Fusarium root rot of snap bean (OPVC reports 2010 and 2011).

Managing irrigation rates to change the soil moisture content has been shown to impact yield loss due to Fusarium root rot in beans (Miller and Burke, 1998). Clearly, soil moisture content is also affected by air temperatures and precipitation events. Investigations into soil moisture and temperature effects have also been linked with incidence and intensity of *Fusarium* and other soilborne pathogens in other crops (Smiley, 2009). Modeling tools currently exist for crops such as wheat to predict *Fusarium* pressure based on climatic events (http://www.wheatscab.psu.edu). Our proposed work involves different disease and crops, yet promises to provide the basis for future decision making tools.

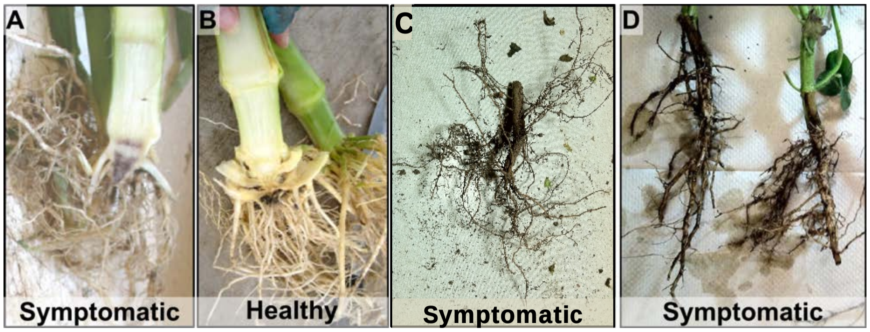

Figure 1. Crown and stalk node rot of sweet corn, 'Jubilee' and root rot of snap bean. (A) Sweet corn plant exhibiting crown and stalk node rot. (B) Crown of corn plant unaffected by Fusarium crown and stalk node rot. Initially, corn leaves turn brown starting at the base of the plant as *Fusarium* grows up the stem and to the roots; infection of the brace root occurs as the pathogen(s) spreads from infected crowns. Rot of stalk nodes and crown tissues interfere with transport through the vascular system and negatively affects yield. This disease is widespread across the Pacific Northwest and occurs on both sweet corn and Round-up Ready dent corn lines. Plants with similar symptoms have been found in sweet corn produced in Midwestern US, Europe, and South America. (C & D) Snap bean plants grown in western Oregon exhibiting root rot due to soilborne *Fusarium*.

Table 1. ***Fusarium* species reported for corn and snap bean in the USA**

Crop	***Fusarium* species reported***	**Diseases incited**
Corn (*Zea mays*)	*F. acuminatum, F. avenaceum, F. culmorum, F. episphaeria, F. equiseti, F. graminearum, F. merismoides, F. oxysporum, F. poae, F. proliferatum, F. rimosum, F. sambucinum, F. scirpi, F. semitectum, F. solani, F. sporotrichioides, F. subglutinans, F. temperatum, F. tricinctum, and F. verticillioides*	Crown rot; crown and stalk node rot; damping-off; ear rot; root rot; seed rot; seedling blight; and stalk rot.
Snap bean (*Phaseolus vulgaris*)	*Fusarium oxysporum* f. sp. *phaseoli,* and *Fusarium solani* f. sp. *phaseoli*	Root rot; and wilt.

Literature Cited:

Miller, D, Burke, D (1986) Reduction of Fusarium root rot and Sclerotinia wilt in beans with irrigation, tillage, and bean genotype. *Plant Disease* 70:163-166.

Miller N, Ocamb CM (2009) Relationships between yield and crown disease of sweet corn grown in the Willamette Valley of Oregon. *Plant Health Progress* doi:10.1094/PHP-2009-0831-01-RS.

Silbernagel MJ, Mills LJ (1990) Genetic and cultural control of Fusarium root rot in bush snap beans. *Plant disease* 74:61-66.

Smiley, RW (2009) Water and temperature parameters associated with winter wheat diseases caused by soilborne pathogens. *Plant Disease* 93:73-80.

Summerell BA, Laurence MH, Liew E, Leslie JF (2010) Biogeography and phylogeography of *Fusarium*: a review. *Fungal Diversity* 44:3-13.

2019-20 BUDGET:

	OPVC
Salaries: Faculty Research Assistant (0.20 FTE)	$10,506
Other students	$4,500
Employee Benefits (OPE): Faculty	$7,480
Equipment	$3,600
Travel: Domestic (in state)	$1,080
Soil testing	$243
Operating Expenses[1]	$5,000
Total	$32,409

[1] Laboratory and field soil and plant sampling supplies.

ANTICIPATED REQUESTS IN COMING YEARS (if applicable):

2020-2021 **2021-2022:**

We anticipate repeating the study as described in 2020-2021 and 2021-2022. Depending on the quality of the data produced, we would plan to expand the soil moisture sensing capability to be able to monitor fields with different rates of irrigation as a comparison. We anticipate the funding request in 2020-2021 would be approximately $35,000 to allow for the purchase of additional sensors with a similar amount of time and salary required to complete the trial. The proposed request in 2021-2022 would not require additional moisture sensors and could be slightly reduced, depending on current salary rates, and is estimated as a $30,000 request.

OTHER SUPPORT OF PROJECT:

Matching funding will be provided from Buckland's program to purchase required data loggers for soil moisture sensing and for travel to and from field sites. The total matching funding for this project is estimated at $4,500. Faculty time, laboratory and field lab space as well as existing equipment from both Buckland and Ocamb is available and will ensure the project is adequately supported.

<u>PROPOSAL TO THE OREGON PROCESSED VEGETABLE COMMISSION (2018)</u>

<u>1. OPVC PROPOSAL COVER PAGE (1 page)</u>

PROJECT TITLE: Broccoli Breeding and Evaluation

PROPOSED PROJECT DURATION: 1 year (renewed yearly)

BUDGET TOTALS
TOTAL BUDGET REQUEST (all years):
Year 1: **$7,541 (breeding)**
$4,990 (processing)
$12,532 (total)

PI: James R. Myers
Organization: Horticulture, Oregon State University
Telephone: 541-737-3083
Email: james.myers@oregonstate.edu

Cooperators: TBD, Food Science and Technology, OSU

2. PROPOSAL NARRATIVE (maximum 5 pages)

JUSTIFICATION and LITERATURE REVIEW

Mechanization has reduced labor costs in many crops, but broccoli and cauliflower remain relatively unmechanized. Large labor crews are typically needed to harvest the crops. Cost and access to labor are the two main problems for broccoli harvest – cost in terms of wages to workers and access in that other crops such as blueberries need labor for harvest at the same time as broccoli. Some progress has been made towards mechanizing the process both in Europe and the U.S., but problems remain in creating a cost competitive approach.

The three parts to the equation for efficient mechanization are the production system, the harvest equipment, and the plant genetics. Our program focuses on the genetics aspect of this equation. The OSU broccoli breeding program has worked for over 20 years to develop cultivars that have architectural traits that make the cultivar more amenable to machine harvest. More recently, the OPVC was awarded a two year USDA Specialty Crop Block Grant in 2016 to automate broccoli harvest through the addition of a robotics approach attached to existing prototype harvesters. We have also recently received funding through a Western SARE grant to examine production questions related to developing the machine harvest package.

Most broccoli cultivars are not well suited for mechanical harvest. The two key factors in developing cultivars that are suitable are uniform heading and appropriate plant architecture. Most commercially available broccoli hybrids are high yielding but have short plants with heavy and poorly exserted heads. Short plants have high fiber in the portion of the stem subtending the head that must be used to achieve a normal-length cut. The lack of height as well as the high fiber makes them a challenge for machine harvest.

Another issue facing broccoli growers in Oregon is that of climate change. Historically, the Willamette Valley of Oregon has been a good environment for broccoli production, with cool days and nights. In recent years, summer temperatures have been warmer but there have been more extreme daytime high temperatures as well. Current broccoli cultivars do not have good heat tolerance and show reduced head quality if periods of extreme temperatures occur during heading. In addition to breeding for traits that increase ease of harvest, there is a need to breed for increased heat tolerance in broccoli cultivars to be produced in Oregon.

In addition to field performance characteristics, processors need broccoli that makes a high quality pack. Most commercial hybrids are bred for fresh market production and lack the traits that processors need. Florets and stems need to be dark green in color and should be uniform in color and shape; beads should be small, and retained during the blast freezing process. Florets larger than 2½ inches have to be diverted through a recutting process in the plant, so plants with small florets are preferred over those with high yields but large florets.

Disease resistances that are desirable include bacterial head rot, downy mildew, and club root resistances. Inbred lines from the Oregon State University breeding program have the genetic potential to create hybrids with greatly improved head exsertion and segmentation, better color, and low fiber. The OSU hybrids are suitable for machine harvest, and some inbreds possess some of the already discussed disease resistance characteristics.

Many OSU hybrids are high quality and have shown stable, high yields over several years, but to bring these into commercial production, cytoplasmic male sterility needs to be backcrossed into inbreds used as the female in crosses. There is also a need to derive new inbreds with improved disease resistance.

OBJECTIVES

1. Develop broccoli varieties adapted to western Oregon with suitable quality, high yields, and disease resistance including concentrated and uniform yield potential, large heads that are well exserted and have minimal leaf development on stems, firm, uniform florets of dark green color, and fine beads with short pedicels, which are retained after freezing.
2. Develop screening methodology for breeding for heat tolerance and identify germplasm with the trait.
3. Develop seed production systems using cytoplasmic male sterility (CMS) or self-incompatibility (SI) to produce field scale quantities of F_1 hybrid seed.

4. Scale up seed production to facilitate wider testing of OSU hybrids.

METHODS

We will continue to derive new inbreds and use these on a small scale to produce F_1 hybrid seed for replicated yield trials. Inbreds lines saved from the 2018 growing season will be grown from cuttings in the greenhouse. During the winter of 2019, these will be bud-pollinated to perpetuate the line, and crossed to other inbred lines to evaluate combining ability for F_1 hybrid production. Crossing efforts will focus on obtaining enough seed for replicated field trials of new hybrid combinations. Our breeding cycle is set up for fall production in the field, but we will attempt to produce enough seed that we can conduct replicated yield trials in fall and spring. Selections from a random-mated mass selected population will be treated in a similar manner, where cuttings will be brought into the greenhouse for self-pollination. Approximately five or more generations of selfing are required to develop homozygous inbreds.

Inbreds and experimental hybrids and commercial hybrids will be grown in the 2019 main fall planting in the field in a single replicate observation trial, and hybrids alone in a replicated yield and quality evaluation trial. Plots will be evaluated for head size, shape, and exsertion, segmentation, floret texture and color, maturity and disease resistance.

Two replicated trials will be conducted in 2019. One would be a fall trial where we will grow commercial and OSU experimental hybrids. In these trials, up to 10 of the most promising OSU experimental hybrids and two to four check varieties will be planted. The other will consist of commercial hybrids selected chosen because of reported heat tolerance and/or have desirable mechanical harvest traits. Hybrids will be transplanted in one row plots 30 feet in length and replicated four times. In addition to observation data, yield data will be obtained. Entries in the yield trials will be taken to the OSU pilot processing plant for blanching and freezing. Frozen material will be evaluated at the OSU winter cutting and will be displayed at the PNVA meetings in Kennewick, WA in November.

Backcrossing of selected hybrids to place the nuclear genome in the Ogura cytoplasmic male sterile (CMS) background will continue. We have in hand a stable CMS form of the inbred S446 and have until recently focused on developing CMS forms of S454, S462, S463 and S465. New inbreds that appear to be very promising in cross combinations to produce productive hybrids include S471, S473 and S475, and these will be added to the list for backcrossing in CMS. Seed production of selected hybrid combinations using a fertile inbred as a male and a CMS inbred as a female will be evaluated in the field using isolation plots and cages with honey bees. We will continue to pursue arrangements with seed companies to use the OSU inbreds to produce commercial hybrids intended for the processing market in the Willamette Valley.

PITFALLS

If inbreds share the same self-incompatibility allele, it may not be possible to produce that combination commercially even if one parent is CMS. For that reason, we generally try to choose inbreds that are self-fertile for introgression of CMS.

3. BUDGET DETAILS (maximum 2 pages)

1) Breeding (Myers)	
Salaries and benefits	
Faculty Research Assistant, field, full time	$2,573
OPE @ 69.48%	$1,787
Wages and benefits	
Student Wages	$1,302
OPE @ 11%	$143
Supplies	$300
Land use and greenhouse rental	$1,436
Total	$7,541
2) Processing (Yorgey)	
Salaries and benefits	
Senior Faculty Research Assistant	$2,796
OPE @ 61.45%	$1,718
Wages and benefits	
Student Wages	$260
OPE @ 11%	$29
Supplies	$187
Total	$4,990
Grand Total	$12,532

BUDGET NARRATIVE

Salary and OPE is requested for a full time faculty research assistant who will commit approximately 6% FTE to broccoli breeding; the remainder of salary will come from other sources. For the senior faculty research assistant, approximately 5% FTE will be required to process broccoli samples; the remainder of salary to come from other sources. $1,302 is requested for a summer undergraduate student to assist in plot maintenance and harvest operations. The SFRA will also supervise an undergraduate student in broccoli processing. Undergraduate student OPE is 11%. Funds for services and supplies includes $300 for field and greenhouse supplies ((fertilizer, pots, labels, stakes, tags, crossing supplies, envelopes, paper bags, etc.). Facilities user charges include land use rental (0.5 acre at $1,322 per acre = $661), and greenhouse rental ($1.55*500 sq. ft. = $775).

PROPOSAL TO THE OREGON PROCESSED VEGETABLE COMMISSION (2019)

1. OPVC PROPOSAL COVER PAGE (1 page)

PROJECT TITLE: Green Bean Breeding and Evaluation

PROPOSED PROJECT DURATION: 1 year (renewed yearly)

BUDGET TOTALS
TOTAL BUDGET REQUEST (all years):

Year 1:	$29,566 breeding
	$7,569 processing
	$37,135 total

Contributions from the OSU breeding program

Year 1:	**$19,639**

PI: James R. Myers
Organization: Horticulture, Oregon State University
Telephone: 541-737-3083
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Cooperators: Brian Yorgey & replacement, Food Science and Technology, OSU

2. PROPOSAL NARRATIVE (maximum 5 pages)

JUSTIFICATION and LITERATURE REVIEW

Green beans grown for freezing in the Willamette Valley contribute significantly to the Oregon state economy each year ($17.1 million in 2016). The industry produces a high quality product with the unique flavor, color, and appearance based on the Bush Blue Lake (BBL) class of green beans. The growing environment in Western Oregon is different from any other green bean production area in the United States. Developing productive varieties that are adapted to this area requires the attention of a substantial breeding effort in Western Oregon. BBL green beans have higher yield potential than those typically bred for the Midwestern U.S. A factor contributing to BBL pod quality is that these types typically have the lowest fiber pods (equivalent to Romano beans and much less than most Midwest and fresh market types). A tradeoff of the higher yields is that BBL beans allocate fewer resources to vegetative growth, which can compromise plant architecture and lead to lodging when pod loads are heavy. Lodging and low fiber content contributes to susceptibility to white and gray mold by BBL types.

White mold disease caused by *Sclerotinia sclerotiorum* is a pathogen of more than 400 species of plants including snap bean. Not only does it have the potential to cause heavy yield loss, but it can adversely affect pod quality and cause rejection of whole lots at the processing plant if moldy pods in the lot exceeds 3%. The growing environment in western Oregon is favorable to disease development, especially during the fall when cooler and moister conditions persist. The disease is mainly controlled by fungicide application, which requires precise timing and can be expensive especially if two sprays are required. Biological control also has potential but is expensive has not been implemented on a wide scale.

If genetic variation exists, resistance is usually the most efficient means of achieving control of any disease, as the costs associated with control of that disease are internalized in the cost of the seed. White mold disease resistance is no exception to this principle.

While partial resistance is known, there are challenges to successful deployment. First, the genetic factors conditioning resistance generally have small individual effect and are strongly influenced by the environment (in this respect, white mold resistance shows many similarities to the genetic control of yield). A number of resistance factors are known but these are in different varieties, many of which are not snap beans. Our work supported by the USDA National Sclerotinia Initiative involving meta-QTL analysis revealed that there are 17 factors contributing to resistance distributed throughout the bean genome. More recently, we conducted a genome wide association study (GWAS) and identified 39 regions of the bean genome that harbor resistance. These resistance factors can be combined in the same variety which is best facilitated by the use of molecular markers for selection. In addition to physiological resistance, avoidance traits such as maturity, growth habit, lodging, flower number and retention, and canopy porosity influence the overall level of resistance. This requires an approach to plant breeding that emphasizes field scale breeding using replicated plots with marker assisted selection.

Our program has focused on using several resistance sources. These can be placed into two groups: resistance factors derived from common bean and resistance factors from the related species, scarlet runner bean. Of the common bean germplasm sources, NY 6020 is a snap bean developed by the snap bean breeding program at Cornell University. It has been well characterized genetically and we know that it has two relatively large resistance factors that have molecular markers for selection. This has been the primary focus of our white mold breeding program. Recently, we have screened additional snap bean lines and have discovered several which have useful levels of resistance. We are only beginning to understand what resistance factors they possess, and have begun crossing to these to introgress from these resistance sources.

From the scarlet runner derived materials we have several snap bean germplasm lines that have significant levels of resistance. WMG904-20-3 resistance was recently characterized in a recombinant inbred population where we found a major factor for resistance residing on common bean linkage group 8.

The NY 6020 derived lines are most advanced in the program and selections have been narrowed to four lines. With this particular form of resistance we have observed a negative correlation between disease resistance and yield. Lines with good white mold resistance generally yield 75 – 85% of susceptible check cultivars and we may ultimately determine that none of this material merits release. Our attention is turning now to some of the newly identified resistance sources. In particular, we have a number of crosses to the wax bean 'Unidor' which has shown good white mold resistance. These need to be evaluated for resistance, increased, and placed into replicated yield trials. Additional crosses are in earlier generations, and need to be moved along the pipeline.

While the main focus of the program is on improving white mold resistance of the BBL types, other traits including yield, maturity, growth habit, pod size, shape and color, and processing characteristics need to be maintained or improved.

OBJECTIVES

1. Breed improved Bush Blue Lake green bean varieties with:
    a. White and gray mold resistance
    b. Root rot resistance
    c. Improved plant architecture
    d. High economic yield
    e. Improved pod quality (including straightness, color, smoothness, texture, flavor and quality retention, and delayed seed size development)
    f. Tolerance to abiotic stresses

METHODS

Breeding for White Mold Resistance: Because of the persistent need for white mold resistant snap bean cultivars, breeding for white mold resistance continues to be the primary objective of the breeding program.

Most NY 6020 derived lines have been evaluated for three or more years and we have winnowed the group down to 4 lines with the best combination of disease resistance, yield and pod quality. It was decided at the 2018 OPVC research reports meeting that these lines do not have sufficiently high enough yields for release as cultivars, but could be released to commercial green bean breeders as germplasm. The focus going forward in 2019 will be to begin trialing new entries in the pipeline. Over 450 breeding lines were massed in 2018, thereby creating enough seed for replicated yield trials. A preliminary trial of approximately 75 entries with three reps and appropriate BBL checks will be grown as described below. In addition to yield and quality trials, these will be screened in our white mold disease trial.

Varietal Development: The program will continue with crosses among elite lines and the best white mold resistant lines. Pedigree and single seed descent breeding methods will be used to advance and select early generation materials. While the emphasis will be on breeding for white mold resistance, we also need to continue to incorporate improved plant architecture and conduct yield and processing trials of the best lines. A replicated preliminary yield trial will be planted between May 10 and July 5. Plots will consist of a single 20-foot row from which 5-foot sections will be harvested one time or two times, two – three days apart. Lines will be evaluated for growth habit, yield and $/acre. Graded samples will be evaluated for pod smoothness, straightness, seed to pod ratio, and color. Those that meet expectations in the raw product evaluation will be canned and frozen for evaluation of the processed product. Industry panels will evaluate quality of canned and frozen samples. Where the opportunity presents, we will evaluate disease resistance. Most of the entries in this the preliminary trial are larger sieve size materials, but we have a set of extra fine to 3 sieve experimental lines that were first tested in 2017 and again in 2018. From the 15 lines trialed in 2017, 5 were advanced for testing in 2018 and three have been selected to go forward in 2019.

Advanced Lines: Seed increase, roguing, and sub-line maintenance of the historical releases will continue. Seed quality of OSU advanced lines will be quantified using germination damage tests that are standard in the industry. In short, seeds are dropped onto a steel plate, and then subjected to cold (10°C) germination tests.

PITFALLS

White mold disease can vary from year to year. However, we have managed to achieve consistent results by using fields with a high sclerotia load and managing them for enhanced infection at bloom.

3. BUDGET DETAILS (maximum 2 pages)

1) Breeding (Myers)	
Salaries and benefits	
Faculty Research Assistant	$17,150
OPE @ 69.48%	$11,916
Wages and benefits	
Student Wages	$0
OPE @11%	$0
Supplies	$500
Travel	$0
Land and greenhouse rental	$0
Total	$29,566
2) Processing Evaluation (Yorgey)	
Salaries and benefits	
Senior Faculty Research Assistant	$2,800
OPE @ 61.45%	$1,721
Wages and benefits	
Student wages	$1,575
OPE (@ 11%	$173
Supplies	$1,300
Total	$7,569
Grand Total	**$37,135**

Contributions of the OSU breeding program	
Student Wages	$8,246
OPE @ 11%	$907
Supplies	$500
Travel	$86
Land and greenhouse rental	$9,901
Total	$19,639

BUDGET NARRATIVE

Request to OPVC:
Salary and OPE is requested for a full time faculty research assistant who will commit 40% FTE to green bean breeding. A senior faculty research assistant will commit approximately 0.05 FTE to processing of entries from green bean trials; the remainder of salary to come from other sources. Undergraduate student wages of $1,575 are requested for the processing program with 11% OPE. OPE for the FRA is 69.48% and that of the SFRA is 61.45%. $500 is requested for materials and supplies for field work (includes stakes, tags, envelopes, paper bags, etc.).

Contributions of the Vegetable Breeding Program:
Undergraduate student wages of $8,246 are estimated for the breeding program with 11% OPE. An additional $500 is required to cover field and greenhouse materials and supplies expenses (fertilizer, pots, labels, stakes, tags, crossing supplies). To cover transport of samples from the farm to campus for processing, $86 is estimated. Land use rental at the OSU Vegetable Research Farm consists of five acres at $1,322 per acre and greenhouse rental of 2,123 ft^2 at $1.55 per square foot.

RESEARCH PROPOSAL TO THE AGRICULTURAL RESEARCH FOUNDATION FOR THE OREGON PROCESSED VEGETABLE COMMISSION

TITLE: Testing efficacy of innovative cultivation equipment in sweet corn and other row crops.

YEAR INITIATED: 2019-20 CURRENT YEAR: 2019-20

PERSONNEL & COOPERATORS:

Ed Peachey, OSU Vegetable Extension, Weed Science, Horticulture Department, ALS 4045, Oregon State University, Ed.Peachey@oregonstate.edu, 541-740-6712.

FUNDING REQUEST 2019-20: $8468

JUSTIFICATION

Shieldex herbicide is now labeled in sweet corn, with potential to substantially reduce weed control costs and to solve MRL problems for produce shipped to Pacific Rim markets. All of the 4-HPPD herbicides are effective, particularly when tankmixed with atrazine. But other weed control practices will be needed if atrazine is not used. Cultivation is a logical choice, particularly for producers that are growing organic.

Cultivation equipment innovation is advancing rapidly, and technology now provides the opportunity to cultivate with vision guidance and optical systems that selectively remove weeds in the row. None of these systems have been tested in the Willamette Valley, but a recent learning tour to Yuma AZ may have opened the door to evaluate this technology.

OBJECTIVES:

Test and demonstrate the potential of in-row cultivation equipment in sweet corn and other row crops in the Willamette Valley with sufficient in-row spacing.

PROCEDURES:

The main focus of this proposal is the Robovator, which has been offered by Mark Siemens of Un of AZ for testing in the Willamette Valley. He has agreed to bring this unit to Oregon and work with growers to test and demonstrate in several fields. The Robovator is unique because it digitally identifies the crop, uses small knives to remove weeds between the crop, and has a row alignment system to keep the cultivator centered on the row.

Dr. Siemens (Ag Engineer, Univ. Az, Yuma) and his assistant will be available for one week to assist with equipment setup and fine-tuning of the equipment. The budget includes 2 days of travel, and per diem for his stay. The budget also includes transportation costs. We are currently negotiating with UC Davis whether it will be possible to lease this equipment for the summer, and whether a private party can transport this machine. It will fit on a flatbed trailer and will not need an oversize permit, but the question of liability and insurance to protect the equipment remains.

ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER:

This project is continuing to explore strategies to reduce the cost of production of sweet corn, and in this case the use of innovative cultivation equipment to manage weeds in sweet corn and other row crops. This project also provides the opportunity to invite other developers of innovative equipment to come and demonstrate their equipment capabilities and compare efficacy against the robovator. We are planning a field day for all interested parties.

2019-20 BUDGET:

Wages + Benefits			
	Per Day	Days	Total
Siemens	400	4	1600
Technician	250	2	500
		Subtotal	2100
Travel			
	Per Day	Days	Total
Lodging	90	3	270
Meals	75	4	300
Plane	1	450	450
Car rental	50	3	150
Parking	4	12	48
		Subtotal	1218
Supplies	Expense	Number	
Misc. - shop	150	1	150
Robovator parts	200	1	200
		Subtotal	350
Ship Robovator	Rate - $/m	Miles	
Yuma-Corvallis	2	1200	2400
Corvallis-Yuma	2	1200	2400
		Subtotal	4800
		Total	8468

ANTICIPATED REQUESTS IN COMING YEARS (not applicable):

OTHER SUPPORT OF PROJECT: none requested

RESEARCH PROPOSAL TO THE AGRICULTURAL RESEARCH FOUNDATION FOR THE OREGON PROCESSED VEGETABLE COMMISSION

TITLE: Effect of Planting Arrangement on Snap Bean Yield

YEAR INITIATED: 2019-20 **CURRENT YEAR:** 2019-20 **TERMINATING YEAR** 2020-21

PERSONNEL & COOPERATORS:

Ed Peachey, OSU Vegetable Extension, Weed Science, Horticulture Department, ALS 4045, Oregon State University, Ed.Peachey@oregonstate.edu, 541-740-6712

FUNDING REQUEST 2019-20: $5,394 2020-21: $5,394

JUSTIFICATION:

Nonchemical weed control strategies are in short supply in snap beans, particularly strategies that target weeds within the seed row. Recent work demonstrated the limitations of propane flaming and organic herbicides for weed control in stale seedbeds. There was very little improvement in weed control with propane flame or organic herbicides, and the stale seedbed system needed to make flame useful reduced snap bean yield by nearly 10 percent.

The vegetable industry is evolving quickly, and new tools are now available to assist with in-row weed control. The Robovator uses electronic guidance to discriminate between weeds and crops and then activates a small sweep to remove weeds between plants. The Robovator effectively controls weeds in many widely spaced crops, but may not be suited for crops like snap beans unless modifications are made to the planting arrangements for snap beans.

HYPOTHESIS & OBJECTIVES:

The objective of this proposal is to measure of the effect of in-row plant arrangement on snap bean yield. We hypothesize that snap bean seeds can be aggregated into 'hills' to increase the area of access by mechanical weeders such as the robovator, and that snap bean yield will not be impacted when using these compressed in-row seed arrangements.

PROCEDURES:

Snap beans will be planted in 30 inch rows at the Vegetable Research Farm with 350 lbs 12-10-10 banded next to the row. Eleven treatments will be applied that represent reasonable plant populations in the field with between-seed spacings that provide a minimum of 6 inches between seed clumps or 'hills' (Table 1). Plots will be 15 ft long and 3 rows wide, but only the middle row will have varied plant spacings between rows. Weeds will be managed with Dual Magnum and Reflex herbicide PRE followed by Raptor and Basagran POST if needed. Snap beans will be harvested from 10 feet of each row and graded. Plant counts will also be taken.

Table 1. Effect of in row seed density (seeds/foot) and spacing between seeds on seed-free area (gray cells) in the row.

	No. seeds /foot	Spacing between seeds 0.5	0.75	1.0	Resulting plant population 30 inch rows
1	6	9.0	7.5	6.0	104544
2	7	8.5	6.75	-	121968
3	8	8.0	6.0	-	139392
4	9	7.5	-	-	156816
5	10	7.0	-	-	174240
6	11	6.5	-	-	191664
7	12	6.0	-	-	209088

ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER:

We were unable to find any references reporting this approach. If successful, new planting arrangements may pave the way for use of in-row electronically guided weeders in crops such as snap beans.

PROJECT TIMELINE: Snap beans planted in June and harvested in August.

2019-20 BUDGET:

	Year 1	Year 2
Salaries (RA 3 weeks)	2596	2596
Benefits	1843	1843
Wages		
Harvest labor	630	630
Equipment	0	0
Supplies	0	0
Travel	0	0
Plot Fees	325	325
Other	0	0
Total	5394	5394

ANTICIPATED REQUESTS IN COMING YEARS $5,394
OTHER SUPPORT OF PROJECT: none

RESEARCH PROPOSAL TO THE AGRICULTURAL RESEARCH FOUNDATION
FOR THE OREGON PROCESSED VEGETABLE COMMISSION

TITLE: **Monitoring and Reporting Insect Pests in Cole Crops and Sweet Corn (VegNet)**

YEAR INITIATED: 1996 CURRENT YEAR: 2019-20 TERMINATING YEAR: ongoing

PERSONNEL & COOPERATORS:

RESEARCH LEADER/PI: Ed Peachey
ORGANIZATION: OSU
PHONE NUMBER: 541-740-6712
E-MAIL ADDRESS: ed.peachey@oregonstate.edu

CO-PI: Jessica Green
ORGANIZATION: OSU
PHONE NUMBER: 541-737-5456
EMAIL: jessica.green@oregonstate.edu

FUNDING HISTORY **2019-20**: $19,714 2018-19 $20,392 2017-18 $20,154

JUSTIFICATION

Pest monitoring is a critical piece of integrated pest management (IPM). Rather than adhering to a calendar schedule, pest monitoring helps growers make informed spray decisions by using insect counts as part of a decision making process. This can help reduce both costs to producers as well as environmental impact of pesticides[2,3]. VegNet program is a stable and widely-used IPM resource. A recent analysis of the nearly 400 subscribers revealed many different 'user groups' including crop consultants, retail nurseries, academic researchers, and home gardeners. Additionally, VegNet is now featured as part of OSU's "Impact" initiative, which is being used to inform state legislatures on the critical work being done in agricultural extension and natural resource stewardship.

Continuation of this important crop pest monitoring program will further strengthen the long-term dataset of activity trends for the species we track. We have been approached by peer researchers and Extension agents who are interested in collaborating on a data analysis project. Properly reviewing the data and how it changes year to year could reveal patterns that could help us better predict, and therefore reduce, pest pressure for growers.

Swede midge is one of many invasive pests threatening vegetable production in the PNW. The main mode of spread is through infested broccoli and cauliflower seedlings, and it has been detected in 7 Northeastern US states and most recently, Minnesota[1]. It is also established as a canola pest in western Canada. Both adults and larvae are extremely small (1-4 mm) and larvae can jump to the soil surface when disturbed, which affects scouting. Development can occur on any weedy crucifer and there are multiple generations per year. Crop rotation out of brassicas may not be sufficient, because pupae can survive in the soil for 2 years.

Plant damage from swede midge includes twisted stems with brown corking, crumpled or draw-string leaves, abnormal meristem growth, multiple or blind heads, and fused flower petals. Some of these symptoms were noted locally in 2018. Moreover, an object resembling a midge maggot was observed upon review of video footage during a field scout of poorly-performing broccoli near Brooks. There are known to be differences in varietal susceptibility, meaning that certain cultivars may show symptoms of swede midge damage while others may not.

HYPOTHESIS & OBJECTIVES

1. Continue operation of a regional pest monitoring and reporting network for damaging crop pests including black cutworm, variegated cutworm, diamondback moth, cabbage looper, 12-spot beetle and others.

2. Conduct a preliminary survey for swede midge, an invasive crucifer pest that has been moving westward since 2015.

PROCEDURES

OBJ. 1 - Field sites will be determined according to grower cooperation and planting schedules. At each location, 'Texas cone' traps will be placed and baited with species-specific pheromone lures. Yellow sticky traps and wing traps will be used in similar fashion, depending on the crop monitored. Traps remain in place for the duration of the season or until crops are harvested. Data collection will occur for 20 weeks (May 1st to September 20th). In addition to weekly data reports, a field day will be scheduled for vegetable growers and field reps to review seasonal trends and potential implications for the following year.

OBJ. 2 – An emergence trap will be placed in the field suspected of swede midge activity last year. Existing brassica field scouting methods will be modified slightly to specifically look for adult midges on yellow sticky cards and symptoms of larvae within fields. A limited number of pheromone traps will be purchased and placed, but because this pest is not widespread, the lure is still very expensive. If larvae are suspected but not found on systematic plant tissue, the sample will be placed in a black plastic bag, placed in the sun, and re-examined 1 hour later.

ANTICIPATED BENEFITS, EXPECTED OUTCOMES, AND INFORMATION TRANSFER:

VegNet has become a relied-upon resource for many people. The short-term benefit is provision of advanced warnings of pest problems so that producers can make informed IPM decisions. Long-term benefits include: adding to a substantial dataset of research-based findings that can be used by other agencies to confirm crop pest models; and highlighting support of IPM in Oregon agriculture. If swede midge is verified, it would be easy to pursue other funding sources to fully investigate it in the near future. Information transfer with this project is concurrent - data and analyses are presented each week through an email subscription platform and a companion blog.

PROJECT TIMELINE:

- Early May – identify field sites and place traps
- May to Sept – monitor traps and send activity reports
- Early Oct – field day

LITERATURE REVIEW:

1 Chen, M., et al. .2011., *Swede Midge (Diptera: Cecidomyiidae), Ten Years of Invasion of Crucifer Crops in North America*. J.Econ.Ent. vol. 104.

2 Olsen, S., et al.. 1999. *Corn Earworm IPM Educational Program in Utah* J. of Extension, vol. 37(5).

3 Piñero, J. and K. Keay. 2018. *Farming Practices, Knowledge, and Use of Integrated Pest Management by Commercial Fruit and Vegetable Growers in Missouri*. J. of Int.Pest Mgmt. vol. 9(1).

BUDGET

	OPVC
Salaries: Faculty	$7958
Graduate student	----
Other students	----
Other labor	$4160
Employee Benefits (OPE): Faculty	$5014
Graduate student	----
Other students	----
Other labor	$332
Equipment	----
Travel: Domestic (in state)	$1440
Domestic (out of state)	----
Foreign (conferences, etc.)	----
Operating Expenses [1]	$810
Other Expenses [2]	----
Total	**$19,714**

ANTICIPATED REQUESTS IN COMING YEARS est. $20, 000/year

PROPOSAL TO THE OREGON PROCESSED VEGETABLE COMMISSION (2019)

1. OPVC PROPOSAL COVER PAGE

PROJECT TITLE: Funding for part-time FTE for Brian Yorgey to overlap with new Food Science berry and vegetable processing and evaluation hire

PROPOSED PROJECT DURATION: 1 year only

BUDGET TOTALS
TOTAL BUDGET REQUEST (all years): **$1500**

PI: Brian Yorgey
Organization: Food Science & Technology, Oregon State University
Telephone: 541-737-6496
Email: brian.yorgey@oregonstate.edu

Cooperators: Jim Myers, Horticulture, OSU

2. PROPOSAL NARRATIVE

JUSTIFICATION

I started working at OSU in 1985 in the Experimental Winery. In the summers of 1989 and 1990 I worked with Professor George Varseveld in the Berry and Vegetable Variety Evaluation program in addition to my winery work. Professor Varseveld intended to retire (which he did in 1991) and wanted to make sure there would be someone who could continue with the processing and evaluation of the new selections of berries and vegetables that were coming out of the OSU and USDA breeding programs. This has been my program since 1991.

I retired on April 1, 2017 but due to lack of foresight and planning by my superior, the search for my replacement didn't start until July and no one was hired until December. Through the summer of 2017, I continued the work as best as I could though the uncertainty surrounding the position made it extremely difficult. The person who was eventually hired was qualified and could have handled the job. However, his fiancée was a grad student in the beer/fermentation program in our department who decided in late spring of 2018 that she didn't want to continue in the graduate program for her PhD; so she finished up her Masters degree and got a job with Cornell University Cooperative Extension in New York. My replacement quit at the beginning of June and they left town. I continued the berry and vegetable processing and evaluation work through the summer on my own on a part time appointment. A second search was started in late summer and my new replacement is slated to start January 28th. Yay.

I continue to work because I care about this program and think it is invaluable to the breeding effort. I still want to make sure that whoever gets hired to take over this work has all the information and insight possible so that he or she will be ready to continue this critical piece of these research programs for the benefit of our Oregon growers and processors.

The only way I see that happening is for me to work part time along with the new person through one complete annual cycle. Over the last two years I asked the Blueberry Commission, the Strawberry Commission, the Raspberry and Blackberry Commission, and the Processed Vegetable Commission to all chip in for supporting me during this overlap period. (I am also leaning on the Food Science Department to chip in.) I have enough funding left to cover my part time salary (30%) through July 1. I'm not happy about having to ask you for more help but I still need funding for the last six months of 2019. I think I can wrap it all up by the end of December.

I can make this work with 30% FTE (Full Time Equivalent) for six months. This breaks down to a day and a half a week. There will be times when I will be working a lot and times when I won't need to be around. The total cost is around $9K. I'm asking each of the commissions I work with for half the amount of the last round. I want to do everything I can to make sure that this transition goes as well as possible. It has been a great pleasure working with you and I love my job. I want to pass that love on as well.

OBJECTIVE

To provide funding so that I can work part-time through the next year after I retire so that I can seamlessly hand off my knowledge and expertise to the new person taking over my position.

3. BUDGET DETAILS

This project will be for one year only.

Proposed Budget:

Senior Faculty Research Assistant	$ 1368
OPE	132
Total	1500

BUDGET NARRATIVE

This budget assumes that my position will be funded at 0.3 FTE for 6 months. The actual amount will depend on the total funding raised. The overhead (OPE) is low (as a percentage) due to the fact that I will be paying for my medical insurance.

Oregon Processed Vegetable Commission

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