SUBCOMMITTEE MEETING NOTICE

The BCTVCB Diagnostics Subcommittee will hold a Meeting on

Tuesday, February 10, 2026 at 9:30 a.m.

California Department of Food and Agriculture
Integrated Pest Control Branch, Fresno Office
2895 N. Larkin Ave, Suite A
Fresno, CA 93727

GoTo Meeting Information:
https://meet.goto.com/604491773
You can also dial in using your phone.
Access Code: 604-491-773
United States: +1 (872) 240-3311

PUBLIC PARTICIPATION

Members of the public are encouraged to provide comment to the Subcommittee and may suggest items to be placed on the agenda for discussion at the next Subcommittee meeting. While the Subcommittee values the participation of the public, the Subcommittee Chair reserves the right to limit the time for public comment to three minutes per commentator. Public comment must be related to the Subcommittee's authority and jurisdiction and its placement on the agenda is within the discretion of the Subcommittee Chair.

All matters noticed on this agenda may be considered for recommendation to the full Board. Items listed on the agenda may be considered in any order at the discretion of the Subcommittee Chair. Any item not so noticed will not be considered or discussed. Each of the agenda items may include discussion and possible recommendation to the full Board by the Subcommittee. Time will be allowed for members of the public to make comments on each agenda item. All meeting agendas and notices are available on the California Department of Food and Agriculture website at: https://www.cdfa.ca.gov/plant/meetings/

For further information, please contact Kendra Tapia, Environmental Scientist, Integrated Pest Control Branch, 2895 N. Larkin Suite A, Fresno, CA 93727. (916) 823-1169.

AMERICAN WITH DISABILITIES ACT

All Subcommittee meetings must be accessible to the physically disabled. Any person needing a disability-related accommodation or modification in order to attend or participate in any Subcommittee or Committee meeting or other Subcommittee activity may request assistance by contacting Kaitlyn Beames at (559) 294-2031. Providing your request at least five (5) business days before the meeting will help ensure availability of the requested accommodation.

California Department of Food and Agriculture
BCTVCB Diagnostics Subcommittee

SUBCOMMITTEE MEETING AGENDA
Tuesday, February 10, 2026 at 9:30 a.m.

California Department of Food and Agriculture
Integrated Pest Control Branch, Fresno Office
2895 N. Larkin Ave, Suite A
Fresno, CA 93727

GoTo Meeting Information:
https://meet.goto.com/604491773
You can also dial in using your phone.
Access Code: 604-491-773
United States: +1 (872) 240-3311

All matters noticed on this agenda may be considered for recommendation to the full Board. Items listed on the agenda may be considered in any order at the discretion of the Subcommittee Chair. Any item not so noticed will not be considered or discussed. Each of the agenda items may include discussion and possible recommendation to the full Board by the Subcommittee. Time will be allowed for members of the public to make comments on each agenda item. All meeting agendas and notices are available on the California Department of Food and Agriculture website at: https://www.cdfa.ca.gov/plant/meetings/

1. **Call to Order/Introductions**
2. **Roll Call**
3. **BCTV Past Trends**
4. **California's Changing Landscape: Impacts on Spread of BCTV**
5. **CTV Program Current Research and Scope 2023**
6. **Public Comments on Matters Not on the Agenda**
7. **Agenda Items for Future Meetings**
8. **Adjourn**

AMERICAN WITH DISABILITIES ACT

Persons needing a disability-related accommodation or modification in order to attend or participate in any Subcommittee or Committee meeting or other Subcommittee activity may request assistance by contacting Kaitlyn Beames at (559) 294-2031. Providing your request at least five (5) business days before the meeting will help ensure availability of the requested accommodation.

Evaluation of Reduced-Risk Insecticides for the Management of Beet Leafhopper

California Department of Food and Agriculture Grant Proposal

A. Cover Sheet

1	Project Title	Reduced Risk Insecticides for Management of Beet Leafhopper and Curly Top Virus
2	Project Leaders	Dr. Erik J. Wenninger University of Idaho 3806 N 3600 E, Kimberly, ID 83341-5082 Phone: 208-423-6677 Email: erikw@uidaho.edu
		Dr. Alexander V. Karasev University of Idaho 604 S. Rayburn St., Moscow, ID 83844 Phone: 208-885-2350 Email: akarasev@uidaho.edu
		Dr. Rajtilak Majumdar USDA-ARS 3793 N 3600 E, Kimberly, ID 83341-5076 Phone: 208-423-6517 Email: raj.majumdar@usda.gov
3	Cooperators	
4	Funding Request	$189,043.43
5	Agreement Manager	Office of Sponsored Programs Sarah Martonick 875 Perimeter Drive MS 3020, Moscow, ID 83843-3020 Phone: 208-885-6651 Email: osp@uidaho.edu

Evaluation of Reduced-Risk Insecticides for the Management of Beet Leafhopper

B. Executive Summary:

Beet curly top virus (BCTV), belonging to the family Geminiviridae, causes a serious disease, curly top, in a wide variety of crops in Western states including sugar beet (*Beta vulgaris* L.), common bean (*Phaseolus vulgaris* L.), tomato (*Solanum lycopersicum*), spinach (*Spinacia oleracea*), pepper (*Capsicum* spp.), melons (*Cucumis melo*), hemp (*Cannabis sativa*), and others (Chen et al. 2009, 2014; Creamer 2020; Creamer et al. 2007; Melgarejo et al. 2022, 2024; Strausbaugh et al., 2024a). BCTV exists as a complex of several distinct strains and multiple recombinants; these strains circulate in different crops in Western U.S. and strain composition was shown to evolve over time (Stenger 1996; Strausbaugh et al. 2008, 2017; Rondon et al. 2016). The virus is transmitted exclusively by the beet leafhopper (BLH, *Circulifer tenellus*) which often acquires the virus when feeding on weedy species near agricultural areas (Strausbaugh et al. 2024a). Chemical management of BCTV targets the insect vector; however, the insecticides used to manage beet leafhoppers are increasingly threatened by regulation, negative public perception, and undesirable non-target effects (Beaumelle et al. 2023; Goulson 2013; Reynolds 2013). Thus, there is a need to develop alternatives and supplements to current chemical management strategies.

This proposal addresses this need by systematically testing reduced risk alternatives and supplements to current broad-spectrum BLH management programs. Our team brings over 15 years of experience conducting trials seeking effective and economical alternatives to broad-spectrum BLH treatment programs, monitoring BCTV incidence and strain composition in BLH, and extensive background data to inform this study. Recent preliminary studies conducted by our group have identified reduced-risk and biologically based compounds that show promise as potential alternatives or supplements to conventional insecticide programs. The proposed project features more extensive evaluation of these promising alternatives, including large field trials examining control of BCTV and BLH and preservation of beneficial arthropods that contribute to BLH control. This study would also entail comparison of effects of conventional insecticides and promising alternatives on key arthropods aside from BLH. Effects of treatments on beneficial insects would be quantified across conventional and reduced-risk treatments to test the hypothesis that alternatives to conventional insecticides preserve predatory arthropods that can contribute to BLH control. BLH populations in non-inoculated plots will also be sampled to examine the interplay among resident BLH, treatments, and conserved beneficials. Furthermore, effects on pests other than BLH will be measured to predict potential pest resurgence that may occur if CDFA were to move away from current management practices that likely suppress multiple pest arthropods aside from BLH.

Our approach will use replicated field trials to compare different insecticide treatments with respect to 1) control of BCTV, 2) control of BLH, 3) protection of crop yield, and 4) effects on non-target arthropods, especially beneficial predators. Studies will be conducted in a susceptible crop, sugar beet. Candidate treatments have been selected through extensive preliminary screening (Majumdar et al. 2025; Strausbaugh et al. 2024b). Promising alternative insecticidal treatments our team has found for BLH management include the insect growth regulator Applaud (buprofezin), the biopesticide SpearT (derived from spider venom peptides), as well as jasmonates (plant defense signaling compounds), which are known to recruit beneficial arthropods and potentially improve plant resistance to insect feeding (Thaler 1999, 2002; Bruce et al. 2003). Treatments will be tested alone and in combination, and their performance will be benchmarked against the current foliar standards used in the California foothills (malathion) and in our sugar beet trials (the pyrethroid esfenvalerate [Asana]) as well as an

untreated control. Each treatment will be tested in replicated plots of at least 25 feet in length, with a minimum of six replicates per treatment. Agronomic practices will follow standard local guidelines for sugar beet fertilization, irrigation, and weed control. To fully address these research questions, we will evaluate all products in two sets of plots: one set that is inoculated with viruliferous BLH and one that is not. Plots to measure effects of insecticides on BCTV and BLH will be 4 rows wide and will be artificially inoculated with viruliferous BLH from a greenhouse-maintained colony. Trials to measure effects of insecticides on beneficial and non-target arthropods will be at least 12 rows wide and will not be inoculated with viruliferous BLH given that high virus pressure severely diminishes plant vigor and suppresses overall insect abundance. Following treatment, arthropods (beneficials, BLH, and other pests) will be sampled using a vacuum sampling device to assess changes in abundance and richness following Wenninger et al. 2024.

Evaluation will focus on several criteria critical to the program's mission. First, treatments must demonstrate efficacy similar to that of the current standards in suppressing BLH populations and preventing BCTV incidence in a susceptible crop. Second, treatments will be evaluated for their compatibility with non-target arthropods, especially beneficial insects. Third, treatments will be analyzed for practicality of adoption, including ease of use, compatibility with existing Beet Curly Top Virus Control Program (BCTVCP) operations, and potential costs relative to current standards. If successful, the project will produce clear, evidence-based recommendations for reduced-risk insecticides and combinations that can immediately be considered for use in the BCTVCP as well as in curly top susceptible crops in California.

The primary beneficiaries of this work will be the California growers of susceptible crops, who will gain access to practical alternatives that reduce reliance on broad-spectrum insecticides. Pest control advisors, researchers, and policymakers will also benefit from the knowledge generated, as it will provide a scientific basis for transitioning to safer pest management practices while maintaining effective control of BCTV. Importantly, this project will help safeguard the long-term sustainability of the program by diversifying its toolbox and addressing growing demands for reduced environmental and human health risks from pesticide use, which provides broad benefits to producers as well as the public.

In summary, this project will evaluate a suite of reduced-risk insecticides and biologically based treatments to identify sustainable alternatives for BLH management, informed by more than a decade of preliminary data and expertise. By rigorously testing Applaud, SpearT, jasmonates, and their combinations against current standards, and by assessing suppression of virus and leafhoppers as well as promotion of beneficial arthropod communities, we aim to provide the BCTVCP with options for reducing reliance on broad-spectrum insecticides while supporting biological control of leafhoppers and other pests. The integration of these alternatives has the potential to reduce the potential environmental and human health risks of BCTV management, protect beneficial insect communities, all while continuing to protect California's most vulnerable cropping systems and building the programs resilience to regulatory changes surrounding broad spectrum insecticides.

C. Justification.

1. BCTVCP Mission and Research Priorities

This project directly supports the mission of the California Department of Food and

Agriculture's BCTVCP to advance the environmentally safe and agronomically sound use of insecticide materials for the control of BCTV. The proposed research addresses the program's stated priority to identify and evaluate less toxic alternatives to broad-spectrum insecticides currently used to manage BLH, the sole vector of BCTV.

At present, the BCTVCP relies heavily on malathion applications to control BLH populations on non-cultivated lands adjacent to susceptible crops. While this approach has effectively reduced curly top incidence, concerns about human and environmental safety, non-target impacts, and potential regulatory restrictions create a need to develop alternative strategies. This project will evaluate a suite of reduced-risk and biologically based compounds that have shown promise in our pilot studies. We will also address potential effects of different insecticides on strain composition of BCTV in specific crops, since effects of these compounds on plant defense systems are not well-understood and could play important roles in disease spread.

By systematically comparing the efficacy of these alternatives in controlling BLH and reducing curly top severity, this project will generate data that can guide the BCTVCP toward adopting management approaches that balance effectiveness with environmental stewardship. This research also supports the program's goal of ensuring sustainable control strategies for California's diverse cropping systems while minimizing risks to pollinators, beneficial insects, and nearby natural ecosystems.

2. Impact

Beet curly top virus continues to cause serious economic losses in a variety of susceptible specialty crops in California and other Western states. Curly top outbreaks can result in complete crop loss when infections occur early in the growing season, leading to substantial financial impacts for growers and processors. Curly top has the potential to cause economic loss in sugar beet (Strausbaugh et al. 2007), tomato (Chen et al. 2016), basil (Chen et al. 2014), hemp (Melgarejo et al. 2022), chili pepper (Creamer et al. 2007) and can cause losses of up to 66% in melon (Flock et al. 1960). The proposed research will provide both agronomic and economic benefits by identifying safer and cost-effective insecticide options that maintain or improve BCTV control efficacy.

This project addresses one of the most pressing environmental concerns associated with current BCTVCP practices: non-target impacts of broad-spectrum insecticides. By testing compounds that have shown promise in our previous trials, including Applaud (an insect growth regulator), SpearT (a biologically derived biopesticide), and jasmonates (plant defense signaling compounds), this work will generate comprehensive data on treatments with inherently reduced toxicity profiles. These alternatives are expected to better conserve natural enemies, reduce pest resurgence, and align with integrated pest management principles. Reducing reliance on broad-spectrum insecticides responds to consumer and public concerns about pesticide safety, while supporting a program of longstanding importance to California agriculture.

Statewide, this research will strengthen the sustainability of California's BCTV management infrastructure by providing field-validated data on alternatives that could be integrated into the BCTVCP's control strategy. Results will also inform growers directly affected by curly top and support integrated pest management education programs across regions where beet leafhopper pressure is high.

3. Long-Term Solutions

The long-term goal of this work is to develop a pest management framework that maintains control of BCTV while reducing reliance on broad-spectrum insecticides and increasing the program's resilience to changing regulatory environment, changing levels of pest resistance, and changing public perception. The identification of effective reduced-risk products—either as stand-alone treatments or in combination with conventional chemistries—offers a pathway toward durable and sustainable management solutions. If proven effective, compounds such as jasmonates may provide dual benefits: enhancing plant resistance to infection and promoting recruitment of natural enemies (Thaler 1999; Bruce et al. 2003). Integrating these biologically compatible approaches with selective insecticides like Applaud and SpearT could significantly lower the environmental footprint of BCTV management while maintaining agronomic performance.

Results from this project could enable CDFA and regional growers to phase out the use of high-toxicity, broad-spectrum compounds, achieving measurable progress toward safer, more integrated pest control strategies. These compounds are already registered for use in California and other states in a variety of susceptible crops. For example, Applaud is registered for use in cucurbits, snap bean, and tomato, and SpearT is registered for use in cucurbits, tomatoes, and several types of beans and peas.

4. Related Research

Beet curly top virus has been a persistent threat to irrigated crops in the Western United States for over a century (Bennett 1971; LF Chen et al. 2009; Strausbaugh et al. 2008), and changes in the climate may lead to even more severe impact (Melgarejo et al. 2024). Management has traditionally depended on insecticidal suppression of BLH populations both within crops and in surrounding rangeland habitats (Creamer 2020). Current BLH management relies primarily on neonicotinoid, pyrethroid, and organophosphate insecticides, which provide strong protection (Kaffka et al. 2002; Strausbaugh et al. 2016). However, insecticide application timing remains a challenge due to year-to-year variability in leafhopper emergence and dispersal patterns (Murphy et al. 2012; Strausbaugh et al. 2024a). Our research group and collaborators have conducted over a decade of trials assessing BCTV control in sugar beet under a range of insecticide regimes, always with the aim to find reduced-risk alternatives with efficacy matching current management tools. Preliminary results are promising for the compounds proposed as treatments here. SpearT and Applaud showed efficacy approaching that of conventional insecticides, and jasmonate applications have been shown to reduce curly top incidence and increase sugar yield when used in combination with traditional insecticides (Fugate et al. 2016; Strausbaugh et al. 2024b)

Insect growth regulators such as Applaud (Echegaray et al. 2012; Van Driesche et al. 2001) and biopesticides like SpearT (Miranda et al. 2024; Powell et al. 2020) have demonstrated selectivity and compatibility with many beneficial insects, though more work is needed to clarify effects on predators that may be important for BLH management. Nevertheless, this collective body of work provides a strong scientific foundation and practical rationale for the proposed evaluation of reduced-risk insecticides under California field conditions. Jasmonates, which are plant hormones, also show promise as reduced risk tools for insect pest management. Studies in multiple crops also indicate that jasmonates, both when endogenous and exogenously applied, can enhance plant resistance to a wide variety of pests and stressors (Bruce et al. 2003; Dar et al. 2015; Thaler et al. 2004). Jasmonates may also promote secondary plant protection by increasing recruitment of natural enemies (Mrazova et al.

2018; Thaler 1999, 2002). This also translates directly to yield in many studies where exogenous methyl jasmonate application has reduced viral disease severity while improving yield (Awang et al. 2015; Cao et al. 2008; Fugate et al. 2016). Together, this literature provides strong support for testing jasmonates as a component of reduced-risk BLH and curly top management.

Our preliminary data also show that jasmonates, when used in combination with conventional insecticides, can reduce curly top incidence and increase beet yield, suggesting they may enhance efficacy or extend the duration of control (Strausbaugh et al. 2016; Strausbaugh et al. 2024b). Similarly, insect growth regulators such as Applaud (buprofezin) and novel biologically based insecticides such as SpearT have demonstrated activity against hemipteran pests, including leafhoppers, in preliminary trials (Strausbaugh et al. 2024b; Majumdar et al. 2025). These compounds are less disruptive to natural enemies than broad-spectrum insecticides and represent realistic candidates for BCTVCP to consider.

5. Contribution to Knowledge Base

Despite decades of experience managing beet curly top, critical gaps remain in our understanding of how reduced-risk insecticides and many biologically based products perform under field conditions against BLH and BCTV. While conventional insecticides continue to provide reliable control, their uncertain regulatory future and undesirable non-target effects necessitate research on alternatives. While biologically based products, including those showing promise for BLH control, are expected to have reduced impacts on beneficial insects, this remains largely understudied in the field. Similarly, there is little known about how non-BLH pests may respond to these more targeted treatments, creating uncertainty about potential secondary pest outbreaks that could occur when growers transition away from broad-spectrum insecticide applications.

This project will make several key contributions to the current knowledge base on BCTV management and sustainable pest control. First, it will provide a robust, well-replicated field comparison of multiple reduced-risk insecticide classes within a BCTV pathosystem.

Second, it will quantify the trade-offs among virus suppression, pest control, and impacts on beneficial insects under field conditions. This project will generate novel data on how these treatments shape arthropod communities, providing essential information for integrated pest management programs. Quantifying the impact on beneficials will allow for the selection of the treatment that would best conserve natural enemies, pollinators, and other non-target arthropods. Additionally, evaluating the response of other arthropod pests to these biologically based alternatives is critical, as current broad-spectrum applications may incidentally suppress other pest species. Reducing this suppression could allow secondary pest populations to rebound, potentially creating new management challenges.

Third, the integration of jasmonates into these trials will advance understanding of their role in enhancing resistance and potential synergism with other control tactics. Previous research demonstrates jasmonates can increase yield and induce plant defenses (Fugate et al. 2016; Strausbaugh et al. 2024b; Majumdar et al. 2025), their ability to enhance natural enemy activity in sugar beet remains unstudied. By testing jasmonates alone and in combination, this project will provide mechanistic insights into their function as enhancers of reduced-risk insecticides and as recruitment tools for beneficial predators.

These outcomes will generate practical and novel information on the compatibility of reduced-risk products with existing BCTVCP control methods, offering data-driven guidance for potential program adoption. Results will be disseminated through extension bulletins, grower field days, and scientific publications, providing valuable resources for both the BCTVCP and the broader agricultural community.

6. Grower Use

Growers and pest control advisors in BCTV-affected regions are increasingly seeking effective pest management tools that are compatible with sustainability goals, cost restrictions, and regulatory constraints. The products evaluated in this project—including Applaud, SpearT, and jasmonates—are already registered for use in numerous crops in California. Their reduced risk profiles should facilitate registration for use in foothills and other non-crop sources of BLH in California.

By identifying effective and environmentally safer options that maintain control of beet leafhopper and BCTV, this project will provide immediate practical applications for California growers and direct benefits to the BCTVCP. Field demonstrations and outreach activities will facilitate adoption by showing comparative performance, cost considerations, and compatibility with standard production practices. Ultimately, the data generated will empower growers to make informed pest management decisions that reduce risks associated with broad-spectrum insecticides while maintaining profitability and crop health. Demonstrating the efficacy of reduced-risk alternatives in suppressing BLH and curly top will make these tools more likely to be adopted, especially if they also support beneficial arthropods and reduce secondary pest outbreaks. Dissemination of results through extension outlets, grower meetings, and peer-reviewed publications will ensure broad reach.

D. Objectives

The goal of the proposed project is to evaluate reduced-risk insecticides as alternatives and supplements to conventional chemistries for the management of BLH and prevention of the spread of BCTV. By assessing efficacy against BCTV and BLH this project aims to identify strategies that reduce reliance on broad-spectrum insecticides while maintaining crop protection. Furthermore, this study will quantify the impact of alternative treatments on both beneficial arthropods as well as pests other than BLH. This will provide novel insight on the broader impacts on agriculturally relevant arthropod species and potential shifts in relevant species for producers should alternative insecticides be used by the BCTVCP. Listed below are the specific objectives of this project:

Inoculated plots:

1. Compare effects of reduced-risk insecticides and conventional insecticides on severity of beet curly top virus, yield, and quality in sugar beet

Non-inoculated plots:

2. Compare effects of reduced-risk insecticides and conventional insecticides on abundance and richness of beneficial, predatory insects
3. Compare effects of reduced-risk insecticides and conventional insecticides on densities of beet leafhoppers and other select arthropod pests

These objectives focus on evaluating reduced-risk chemistries under field conditions and determining their potential as replacements or supplements to current standards for BCTV management by the BCTVCP. By incorporating both crop protection efficacy and non-target arthropod assessments, the project will generate information critical to advancing sustainable pest management strategies. Findings will contribute to the development of management practices that reduce environmental risk, maintain effectiveness against BCTV, and preserve beneficial insect activity, supporting long-term agricultural resilience in California's production systems susceptible to BCTV.

E. Work Plans and Methods

1. Work Plan (to be repeated each year)

Task 1. Establishment of Field Trials (Objectives 1, 2, and 3)

- Design: Field trials will be conducted at the USDA-ARS Farm in Kimberly, Idaho, using a commercial sugar beet cultivar with low or moderate resistance to curly top disease. Treatments will be arranged in a randomized complete block design with at least six replications. Each plot will be at least 25 ft long with 22-in row spacing. Four-row plots will be used for Objective 1 (BCTV severity), and 12-row plots will be used for Objectives 2 and 3 (beneficial and pest populations).
- Activities:
  - Field site preparation: Site preparation and maintenance, including tillage, fertility, planting, irrigation, and weed management will follow standard production practices outlined in the 2025 Sugar Beet Grower's Guide Book (Amalgamated Sugar Co. LLC, Boise, ID), with planting occurring in April.
  - Initial insect counts: Initial insect counts will be taken in May, before application of insecticide treatments using methods described in (Wenninger et al. 2024).
- Deliverables: Established field plots by June with uniform plant emergence and growth, and initial insect counts taken.

Task 2. Application of Insecticide Treatments and Inoculation (Objectives 1, 2, and 3)

- Activities:
  - Foliar treatments: To both inoculated and non-inoculated plots, foliar treatments will be applied at least once, approximately one week prior to inoculation with viruliferous BLH (in inoculated plots).
  - Inoculation: Plants in inoculated plots will be inoculated at the eight-leaf stage using approximately six BLH per plant from a colony testing positive for BCTV (Strausbaugh et al. 2021).
- Deliverable: All treatments applied and inoculation completed by late June.

Task 3. Arthropod Sampling and Monitoring (Objectives 2 and 3)

- Activities:
  - Beneficial sampling: To evaluate the impacts of treatments on beneficial insects, vacuum sampling will be conducted in the non-inoculated plots. Beneficial arthropods (predators and parasitoids) will be sampled at least twice after insecticide applications by following (Wenninger et al. 2024).
  - BLH sampling: To evaluate the effects of treatments on BLH, vacuum sampling will be conducted in both inoculated and non-inoculated plots at weekly intervals after treatment by vacuum sampling Wenninger et al. (2024).

  - Other pest sampling: To evaluate the impact of treatments on other insect pests, additional sampling will occur in non-inoculated plots at weekly intervals after treatment as described in (E. Wenninger et al., 2019). Pests sampled will include beet leafminer flies, black bean aphids, Lygus bugs, and—shortly before harvest—sugar beet root aphids.
- Deliverable: Weekly pest density datasets and at least two post-treatment beneficial insect datasets per plot.

Task 4. Disease Rating and Yield Assessment (Objective 1)

- Activities:
  - Disease rating: Inoculated plots will be rated twice during August for foliar BCTV symptom development (*Plant Dis.* 90:1539–1544; Wenninger et al. 2019).
  - Prior to disease rating, 10-20 randomly collected leaves/plants per plot will be tested for BCTV using previously published method (Durrin et al. 2010). All BCTV-positive plants will be typed to strain using methodology described by Strausbaugh et al. (2008, 2017).
  - Harvest: The center two rows of each plot (both inoculated and non-inoculated) will be defoliated and harvested in September using a small-plot harvester.
  - Yield Evaluation: Two eight-beet subsamples from each plot will be collected and submitted to the Amalgamated Sugar Co. Tare Lab (Paul, ID) for sucrose and estimated recoverable sucrose (ERS) analysis.
- Deliverable: Curly top severity ratings, yield data, and sucrose content data compiled by October.

Task 5. Data Analysis and Reporting

- Activities:
  - Collected data will be subjected to statistical analysis to evaluate treatment efficacy and non-target effects. A comprehensive summary report will be prepared for the BCTVCP, detailing treatment comparisons and recommendations.
- Deliverable: One year of data and associated progress report by February. Final dataset in year 2 including statistical summaries, and final report submitted to BCTVCP by February.

2. Methods

Objectives 1–3 will be addressed with a field study designed to evaluate the efficacy and non-target impacts of reduced-risk insecticides in sugar beet production. Field trials will be conducted using a sugar beet variety with low to moderate resistance to curly top disease. Tillage, planting, fertility, irrigation, and disease and weed management practices will follow recommendations from the 2025 Sugar Beet Grower's Guide Book (Amalgamated Sugar Co. LLC, Boise, ID). Row spacing will be 22-in. Treatments will be arranged in a randomized complete block design with at least 6 replications. Plot lengths will be at least 25 ft long. For objective 1, which focuses on BCTV severity, 4-row plots will be used. For objectives 2 and 3, which focuses on effects of treatments on non-target arthropods, treatments will be arranged in 12-row plots to account for potential dispersal of beneficial arthropods among plots. Treatments will be applied as foliar sprays at least once, with the final foliar application occurring approximately one week prior to inoculation with viruliferous BLH. Plants will be inoculated at the eight-leaf growth stage using approximately six BLH per plant from a colony testing positive for BCTV (Strausbaugh et al. 2021).

Up to ten treatments will be evaluated, including foliar applications of reduced risk insecticides (alone and in combination) or conventional insecticides: (1) Non-treated check, (2) Asana (foliar pyrethroid standard), (3) Malathion (organophosphate currently in use in California), (4) Applaud (insect growth regulator), (5) SpearT (biopesticide derived from spider venom), (6) Applaud + SpearT,

(7) Jasmonates + Applaud, (8) Jasmonates + SpearT, and (9) Jasmonates + Applaud + SpearT. The application rate of each product will be the highest label rate, and the doses of jasmonates will be the same as earlier reported in Strausbaugh et al. (2024b).

For the non-inoculated plots—prior to foliar applications of insecticides and at regular intervals thereafter—several insect pests of sugar beet will be sampled using methods described by (Wenninger et al., 2019). Pests sampled will include beet leafminer flies, black bean aphids, Lygus bugs, and—shortly before harvest—sugar beet root aphids. In addition, at least twice after applications, beneficial insects in the foliage will be collected by vacuum samples as described by Wenninger et al., 2020. BLH will also be sampled via vacuum sampling in both non-inoculated and inoculated plots. All collected insects will be returned to the laboratory for identification to the lowest taxonomic resolution possible.

Plots will be rated for foliar BCTV symptom development using an established scale and sugar yield will be assessed using established protocols (Wenninger et al. 2019; Plant Dis. 90:1539-1544). BCTV ratings and yield metrics will serve as proxies for efficacy against BLH and viral transmission. In addition, prior to disease rating, 10-20 randomly collected leaves/plants per plot will be tested for BCTV using previously published method (Durrin et al. 2010). All BCTV-positive plants will be typed to strain using methodology described by Strausbaugh et al. (2008, 2017). Data will be analyzed using the generalized linear model procedure and Fisher's protected least significant difference (LSD; $\alpha = 0.05$) will be used for mean comparisons or with repeated measures analyses and/or nonparametric methods as necessary.

3. Experimental Site

The field trial will be conducted at the USDA-ARS farm near Kimberly, Idaho. This site has been in use for large sugar beet field trials for decades and offers uniform silt loam soils typical of sugar beet production areas in the Snake River Plain. The region is a representative environment for curly top outbreaks and supports reliable populations of common insect pests of sugar beet as well as a diversity of natural enemies.

References

Awang NA, et al. 2015. Comparative study of the application of jasmonic acid and pesticide in chili: effects on physiological activities, yield and viruses control. *Biosci. J.* 31:672–681.

Beaumelle L, et al. 2023. Pesticide effects on soil fauna communities—a meta-analysis. *J. Appl. Ecol.* 60:1239–1253.

Bennett CW. 1971. The Curly Top Disease of Sugarbeet and Other Plants. *Am. Phytopathol. Soc.* 7.

Bruce TJA, et al. 2003. cis-Jasmone treatment induces resistance in wheat plants against the grain aphid, *Sitobion avenae* (Fabricius) (Homoptera: Aphididae). *Pest Manag. Sci.* 59:1031–1036.

Cao S, et al. 2008. Effect of methyl jasmonate on the inhibition of *Colletotrichum acutatum* infection in loquat fruit and the possible mechanisms. *Postharvest Biol. Technol*. 49:301–307.

Chen LF, et al. 2009. Characterization of curtoviruses associated with curly top disease of tomato in California and monitoring for these viruses in beet leafhoppers. *Plant Dis.* 94:99–108.

Chen LF, et al. 2014. First report of curly top disease of basil caused by Beet severe curly top virus in California. *Plant Dis.* 98:286.

Chen LF, et al. 2016. Transmission of curtoviruses (Beet curly top virus) by the beet leafhopper (*Circulifer tenellus*). In: Brown JK, ed. Vector-Mediated Transmission of Plant Pathogens. *Am. Phytopathol. Soc*. p. 243–262.

Creamer R. 2020. Beet curly top virus transmission, epidemiology, and management. In: Awasthi LP, ed. Applied Plant Virology: Advances, Detection, and Antiviral Strategies. *Academic Press*. p. 521–527.

Creamer R, et al. 2007. Curtovirus infection of chile pepper in New Mexico. *Plant Dis*. 89:480–486.

Dar TA, et al. 2015. Jasmonates counter plant stress: a review. *Environ. Exp. Bot*. 115:49–57.

Durrin JS, et al. 2010. Immunodetection of two curtoviruses infecting sugar beet. *Plant Dis.* 94: 972-976.

Echegaray ER, et al. 2012. Effects of reduced-risk pesticides and plant growth regulators on rove beetle (Coleoptera: Staphylinidae) adults. *J. Econ. Entomol*. 105:2097–2106.

Flock R, et al. 1960. Loss caused by late infection of cantaloupes by the curly top virus. *Phytopathology*. 50.

Fugate K, et al. 2016. Effect of methyl jasmonate, salicylic acid, headline and stadium on sucrose yield and storage properties. *Sugarbeet Res. Ext. Rep*. 46:73–76.

Goulson D. 2013. An overview of the environmental risks posed by neonicotinoid insecticides. *J. Appl. Ecol*. 50:977–987.

Kaffka SR, et al. 2002. Comparisons of soil and seed applied systemic insecticides to control beet curly top virus in the San Joaquin Valley. *J. Sugarbeet Res*. 39:59–74.

Majumdar R, et al. 2025. Foliar and seed treatment products for the control of beet curly top in Idaho sugar beet, 2024. *Plant Dis. Manag. Rep*. 26:440.

Melgarejo TA, et al. 2024. Unusual outbreaks of curly top disease in processing tomato fields in northern California in 2021 and 2022 were caused by a rare strain of Beet curly top virus and facilitated by extreme weather events. *Virology*. 591:109981.

Melgarejo TA, et al. 2022. Curly top disease of hemp (*Cannabis sativa*) in California is caused by mild-type strains of Beet curly top virus often in mixed infection. *Plant Dis*. 106:3022–3026.

Miranda MP, et al. 2024. Spider venom neurotoxin-based bioinsecticides: a novel bioactive for the control of the Asian citrus psyllid *Diaphorina citri* (Hemiptera). *Toxicon*. 239:107616.

Mrazova A, et al. 2018. Application of methyl jasmonate to grey willow (Salix cinerea) attracts insectivorous birds in nature. *Arthropod-Plant Interact*. 12:1–8.

Murphy AF, et al. 2012. Population dynamics of the beet leafhopper (Hemiptera: Cicadellidae) in the Columbia Basin as influenced by abiotic variables. *Environ. Entomol*. 41:768–775.

Powell ME, et al. 2020. Demonstrating the potential of a novel spider venom-based biopesticide for target-specific control of the small hive beetle, a serious pest of the European honeybee. *J. Pest Sci*. 93:391–402.

Reynolds D. 2013. EPA toughens requirements for neonicotinoid use to protect bees. *JSTOR*. 20:1–11.

Rondon SI, et al. 2016. Characterization of beet curly top virus strains circulating in beet leafhoppers (Hemiptera: Cicadellidae) in northeastern Oregon. *Plant Dis.* 100:1586-1590.

Stenger DC, et al. 1996. Genetic complexity of a beet curly top virus population used to assess sugar beet cultivar response to infection. *Phytopathology* 86:929-933.

Strausbaugh CA, et al. 2007. Relationship of beet curly top foliar ratings to sugar beet yield. *Plant Dis*. 91:1459–1463.

Strausbaugh CA, et al. 2008. Curly top survey in the western United States. *Phytopathology*. 98:1212–1217.

Strausbaugh CA, et al. 2016. Length of efficacy for control of curly top in sugar beet with seed and foliar insecticides. *Plant Dis*. 100:1364–1370.

Strausbaugh CA, et al. 2017. Beet curly top virus strains associated with sugar beet in Idaho, Oregon, and a Western U.S. Collection. *Plant Dis*. 101:1373–1382.

Strausbaugh CA, et al. 2024a. Curly top viruses and phytoplasmas in sugar beets, common beans, and beet leafhoppers along with vector population dynamics in southern Idaho. *PhytoFrontiers* 4:305–318.

Strausbaugh CA, et al. 2024b. Foliar and seed treatment insecticides for the control of beet curly top in Idaho sugar beet, 2023. *Plant Dis*. *Manag. Rep*. 18(V008).

Thaler JS. 1999. Jasmonate-inducible plant defenses cause increased parasitism of herbivores. *Nature*. 399:686–688.

Thaler JS. 2002. Effect of jasmonate-induced plant responses on the natural enemies of herbivores. *J. Anim. Ecol*. 71:141–150.

Thaler JS, et al. 2004. The role of the jasmonate response in plant susceptibility to diverse pathogens with a range of lifestyles. *Plant Physiol*. 135:530–538.

Van Driesche RG, et al. 2001. Compatibility of insect growth regulators with *Eretmocerus eremicus* (Hymenoptera: Aphelinidae) for whitefly (Homoptera: Aleyrodidae) control on poinsettias: II. trials in commercial poinsettia crops. *Biol. Control*. 20:132–146.

Wenninger EJ, et al. 2019. Effects of strip tillage and irrigation rate on sugar beet crop yield and incidence of insect pests, weeds, and plant pathogens. *J. Sugarbeet Res*. 56:79–110.

Wenninger EJ, et al. 2025. Responses of non-target arthropods to a dsRNA bioinsecticide and to conventional insecticides targeting the Colorado potato beetle, *Leptinotarsa decemlineata* (Say). Am. J. Potato Res. 102: 129–151. Wenninger EJ, et al. 2020. Effects of strip tillage in sugar beet on density and richness of predatory arthropods. *Environ. Entomol*. 49:33–48.

F. Project Management, Evaluation, and Outreach

1. Project Management

The project will be led by Dr. Erik Wenninger, who will serve as Project Director and be responsible for ensuring the successful implementation of all research and outreach activities, as well as serving as the primary liaison between the research team and the BCTVCP. Dr. Wenninger's key responsibilities will include execution of the above stated tasks and methods, coordinating project logistics, and ensuring compliance with the terms and conditions of the BCTVCP grant. Drawing upon over fifteen years of experience conducting insecticide efficacy trials and vector management research, Dr. Wenninger will provide technical oversight, manage experimental design, and ensure scientific rigor and alignment with University of Idaho research policies, CDFA standards, and applicable pesticide safety and environmental protection regulations throughout the duration of the project. Dr. Wenninger will also oversee all reporting requirements, including submission of interim and final technical reports, financial documentation, and dissemination of findings through grower outreach and scientific publication.

The project co-leads will assist with study design, statistical analysis, and interpretation of results, contributing specialized expertise in entomology, virology, plant pathology, field research, and integrated pest management. Field and laboratory technicians will perform insect sampling, disease severity ratings, data collection, and sample processing under the direction of Dr. Wenninger. Coordination among team members will be maintained through every other week progress meetings during the field season and quarterly project updates throughout the year

2. Evaluation

The project team will implement a structured evaluation plan to ensure that all objectives are achieved effectively and that results are meaningful to the BCTVCP and growers.

1. Setup and Progress Evaluation: Progress through trail setup and data collection will be measured against expected completion dates referencing over 10 years of preliminary studies conducted with a very similar framework.

2. Performance Validation: Success of field trails will entail complete data collection and analysis, allowing conclusions to be drawn for all three objectives. Each treatment's performance will be compared to malathion and pyrethroid "standards" to determine whether reduced-risk insecticides can meet or exceed existing benchmarks for BLH suppression and virus control. Beneficial and non-target insect data will be analyzed to quantify effects on these insect groups, allowing a comprehensive cost–benefit assessment that integrates economic and environmental factors.

3. Impact Assessment and Outreach: In the final phase, the project team will prepare detailed technical summaries and provide recommendations to BCTVCP for integration of reduced-risk products into control protocols in a full report. The team will also evaluate barriers to adoption, including the potential need for changes in application timing or frequency, potential resurgence of secondary pests, or differences in cost and logistics relative to existing malathion-based operations. Successful outreach will be measured with engagement data from online resources created, in-person events held, and knowledge change data related to BCTV management from key events.

Throughout all phases, progress will be monitored through internal data reviews, team meetings, and milestone checklists. At the end of each field season, data will be reviewed as it relates to project objectives and to create immediate, preliminary insights to share with stakeholders to maintain engagement. The project's success will be determined by its ability to determine if the potential alternatives tested here control BLH and BCTV at similar levels to current program standards, with reduced impacts on beneficial insects, and to provide insight into potential changes in pest populations should tested alternatives be adopted.

3. Outreach

The outreach component of this project is designed to ensure that results are effectively communicated to the full range of stakeholders engaged in BCTV management, from growers and pest control advisors to state program personnel. Outreach activities will be conducted in collaboration with University Extension, industry, and CDFA partners to promote adoption of tactics found to be most effective in this study. As both CDFA in their non-crop control work and growers in their in-crop control efforts for BLH could reasonably use the chemistries of study here, communication with both CDFA and growers is valuable.

Key outreach activities will include:

- Annual Field Days and Demonstrations: On-site demonstrations at trial locations will showcase treatment comparisons and preliminary results for growers, pest control advisors, and CDFA representatives who wish to attend.
- Workshops and Presentations: Project results will be presented at regional pest management meetings and extension events throughout the West, including meetings such as the curly top WERA and Pacific Branch Entomological Society of America.
- Extension Publications and Reports: Summaries of findings will be distributed through extension newsletters, University, and CDFA websites, and professional society meetings.
- Program Integration: Final recommendations and data summaries will be provided to the BCTVCP Board for consideration in future program planning.
- By linking research with outreach and evaluation, this project will facilitate grower adoption of reduced-risk insecticides, strengthen partnerships between researchers and the BCTVCP, and advance statewide efforts toward safer, more sustainable management of beet curly top virus.

G. Budget Narrative

A. Personnel. (Year 1: $73,667.16; Year 2: $75,140.50; Total $148,807.66)

<u>Graduate Student, TBD (Wenninger).</u> Funds are requested for a full-time graduate student in Years 1-2 of the project. Year 1 $43,000 salary and $1,376 fringe (3.2%); Year 2 $43,860 salary and $1,403.52 fringe (2% cost of living adjustment in Year 2). Cumulative total $86,860 salary and $2,779.52 fringe. The Graduate Student will conduct the bulk of the work on the project, under the guidance of Wenninger. Salary amount includes sufficient funding for the student to cover tuition/fees ($11,132/year) and mandatory student health insurance program ($2,200/year).

<u>Research Aide, Anastasia Stanzak, 0.3 FTE (Wenninger).</u> Funds are requested for 0.244 FTE of Stanzak's time each year. Base pay rate is $24.58/hr. Year 1 $12,480 salary and $4,580.16 fringe (36.7%); Year 2 $12,729.60 salary and $4,671.76 fringe (2% cost of living adjustment in Year 2). Cumulative total $25,209.60 salary and $9,251.92 fringe. The Research Aide will assist the Graduate Student with the labor-intensive work of insect sampling, insect identification, and plot spraying.

<u>Alexander Karasev (0.006 FTE, summer salary).</u> Funds are requested for 0.006 FTE of Karasev's time each summer. Base pay rate is $76.69/hr. Year 1 $1,000 salary and $295 fringe (29.5%); Year 2

$1,020 salary and $300.90 fringe (2% cost of living adjustment in Year 2). Cumulative total $2,020 salary and $595.90 fringe. Karasev will oversee the molecular testing of plants for curly top virus.

Research Technician, TBD, 0.2 FTE (Karasev). Funds are requested for 0.2 FTE of a Research Technician's time each year. Base pay rate is $19.23/hr. Year 1 $8,000 salary and $2,936 fringe (36.7%); Year 2 $8,160 salary and $2,994.72 fringe. Cumulative total $16,196 salary and $5,930.72 fringe. The Research Technician will conduct molecular work under the guidance of Karasev.

B. Operating Expenses. (Year 1: $12,375.00; Year 2: $10,675.00; Total: $23,050)

Supplies. (Year 1: $12,200.00; Year 2: $10,500.00; Total: $22,700)
Funds are requested for the following project-specific supplies:

Wenninger. ($3,700).
Year 1 $2,700 total. Computer and peripherals for graduate student ($1,700) and insect collection and curation supplies, including nets, vials, ethanol, pins, collection boxes ($1,000).
Year 2 $1,000 total. Insect collection and curation supplies, including nets, vials, ethanol, pins, collection boxes ($1,000).

Karasev. ($19,000).
Years 1 and 2, $9,500 total each year. Materials and kits for virus detection using molecular techniques, including ELISA kits ($2,000), kits for nucleic acid extractions ($3,000), and RT-PCR ($1,000). Significant cost items include miscellaneous supplies (reverse transcriptase and Taq-polymerase enzymes, primers, plasticware, and sequencing kits), RNase and DNase free agarose and reagents for cloning ($2,500). General laboratory supplies, disposable Petri dishes, agar, antibiotics, chemical and laboratory supplies for analysis, and miscellaneous supplies ($1,000).

Equipment. Not requested.

Travel. (Year 1: $175.00; Year 2: $175.00; Total: $350).
Wenninger. ($350).
Funds are requested in Years 1 and 2 for Wenninger team travel to the field site at the USDA-ARS south farm, which is a ten-mile round trip. Estimate 25 trips per year x 10 miles x $0.70/mile = $175/year. Total $350.

C. Indirect Costs. (Year 1: $8,604.22; Year 2: $8,581.55; Total: $17,185.77).

Indirect costs were calculated using the funder limit of 10% of Total Costs.

D. Other Funding Sources N/A

Total Project Budget (Year 1: $94,646.38; Year 2: $94,397.05; Total project: $189,043.43)

H. Budget Template

See attached.

I. Appendices

See attached.

J. CEQA

N/A