UC Cooperative Extension
University of California
Agriculture & Natural Resources

Sacramento Valley Field Crops Newsletter
August 2026

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Fusarium falciforme, an emerging root and stem rot pathogen of beans and other California crops

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Fusarium falciforme is a soil-borne fungal pathogen that causes root and stem rot and plant decline in many crops including lima bean, common bean, and chickpea. In California, *F. falciforme* has been isolated over multiple years from diseased plants including blackeye bean (cowpea), common bean, long bean, chickpea (garbanzo), and alfalfa (Table 1). This pathogen has been recovered from legume crops across California, spanning a geographic range from Glenn to Kern Counties (Table 1). Symptoms include root and stem rot which can result in plant decline and crop loss (Figure 1).

Table 1: California legume crops associated with *F. falciforme*

Crop	Year	County	Symptoms
Blackeye bean	2018, 2019	Tulare	Root and stem rot
Common bean (kidney)	2020	Kern	Root and stem rot
Common bean (canary)	2021	Glenn	Crown and stem rot
Chickpea	2021	Yolo	Root rot
Long bean (fresh)	2024	Fresno	Root and stem rot
Alfalfa	2024	Fresno	Crown rot

Figure 1: (A-B) Tap root and stem rot and (C-D) canopy symptoms in blackeye plants from Tulare County (A/D photo credit: Nicholas E. Clark)

To confirm *F. falciforme* is an issue in California, researchers from University of California Davis conducted greenhouse trials to see if this species was a pathogen of blackeyes. All *F. falciforme* isolates from blackeyes were able to cause disease in new blackeye plants, replicating the root and stem rot seen in the field (Figure 2). This means that *F. falciforme* is a confirmed pathogen and could be a management target when planting blackeyes.

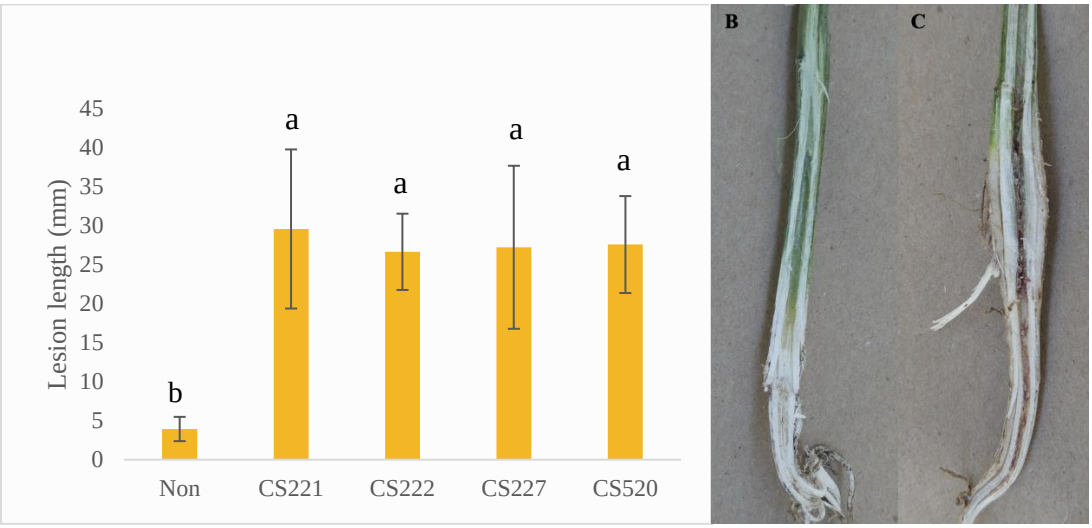

Figure 2: (A) Total lesion length in blackeye plants inoculated with *F. falciforme* isolates (CS221, CS222, CS227, and CS520) or a negative control (non). (B-C) Symptoms in greenhouse trials resulting from inoculation with (B) the negative control or (C) *F. falciforme*.

Beyond beans, *F. falciforme* is also a pathogen of other annual crops in California like melons, pepper, and cotton, and causes a very minor disease in tomato. When *F. falciforme* isolates recovered from these other crops were inoculated on blackeye, all isolates caused stem rot (Figure 3). Overall, this and complimenting studies in potato suggest that *F. falciforme* is a generalist pathogen that can infect many annual and perennial crops grown in California including dry beans, tomato, cotton, melon, peppers, garlic, and pistachio.

Rotation with other known susceptible crops is not recommended if *F. falciforme* is present in a field. It is not a good idea to rotate with tomato even though it is less susceptible. This is because the inoculum from the pathogen can build-up in the soil while the tomato crop is growing, which can make disease worse when rotating back to beans. Research is still ongoing to evaluate cross-pathogenicity of *F. falciforme* recovered from stem and root rot symptoms in a wide range of crops, including grapes, lettuce, alfalfa, cilantro, and onion.

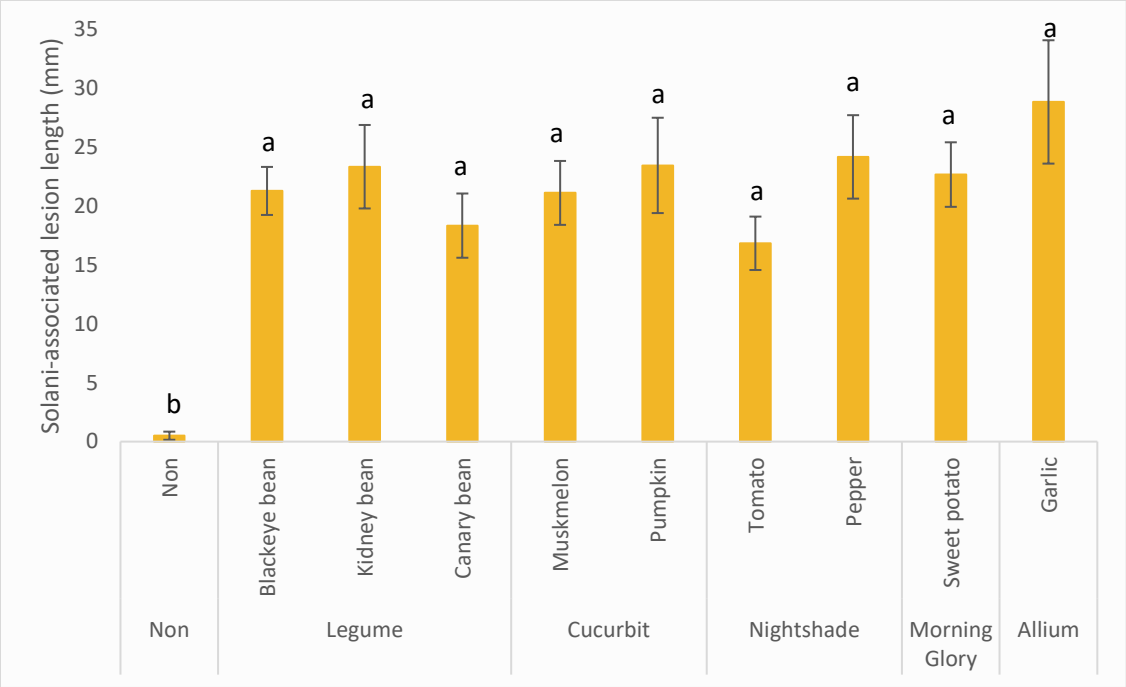

Figure 3: Lesion length in blackeye plants where an isolate with *F. solani* morphology (*F. falciforme* is part of the *F. solani* group) was isolated.

Although survival studies have not been conducted for *F. falciforme* in California, studies in closely related species indicate that a minimum nine month and optimally three-year rotation out of susceptible crops is needed to effectively reduce inoculum loads. Given the wide host range, crop rotation is likely to be challenging to implement effectively, but fallowing for 9-12 months might help reducing inoculum loads. More resistant cultivars, cultural practices (like drought stress management), and potentially chemical-based management are likely to provide effective complimenting strategies for reducing disease losses. Future studies are needed to develop better management tools in beans and other affected crops.

In making management decisions, it is important to accurately diagnose this disease, as *F. falciforme* symptoms may resemble other diseases including Fusarium wilt, Rhizoctonia root rot, and Pythium root rot. Consult with your local Farm Advisor if you think this may be a problem in your field; samples will likely need to be submitted to a diagnostic laboratory as field symptoms alone are insufficient for diagnosis.

Broomrape Basics

Mandeep Singh, UCCE Agronomy Advisor

Broomrape is a parasitic weed. It was previously found in Yolo, Solano, and San Joaquin counties, and was found in Sutter County last year. It lacks chlorophyll and depends upon its host plant for water and nutrients. Once the seed is preconditioned with warm temperature (59–68°F for 5–21 days) and in moist soil, it requires a chemical signal called strigolactone from the host crop to trigger its germination.

After germination, a modified organ called a haustorium attaches to the host roots to extract water and nutrients, and later stores them in an organ called tubercle. Eventually, yellowish

colored shoots emerge aboveground (Photo 1) and produce pale white to purplish flowers within 3 to 7 days (Photo 2). The two species found in California are branched broomrape (*Phelipanche ramosa*) and Egyptian broomrape (*Phelipanche aegyptiaca*), with most reports of branched broomrape. Both look similar and have branching stems. However, branched broomrape has a slightly smaller plant and inflorescence size than Egyptian broomrape. Only branched broomrape has been found in Sutter County.

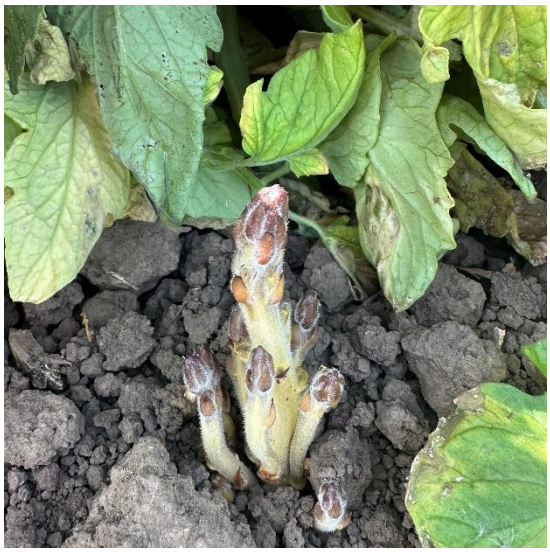

Photo 1: Broomrape emerging on a tomato plant.

Photo 2: Broomrape flowering in a tomato field.

Why is it a big concern?

1. It is an ‘A-rated’ pest, meaning it is of known economic importance subject to state-enforced action.
2. It spends major part of its life cycle underground, so early detection is difficult.
3. It can produce multiple flushes in the same season under the right environmental conditions.
4. One plant can produce thousands of tiny seeds, which can be viable for up to two decades.
5. It has wide range of host plants, including several economically important annual crops in California such as sunflower, tomato, garbanzo, canola, squash, carrot, etc., This makes broomrape control with crop rotation difficult in infected fields.

What to do about new detections?

Since it is a highly regulated pest, if you see it, please contact your County Agriculture Commissioner, or reach out to your local UCCE Extension Advisor for help with identification. It is very important to scout and hand rouge broomrape plants by the early flowering stage. Then bag and dispose of the plants in landfill. This is very important early on when broomrape is new to a field and has very low densities. For a newly detected field, consider rouging, bagging, and disposing of the host plant along with the broomrape to control the spread. Rotating these fields to false (trap) or non-host crops could help with depleting the seedbank.

Field equipment (e.g., harvesters and trailers) and footwear can move broomrape seed contained in soil or plant debris from one field to another. Therefore, it is important to clean equipment and boots before moving between the fields. The most important step is always the physical removal of loose soil and plant debris with air or water. This greatly reduces the potential of spreading broomrape seeds through contaminated debris. Only after the physical cleaning, sanitizers (e.g., Quaternary Ammonium Compounds, at least a 1% solution) are to be used; otherwise, debris can reduce their efficacy. Please click here to learn more about best management practices for field equipment sanitation.

Where to learn more?

Many aspects of the broomrape have been well-researched by UC researchers. While foliar maleic hydrazide is being evaluated for crop safety in sunflower this year, most of the broomrape research has been conducted in processing tomatoes as it being the main host crop in the region. Some of these resources are listed below for further reference:

Chemical control

- Fatino, Hanson (2025) Sequential applications of chemigated rimsulfuron reduce broomrape emergence in California tomatoes.
- Fatino, Hanson (2025) Chemigation alternatives for branched broomrape control in processing tomato: Promising Steps Forward

Non-chemical management

- Bhusal, Vulchi, Hanson (2026) Delayed transplanting suppresses branched broomrape in California processing tomatoes.
- Hosseini, Burgess, Vulchi, Tang, Hanson (2025) Branched broomrape hand weeding and heat treatment.

Growing Degree Day Calculator to schedule Matrix chemigation and rogueing

- Vulchi, Hanson (2026) The broomrape GDD calculator for scheduling chemigation and rogueing operations in california-grown processing tomatoes

Overall Resources

- UC Davis Broomrape website. https://broomrape.ucdavis.edu/
- UC Davis Broomrape Research YouTube channel. https://www.youtube.com/@UCDavisBroomrapeResearch
- CTRI Broomrape Resources webpage. https://tomatonet.org/grower-resources/broomrape-resources/

Nitrogen Release from Combined Cover Crop and Organic Amendment Applications Closely Matches Expectations

Makena Savidge – UC Davis PhD Candidate in Soils and Biogeochemistry

When organic materials are applied together, nitrogen (N) cycling dynamics may differ compared to when they're applied independently. Soil microbes use carbon (C) for energy. Materials with a high C:N ratio encourage soil microorganisms to use existing N that is present in the soil so that they can digest the carbon. This process is called immobilization and slows down the N release from soil that is available to crops. But could highly available N

from one amendment compensate for another high C:N material and increase combined N release? Or could excess carbon from a cover crop residue suppress N release from another organic amendment that has a low C:N?

Cover crop residues incorporated before pre-plant fertilizer applications.

A controlled laboratory experiment was conducted comparing N release from materials applied at the same time to the sum of the same materials applied independently. The study examined barley (high C:N) and vetch (low C:N) cover crops applied individually and together, as well as barley, vetch, and a barley/vetch mix each applied with low C:N organic fertilizers (organic 6-6-2 and soy hydrolysate).

There were no significant effects when combining vetch and barley together, indicating that mixing high and low C:N cover crop residues did not affect the N released (Figure 1A). However, significant differences were measured when cover crops were combined with organic amendments (Figure 1B and Figure 1C). After 1 week, barley applied with soy hydrolysate released less N than the sum of the materials applied independently. This suggests that microbes immobilized more N during early decomposition when the materials were applied together. This was likely due to soil microbes using the available N from the soy hydrolysate during the early decomposition of the barley residue.

The effect was short-lived. By week 12, this effect had reversed, and most cover crop and amendment combinations released more N than expected after this date (Figure 1). Another relevant finding for growers using cover crops to meet their crop N demand was that all treatment differences in N release accounted for less than 12% of total N applied. This means that applying these materials together had minimal impacts on expected total N release.

The C:N ratio of each material, averaged together, reliably predicted how much N was released from the combination and explained why some combinations released more N than their individual components.

Can individual material N release and C:N ratios be used to estimate combined N release from cover crops and organic amendments? Yes. Applying materials together had a minimal effect on N release. Any effects of N release were positive, meaning that more N than expected was available for plant uptake. This work was done in a controlled laboratory environment. Materials with higher C:N ratios warrant further evaluation in a field setting.

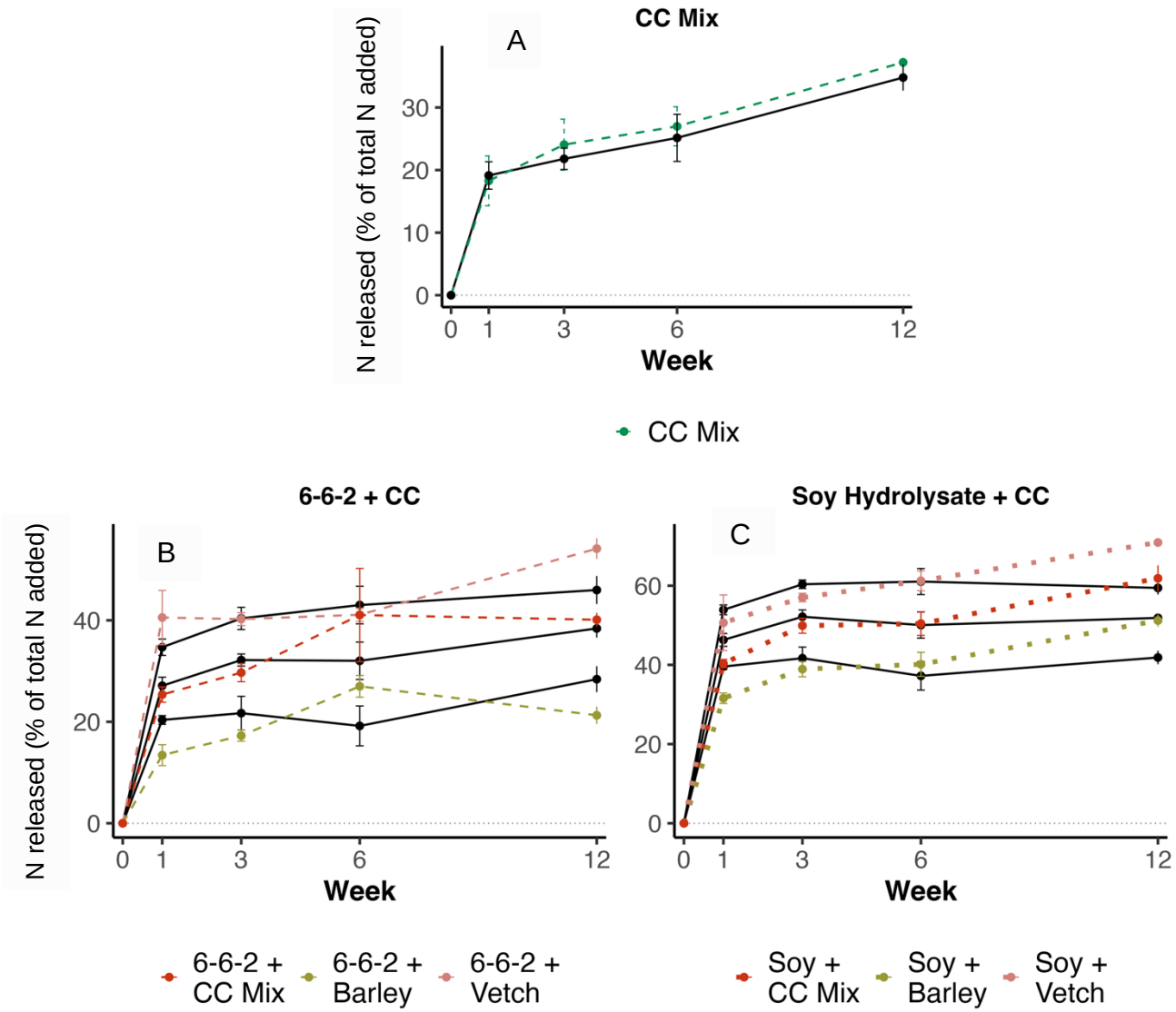

Figure 1: Nitrogen released to be plant available as a percentage of the total N added over the 12-week incubation for (A) the cover crop mix, (B) cover crops plus organic 6-6-2 fertilizer, (C) cover crops plus soy hydrolysate.

New Cover Crop Selector and Database Available for California

Sarah Light, UCCE Agronomy Advisor

There is a new cover crop tool available for growers, technical assistance providers, crop advisors, and other users in California. Cover crops provide many benefits because they keep soil covered, maintain living roots that support microbial life, and integrate a new plant species into the crop rotation. In an annual cropping system, cover crops are planted on ground that would otherwise be fallow. The Cover Crop Species Selector is a cover crop database and a

species selector tool. Last September states in the west were added to this national resource including California.

Start by selecting your state. This filters down to a list of cover crop species commonly grown in that state. For example, three native species are included for California. Then select either “Get a Recommendation” or “Browse Cover Crops.” Browsing allows you to explore the traits of many different cover crops used in your state. Once you select a cover crop you’re interested in you’ll see a description of the species and photos, as well as information about basic agronomics, environmental tolerances, tolerable soil conditions, and growth habit. Planting considerations include seeding rate and depth, and typical seeds per pound, and termination methods and timing guidelines are also included. The tool includes relevant notes such as grazing limitations, some planting and establishment nuances, and pest and disease information related to crops in nearby fields or the following crop. Each cover crop species is also rated for seed persistence, residue management challenges, and volunteer establishment in following crops.

To “Get a Recommendation” select your field location. This automatically pulls soil and environmental data for the field including soil texture and drainage class (can be changed), frost dates, and precipitation. Then choose from a list of 14 goals. Up to three goals can be selected and adjusted in order of priority. To optimize recommendations, select your cover crop planting season and indicate whether you will irrigate the cover crop, also identify your cash crop growing window, as well as cropping system (annual or perennial).

The following page leads to a ranked list of all cover crops based on your goals, climate and soil type. The first goal selected (Goal 1) is an important sort and filter component of the data set. You can re-order goals by clicking on the column headers for your goals, but this doesn’t generate a new list of recommended cover crops. To get a new recommendation based on new or re-ordered goals, return to the goals tab. The output page also depicts the reliable cover crop establishment window for each species with the user-inputted cash crop growing window overlaying it. This visual shows if there is an overlap with an annual crop or a conflict in management window for a perennial system. Cover crop species are greyed out if the species rank low for Goal 1 or if the reliable establishment window conflicts with the cash crop season. You can click on individual cover crop species names to see the information sheet for that species. Finally, the tool has a variety of filters that allow the user to filter down their results even further. We recommended not over filtering the results and instead exploring different cover crop species in the database that are highly ranked for your goals, location, and growing window.

Common vetch cover crop

The tool can be accessed through the Western Cover Crops Council website or at https://covercrop-selector.org. The dataset for this tool was created by experts in the Western states including researchers, Extension professionals, farmers, natural resource partners, seed industry and non-profit representatives. If you have experience with a cover crop species and it doesn’t match the information in the tool, please write us a note in the Feedback tab.

SHAPE

Probing Our Country's Soil Health

FREE SOIL HEALTH TESTING

A new national effort called **Probing Our Country's Soil Health** is focused on creating a free and user-friendly tool for farmers to benchmark the soil health of their fields.

The tool is called **Soil Health Assessment Protocol and Evaluation (SHAPE)**. The tool will also provide insights of management practices that may improve crop yields when enhancing soil health.

Join the project today! After a one-hour Zoom meeting, a soil sampling team will hand-probe from 2-3 sites per field. You will be compensated for your time and receive a personalized soil health report, as well as a hard copy photo book of the project.

HOW TO ENROLL:

Scan the code to schedule a virtual meeting with a facilitator.

PROJECT OVERVIEW VIDEO:

Scan here to watch a short video about the project.

Project Management by AGES, LLC (Newell Kitchen).