An experiential learning-based public plant breeding pipeline for organic cultivar development

Student Collaborative Organic Plant Breeding Education (SCOPE) at UC Davis

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Background:

Student Collaborative Organic Plant Breeding Education (SCOPE) is a student-led collaborative of student and faculty plant breeders working with local organic growers on improving crop varieties for organic farming systems in Northern California with the possibility of future expansion to other regions. The organic plant-breeding project was developed in direct response to California organic growers, who have reported that the scarcity of seeds for cultivars that meet the needs of organic farming can seriously impact a farm's bottom line. Using traditional, field-based plant breeding methods, new varieties of heirloom-like tomatoes, jalapeno poppers, bell peppers, pest resistant common bean and lima bean are being developed on certified organic land at The Student Farm at UC Davis. The breeding objectives of these projects were selected based on input from local organic farmers, the Organic Seed Alliance, and faculty participants. In addition to the breeding projects, the students participate in seminars focused around how to conduct outreach activities, organic farming methods, and project management as well as participate in Field Days to showcase their work to a broader audience.

Breeding Projects:

Figure 1. Heirloom tomatoes harvested from the SCOPE tomato 2016 field trial.

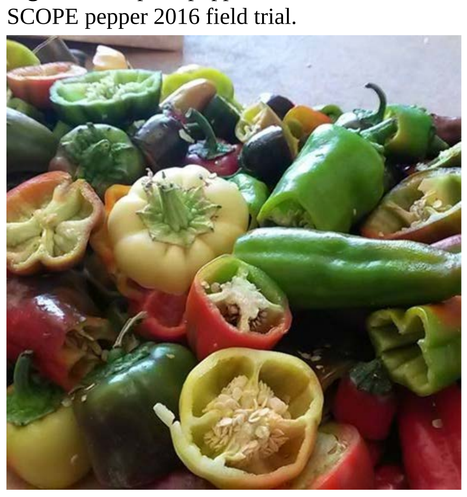
Breeding Objectives:

Develop *heirloom-like* tomato varieties with:

1. Increased disease resistance
2. Heat tolerance at flowering
3. Improved fruit quality, like selecting lines with minimal cracking

Maintaining the iconic *tomato taste* is also an important trait, and has been tested using tasting panels. Some of the initial varieties selected for the breeding program are shown in **Figure 1**, and F_1 x OP and F_1 x F_1 crosses have been made so far.

Figure 2. Jalapeno popper selection from the SCOPE pepper 2016 field trial.



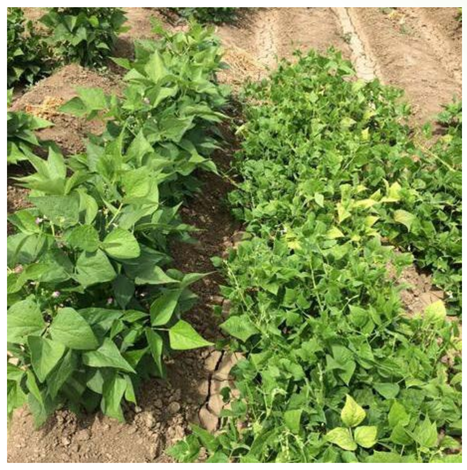
Breeding Objectives:

The pepper team has two breeding projects:

1. Develop a jalapeno popper pepper, with a large cavity and thick pericarp (**Figure 2**).
2. Develop a bell pepper variety that is resilient to sunscald

The popper project was started nearly four years ago by PhD student Jorge Berny, and F3 selections are already showing promise. The bell project was initiated in late 2015 based on growers responses to a wide survey conducted by Erin Wilkus.

Figure 3. Common bean with and without BCMV.



Breeding Objectives:

Develop new bean varieties with

1. Seed coat patterns and cooking quality typically found only in heirlooms
2. Resistance to bean common mosaic virus (BCMV) (**Figure 3**)
3. Upright plant architecture
4. Increased yields

The backcrossing program from the BC2F1 generation to the BC5F2 generation has been advanced. F_2 and F_3 families from about a dozen heirloom x elite crosses have been evaluated and intercrossed.

Figure 4. Diversity of colors available in lima beans.

Breeding Objectives:

Develop new lima bean varieties with

1. White seed coat pattern
2. Resistance to *Lygus* sp.
3. Bush type
4. Reduction in 'fish lips' (cotyledon coming apart)
5. Increased yields

Similar progress has been made as in the common bean project with the addition of advancing 35 crosses to F_2 and three to F_3. The seed coat colors (**Figure 4**) may be of interest to gardeners or small scale farmers.

Outreach:

Educational:

Figure 5. Presenting the SCOPE project at the 2016 Student Farm Fall Welcome

Figure 6. Paul Gepts and Antonia Palkovic talk about beans at the SCOPE Field Day

Collaborative:

Figure 7. Zach Dashner presents current research to farmers on the Bean Field Day

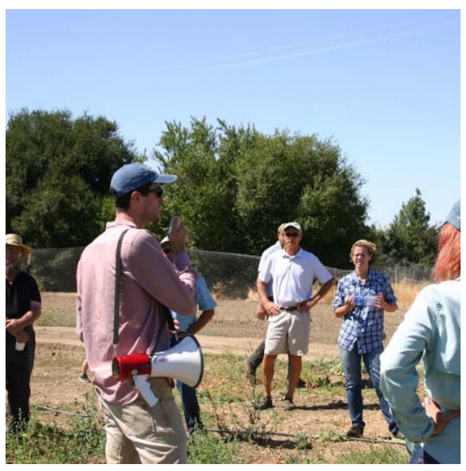


Figure 8. Faculty and farmers meet to discuss SCOPE collaborations

Public Outreach:

As part of the public outreach, the SCOPE research projects have participated in several public events. In **Figure 5**, a group of people interested in organic agriculture hear about the SCOPE project as they make pepper ristras at the annual Student Farm Fall Welcome.

Student Outreach:

To engage current students at UC Davis and increase awareness of the SCOPE program, a Field Day showcasing all projects with all PIs in attendance was held. Students from different backgrounds attended and were engaged by the various projects.

Grower Outreach:

At the Bean Field Day, growers and those interested in bean research were able to attend and find out more about the bean research happening at UC Davis, including the projects about breeding for organic conditions.

Collaborator Outreach:

Several local farmers have been involved in the direction of SCOPE. Initially, a survey of local growers influenced the breeding objectives of both the tomato and pepper projects.

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