EFAO 2025: Working draft research protocol

Polycultures for Cucumbers

Farmer-researcher(s): Cole Etherington, The Good Shit - East

Project type: Research trial

Research priorities: Disease & pest control, Pollinator services, Soil health, Weed control

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Objective

To quantify any benefits of growing vegetables in polyculture vs monoculture.

Does polyculture (i.e., growing multiple crops in the same space) yield higher productivity, increased biodiversity, and enhanced resilience compared to monoculture (i.e., the cultivation of a single crop in a given area)?

Background

My curiosity was sparked by observing the dynamics of plant interactions in my own gardens. It became evident that cultivating a variety of plant species together might have advantages over the traditional single-crop approach. Previous studies have indicated the potential benefits of mixed-crop systems (e.g., increased productivity, enhanced biodiversity, improved resilience to environmental stress), but there is a need for more zone-specific evidence, particularly in the context of the increasing climate crisis.

References

Malézieux, E. et al. (2009). Mixing Plant Species in Cropping Systems: Concepts, Tools and Models: A Review. In: Lichtfouse, E., Navarrete, M., Debaeke, P., Véronique, S., Alberola, C. (eds) Sustainable Agriculture. Springer, Dordrecht.

Griffiths-Lee, J., Nicholls, E. and Goulson, D. (2020), Companion planting to attract pollinators increases the yield and quality of strawberry fruit in gardens and allotments. Ecol Entomol, 45: 1025-1034. https://doi.org/10.1111/een.12880

Montoya, J. E., Jr., Arnold, M. A., Rangel, J., Stein, L. R., & Palma, M. A. (2020). Pollinator-attracting Companion Plantings Increase Crop Yield of Cucumbers and Habanero Peppers. HortScience horts, 55(2), 164-169.

Conboy NJA, McDaniel T, Ormerod A, George D, Gatehouse AMR, Wharton E, et al. (2019) Companion planting with French marigolds protects tomato plants from glasshouse whiteflies through the emission of airborne limonene. PLoS ONE 14(3): e0213071. https://doi.org/10.1371/journal.pone.0213071

Lizarazo CI, Tuulos A, Jokela V and Mäkelä PSA (2020) Sustainable Mixed Cropping Systems for the Boreal-Nemoral Region. Front. Sustain. Food Syst. 4:103. doi: 10.3389/fsufs.2020.00103

Experimental Design

Treatments

1. **Cucumbers grown in monoculture**
    a. Marketmore cucumbers; 5 rows of 5 plants (25 plants total); 1 cucumber plant square foot in each row; 5'x5' plot
2. **Cucumbers grown in a simple polyculture**
    a. Same as above with addition of Easter Egg Radish (n=60), Mammoth Dill (n=4), and Jewel Mix Nasturtium (n=4) per plot (see treatment layout below)
3. **Cucumbers grown in a complex polyculture**
    a. Cucumbers, Dill, Nasturtium, Radish remain the same as above; addition of Marigolds - Durango Outback (n=4); Bush Beans - Provider (n=16), chives - Nelly (n=4)

Field Layout

Monoculture 5 x5 ft	20 ft	Monoculture 5 x5 ft	20 ft	Simple Poly 5 x 5 ft	20 ft	Complex Poly 5 x 5 ft
10 ft		10 ft		10 ft		10 ft
Simple Poly 5 x 5 ft		Complex Poly 5 x 5 ft		Monoculture 5x5 ft		Simple Poly 5 x 5 ft

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10 ft		10 ft		10 ft		10 ft
Complex Poly 5 x 5 ft		Simple Poly 5 x 5 ft		Complex Poly 5 x 5 ft		Monoculture 5x5 ft

Cole found in literature that often a buffer zone of just 3-5ft is used in companion planting/pest control experiments. Using much more space than that, Cole will separate each treatment within blocks by 10 ft and each replicate block by 20 ft.

Treatment layouts, using a random number generator.

Simple Polyculture:

Row 1 (North side) | (A1) C + D | (A2) C + R | (A3) C + R | (A4) C + R | (A5) C + N
Row 2 | (B1) C + N | (B2) C + R | (B3) C + R | (B4) C + R | (B5) C + D
Row 3 | (C1) C + R | (C2) C + R | (C3) C + D | (C4) C + R | (C5) C + N
Row 4 | (D1) C + R | (D2) C + D | (D3) C + R | (D4) C + N | (D5) C + R
Row 5 (South side) | (E1) C + N | (E2) C + R | (E3) C + R | (E4) C + D | (E5) C + R

Cucumbers (C): 25 total (1 in every square)
Radish (R): 15 squares × ~4 radishes each = ~60 radishes
Dill (D): 5 squares (1 dill plant each)
Nasturtium (N): 4 squares (1 nasturtium plant each)

Complex Polyculture:

Row A (North) | A1: C + R | A2: C + D | A3: C + N | A4: C + M | A5: C + B
Row B | B1: C + M | B2: C + B | B3: C + Ch | B4: C + R | B5: C + N
Row C | C1: C + Ch | C2: C + R | C3: C + D | C4: C + B | C5: C + M
Row D | D1: C + B | D2: C + N | D3: C + M | D4: C + Ch | D5: C + D
Row E (South) | E1: C + D | E2: C + Ch | E3: C + R | E4: C + N | E5: C + R

Radishes (R): 15 squares → ~4 radish plants around the cucumber
Dill (D): 4 squares → 1 dill plant each
Nasturtiums (N): 4 squares → 1 nasturtium plant each
Marigolds (M): 4 squares → 1 marigold plant each
Bush Beans (B): 4 squares → sow 4 seeds around edges
Chives (Ch): 4 squares → 1 bunch per square

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Cucumbers (C): 25 squares → 1 in center of every square

Statistical model

The design of this trial is a randomized complete block design with three treatments and four replicate blocks. For this reason, we will use an analysis of variance to test for treatment differences.

Measurements

Quantitative

Productivity, as yield

- Weekly count of the number of harvestable cucumbers (fruit min. 7" long)
- Data collection form: https://airtable.com/appn0aJ32Hlq9bAOy/shrBuQagw76XRKMJz

Resilience

- Record how long each cucumber produces marketable yields
- Use data collection form to calculate this

Qualitative data

Biodiversity

- Observe and record type and number of different species present in each plot (morning, afternoon, evening)
- Data collection form: https://airtable.com/appn0aJ32Hlq9bAOy/shrzegy0wczgZbEQd

Pests and Disease

- Observe and record type, number, and extent of pest and/or disease pressure
- Data collection form: https://airtable.com/appn0aJ32Hlq9bAOy/shrzegy0wczgZbEQd
- (Same form as for Biodiversity)

Photos

- 1 photo of each plot every Saturday Morning (8-10am), from May to October, using Samsung Galaxy S23
- 1 photo of each weekly harvest, using Samsung Galaxy S23

Social media

If you are posting about your trial on social media, please tag EFAO, @efao2.

Research Plan

Please note that if data is submitted after the submission deadline, EFAO staff cannot guarantee that your data will be analyzed and written up before the Research Symposium and/or the next growing season.

Time	Task	Methods & Measurements or Action Item
March 31, 2025	Prepare beds Seed dill	Clear any debris, loosen soil with broadfork, amend with chicken manure compost; start dill indoors
April 6, 2025	Seed cucumbers, radish	Start cucumber seeds indoors; direct sow radish
May 19, 2025	Transplant seedlings, sow bush beans	Transplant all crops to beds, direct sow bush bean seeds
Every Saturday	Photos!	Take photos of the plot
Weekly May -Oct	Maintain beds	Water, weed, general maintenance
Weekly May - Oct	Biodiversity, pest and disease observations	Record in data collection table, photograph plots
Weekly May - Oct	Harvest	Harvest all cucumbers that are min 7” long, count, photograph
Every harvest	Photos!	Take photos of the harvest
May - October monthly	Video or SM	Take video and send to EFAO; take social media posts
Nov 1, 2025	Data submission	
December 15, 2025	Farmer-fee and	Submit invoices at this site:

	research expense invoice with receipts for expenses	https://efao.ca/data/
Winter/spring 2025/2026	Finalize and publish research report	Work with EFAO staff to review polished research report for publication.

Staff check-ins

Monthly check-ins

Materials

Please list all materials, supplies and equipment that will be reimbursed for this project. If possible, please also indicate a short-list of any in-kind materials, supplies and equipment that you will use.

Material	Unit	Quantity Required	Total Cost*	Note
Organic Provider Bush Bean Seeds		64	9.10	
Organic Marketmore Cucumber Seeds		300	9.10	
Organic Mammoth Dill Seeds		32	2.99	
Organic Jewel Mix Nasturtium Seedlings		32	22.40	
Organic Durango Outback Marigold Seedlings		16	11.20	
Organic Easter Egg Radish Seeds		480	13.26	
Organic Chives seedlings		16	11.20	

Total			$79.25	Approx cost

Farmer-fee

Farmer-fees for this project are $1000 in total. You are eligible for 50% ($500) for implementing the trial, and 50% ($500) for submitting data and photos. EFAO staff will be in touch in the fall with invoicing instructions and deadlines. If you decline, cancel, or defer the trial, you also forfeit the payment

Memorandum of Understanding

Please fill out the MOU at https://airtable.com/appPSElrt17OMWXia/shrKoxUq7bAe5oIH3. The terms of the MOU are listed here: https://efao.ca/wp-content/uploads/EFAO_FLRP_MemorandumofUnderstanding_2025.pdf.