Removing the Metam
Alternatives to Metam Fumigation for Managing Verticillium Wilt

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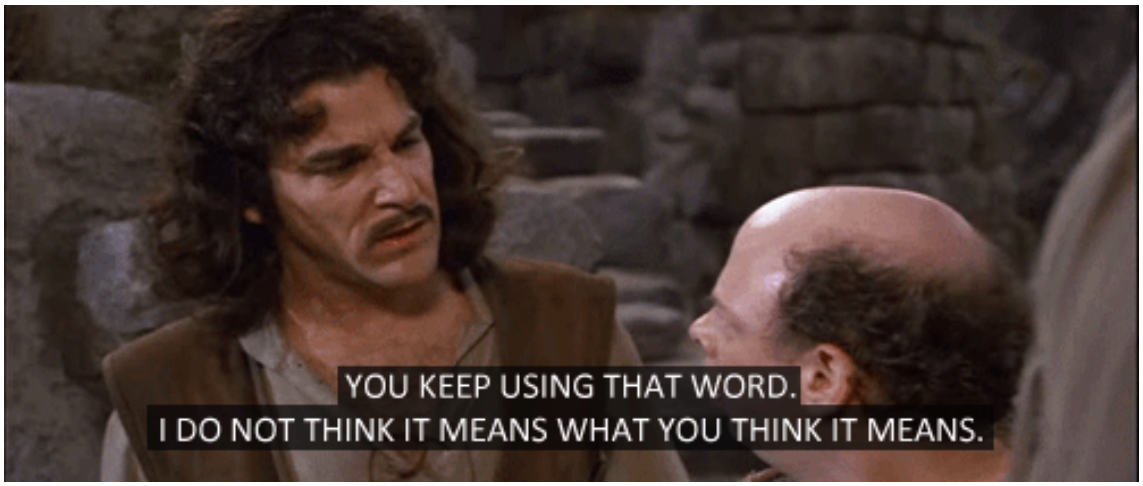
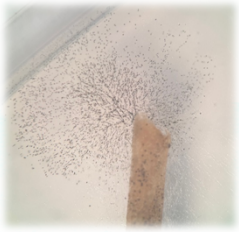
Verticillium Wilt vs. Potato Early Die



Verticillium Wilt vs. Potato Early Die

Verticillium Wilt

- *Verticillium dahliae*
- *(Verticillium albo-atrum)*

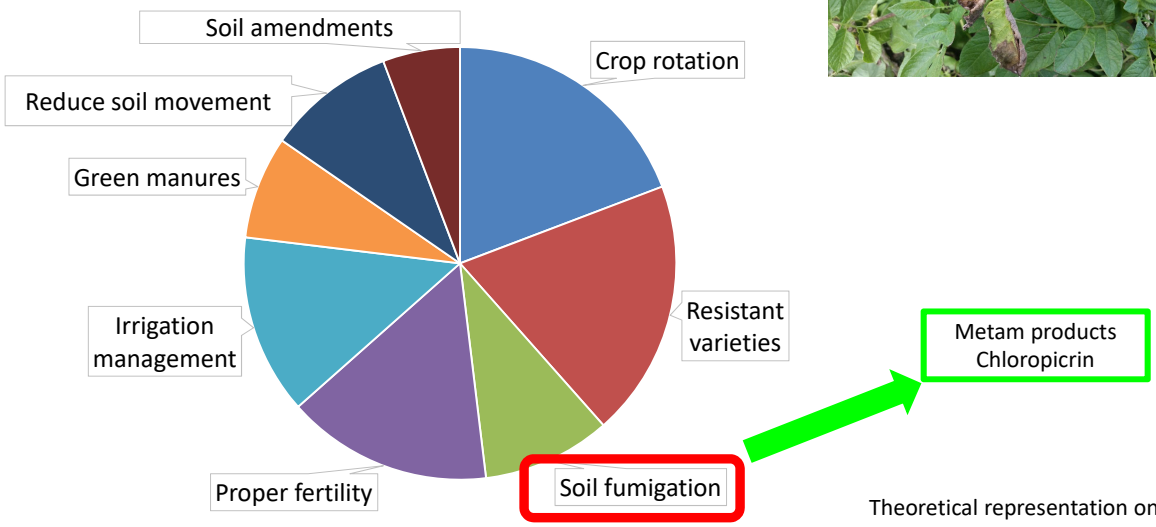


Potato Early Die *

- *Verticillium dahliae*
- *(Verticillium albo-atrum)*
- Root lesion nematodes (*Pratylenchus* sp.)
- Soft rot bacteria (e.g. *Pectobacterium* sp.)
- Black dot (*Colletotrichum coccodes*)
- Early blight (*Alternaria* sp.)

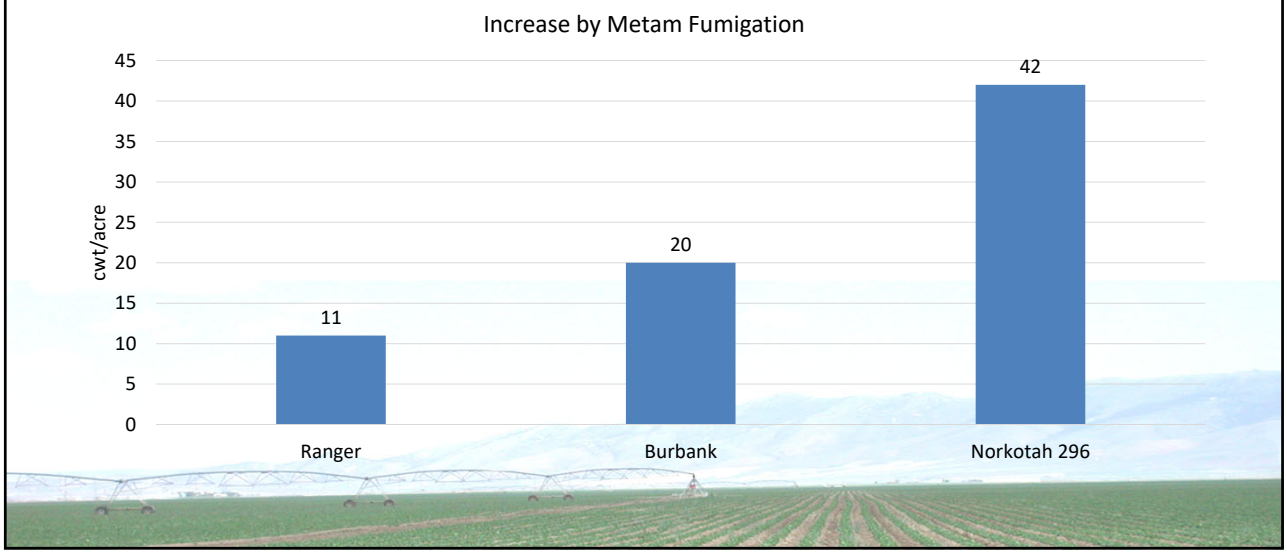
*From Disease Management in Potato Production Systems (2020), p. 235.

Managing Verticillium Wilt



Theoretical representation only

Variety response to metam, 3-year rotation



Why should I remove the metam?

- 🙂 Effective against Verticillium
- 🙂 Effective against nematodes
  - **Root lesion**
  - Root knot
- 🙂 Some weed control
- ☹ Expensive (~$300/acre)
- ☹ Product toxicity
- ☹ High active ingredient load
  - 40 gal/acre = 170 lb a.i/acre
- ☹ Use restrictions

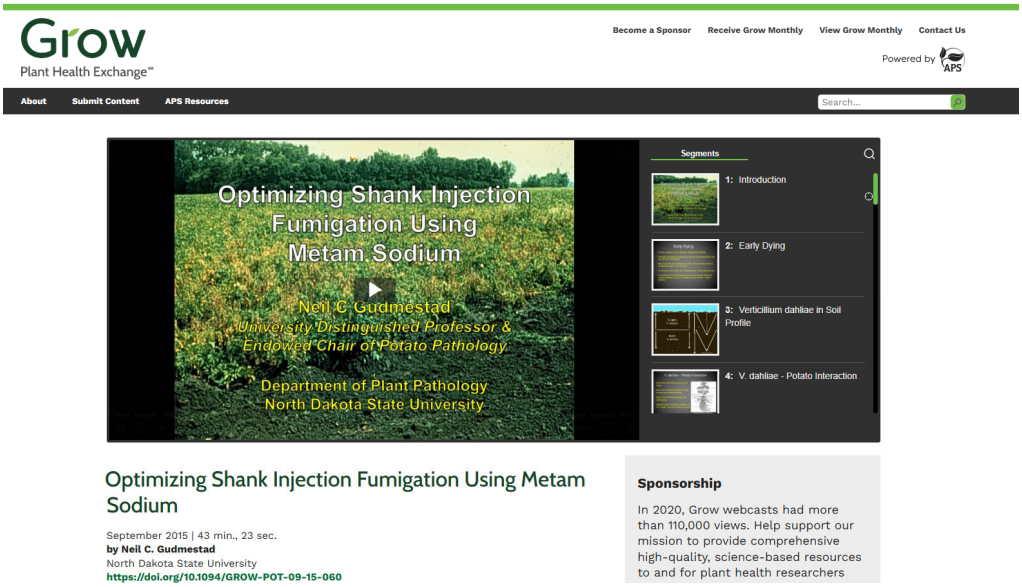
vapam HL SOIL FUMIGANT

Sectagon®-42 Agricultural Fumigant

k-pam HL

Sectagon-K54® Agricultural Fumigant

Focus on Potato



Optimizing Shank Injection Fumigation Using Metam Sodium

- Cooler temperatures are better (< 50 F)
  - 39 F was better than 59 F or 55 F
  - MITC movement in soil is slower
- Single injection depth just as effective as two
  - 10” vs 6 + 10”
- Metam rate more critical at higher temps
  - Rate response (40, 50, 60, 70 gallons) at 55 F
    - Higher (70 gal) can be more effective than lower (40 gal)
  - All rates similar at 39 F
- Marketable yield higher at 39 F fumigation

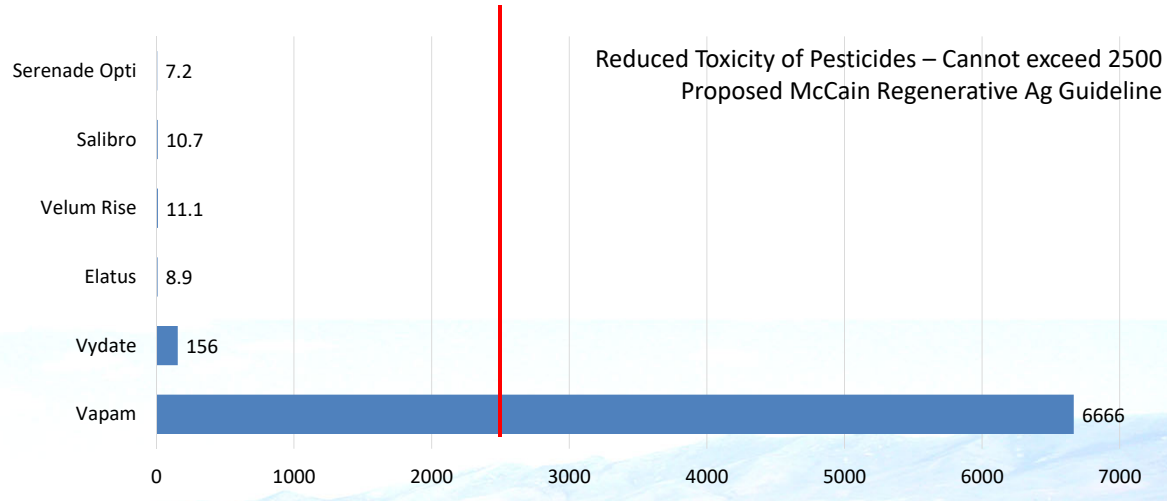
Environmental Impact Quotient (EIQ)

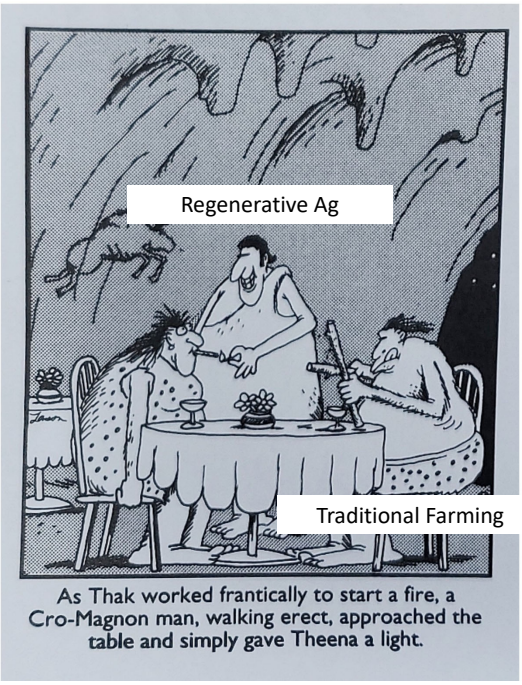
- Chronic toxicity
- Dermal toxicity
- Plant surface half-life (weeks)
- Soil half-life (days)
- Systemicity
- Leaching potential
- Fish toxicity
- Runoff potential
- Bird toxicity
- Bee toxicity
- Beneficial arthropod toxicity

Higher the EIQ, the higher the pesticide hazard

Environmental Risk of Pesticide Use in Ontario: 2013/2014 Pesticide Use Survey
Laura L. Van Eerd, University of Guelph, 5 October 2016

Ecological Field Use – EIQ





Objectives

1. Evaluate alternatives to metam for control of Verticillium wilt.
2. Measure timing of pathogen infection.

In cooperation with Dr. Ken Frost

Oregon State University

What else might control Verticillium wilt?

Velum Rise label:

USE DIRECTIONS

POTATO		
Disease Suppression	**Application Rate**	**Application Instructions**
Stem & stolon canker and Tuber black scurf[1] caused by soilborne *Rhizoctonia solani.* Black dot[1] *(Colletotrichum coccodes)* Early blight[1] *(Alternaria solani)* White mold[1] *(Sclerotinia sclerotiorum)* Potato early dying/ Verticilium Wilt[1] *(Verticilium dalia)*	13.0 fl oz/acre (0.212 lb/acre fluopyram) (0.090 lb/acre penflufen)	Apply as an in-furrow spray at planting. In furrow spray - Mount spray nozzles to direct the spray as a 3- to 6-inch band down the row center onto the seed pieces in the furrow just before the seed is covered.

What else might control Verticillium wilt?

"Overall, Salibro look promising in controlling Potato Early Die Complex but more work needs to be done to solidify results."

(Emilie Cole and Marisol Quintanilla, Michigan State University, Michigan Potato Research Report, 2018).

Crops	Diseases
Root, Tuber, and Corm Vegetables: Carrot Sweet Potato Beet Sugar Beet Horseradish Radish Turnip Potato Parsnip Cassava Ginger Ginseng and other root, tuber and corm crops (including those grown for seed production)	*Rhizoctonia* Common Scab *(Streptomyces scabies)* *Phytophthora* *Fusarium* *Sclerotinia* *Verticillium* *Erwinia*

Bexfond™ BIOLOGICAL FUNGICIDE

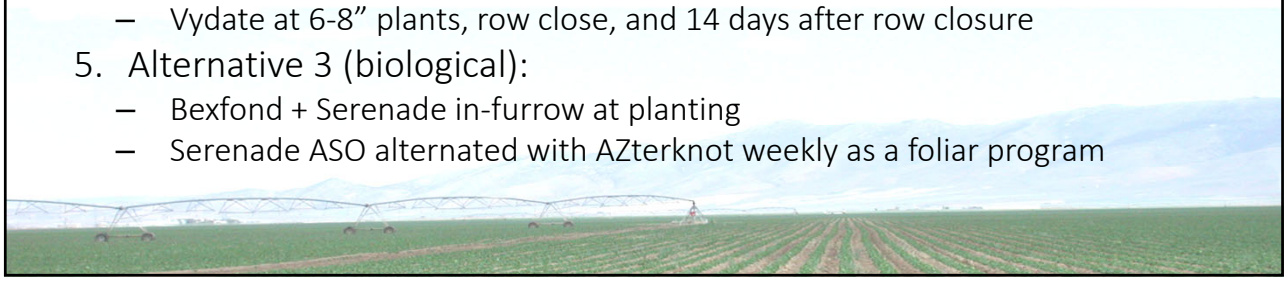
ROOT AND TUBER VEGETABLES – SOIL APPLICATION (INCLUDING LEAVES OF ROOT AND TUBER VEGETABLES)
Includes cultivars, varieties and/or hybrids of these commodities.

Target Diseases
Aphanomyces* spp.
Clubroot* - *Plasmodiophora brassicae*
***Colletotrichum* spp.**
***Erwinia* spp.**
***Fusarium* spp.**
***Macrophomina* spp.**
***Phytophthora* spp.**
***Pythium* spp.**
***Rhizoctonia* spp.**
Sclerotium rolfsii
***Verticillium* spp.**
Common Scab - *Streptomyces scabies*
***NOT FOR USE IN CALIFORNIA**

SERENADE® ASO

Field Trial Treatments

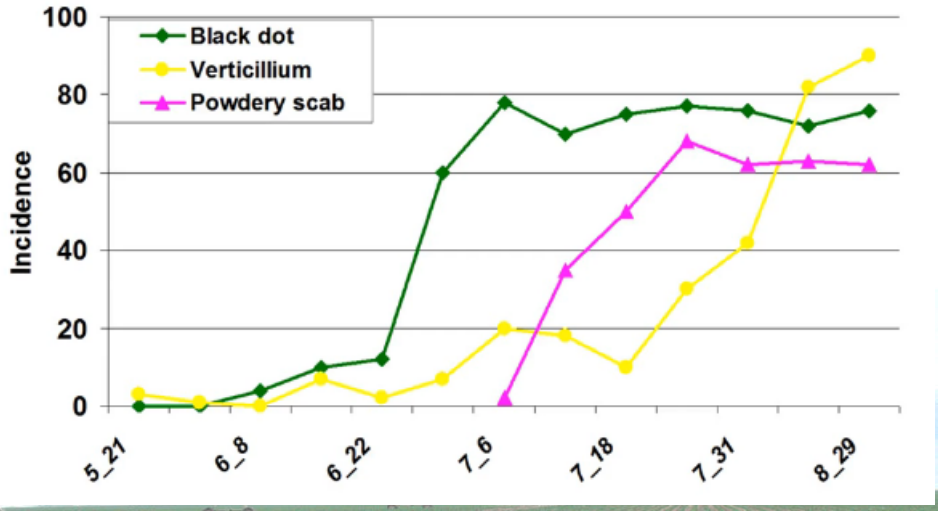
1. Untreated control
2. Fall (2023) metam sodium application (40 gal/acre)
3. Alternative 1:
   - Elatus + Velum Rise in-furrow at planting
   - Velum Prime at 6-8" plants
4. Alternative 2:
   - Salibro + Quadris + Bexfond in-furrow at planting
   - Vydate at 6-8" plants, row close, and 14 days after row closure
5. Alternative 3 (biological):
   - Bexfond + Serenade in-furrow at planting
   - Serenade ASO alternated with AZterknot weekly as a foliar program



Methods

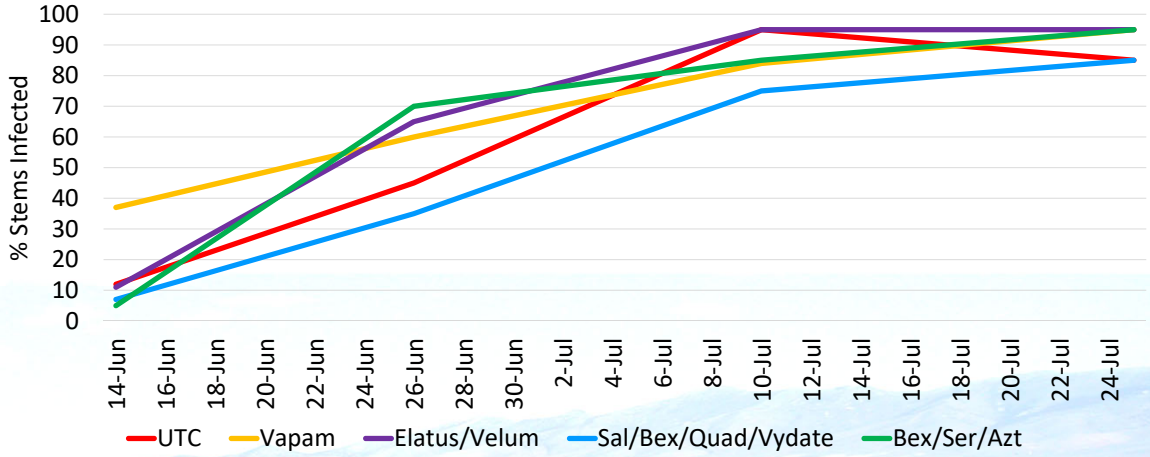
- 8 row plots
- Estimates of soil-borne pathogens
- Measurement of root and stem infection
  - *V. dahliae*
  - *C. coccodes*
- Visual disease evaluation
- Yield, grade, economic return

Disease incidence in fields - Washington

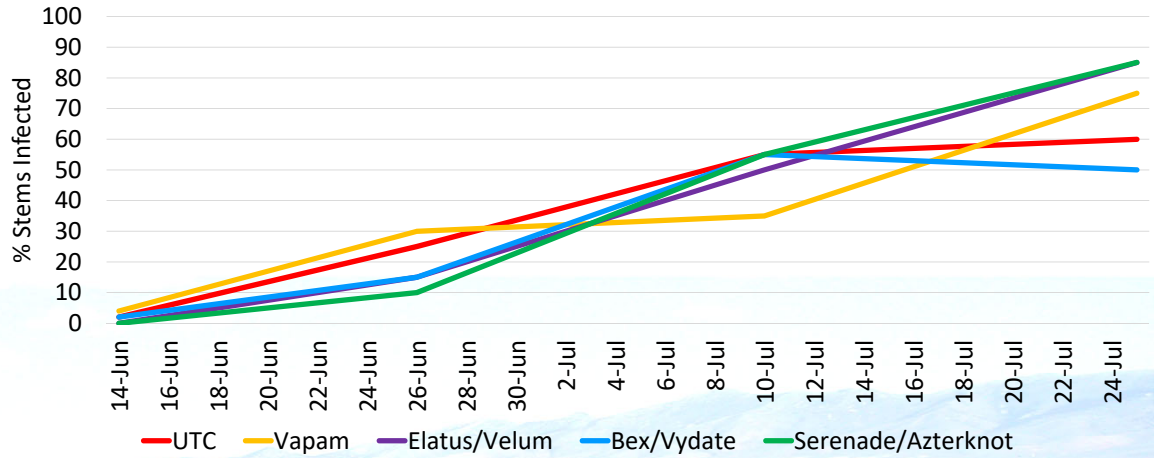


Data from Dennis Johnson, Washington State University

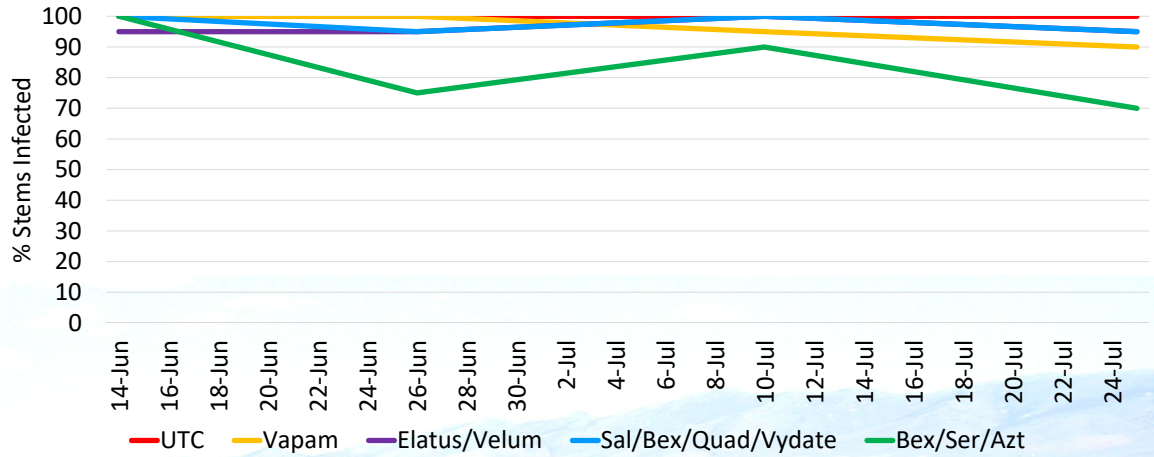
Verticillium dahliae Incidence - Roots



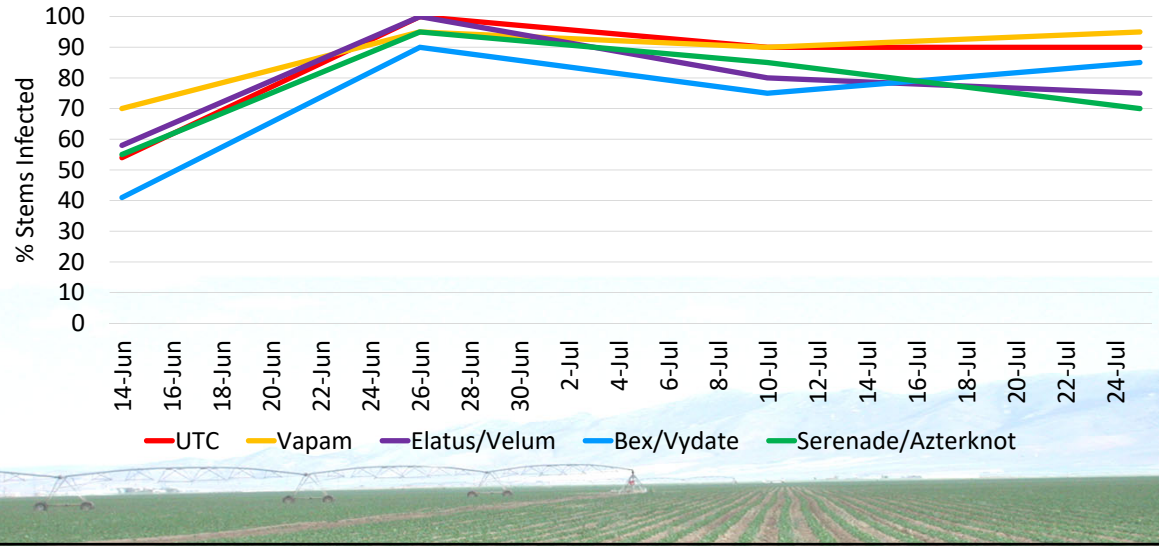
Verticillium dahliae Incidence - Stems



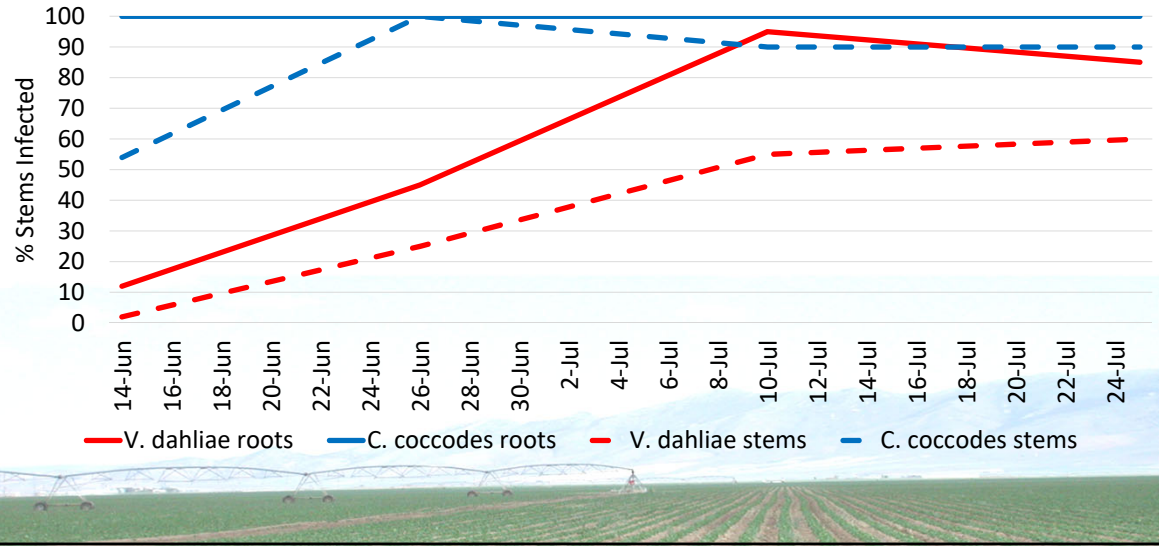
Colletotrichum coccodes Incidence - Roots



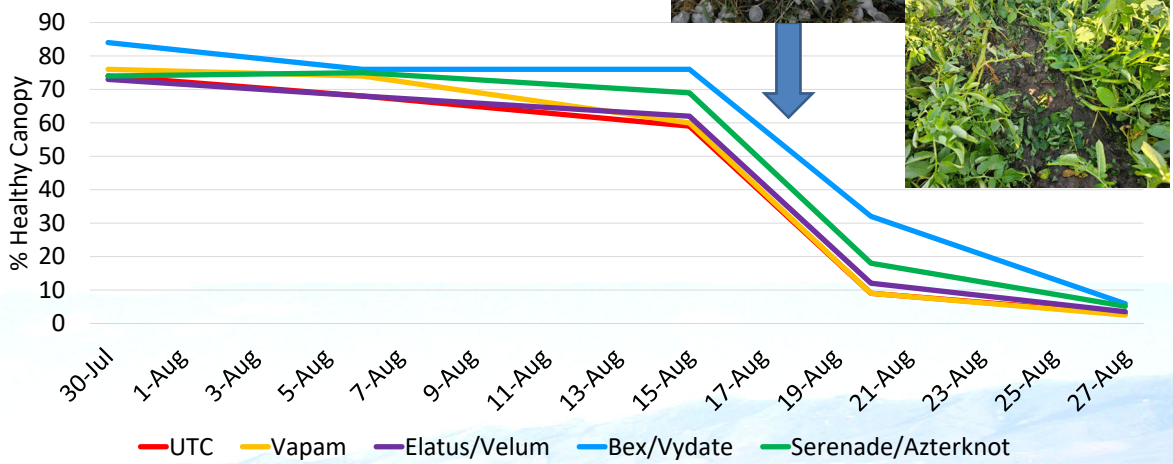
Colletotrichum coccodes Incidence - Stems



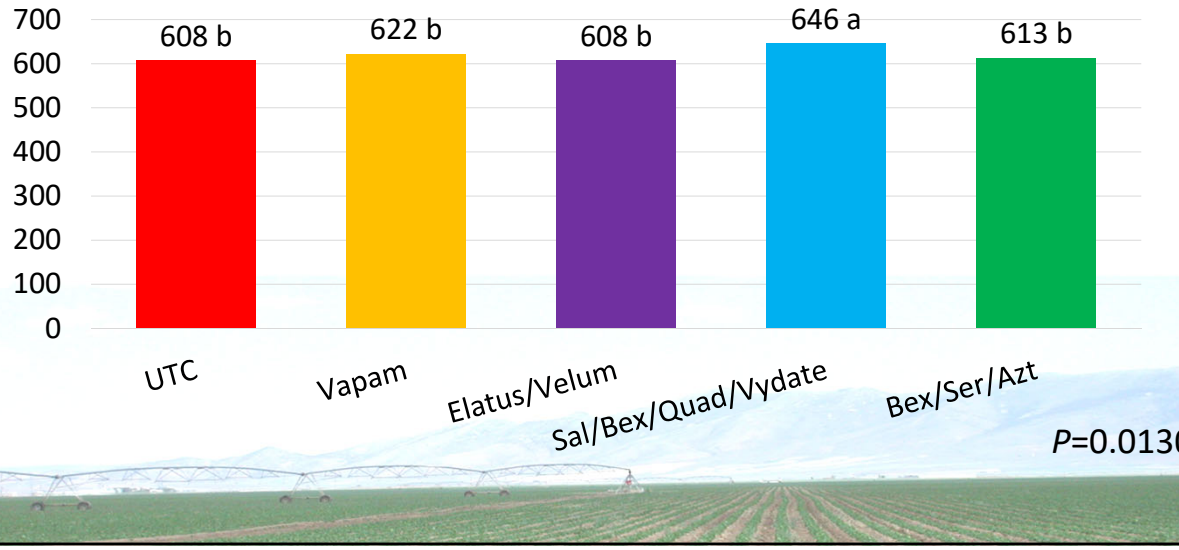
Relative Incidence - 2024



Plant Vigor

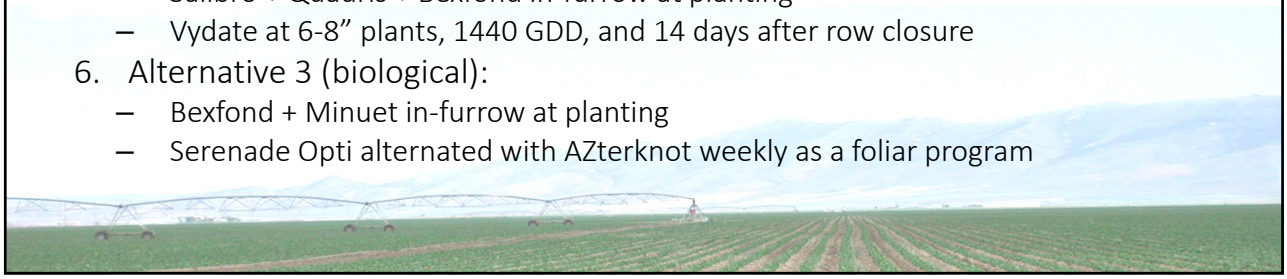


Total Yield



Proposed Field Trial Treatments – 2025

1. Untreated control
2. Fall metam sodium application (40 gal/acre)
3. Fall chloropicrin (Strike 80, 8 gal/acre)
4. Alternative 1:
   - Elatus + Velum Rise in-furrow at planting
   - Velum Prime at 6-8" plants (chemigated), Movento 2X (foliar)
5. Alternative 2:
   - Salibro + Quadris + Bexfond in-furrow at planting
   - Vydate at 6-8" plants, 1440 GDD, and 14 days after row closure
6. Alternative 3 (biological):
   - Bexfond + Minuet in-furrow at planting
   - Serenade Opti alternated with AZterknot weekly as a foliar program



Take Home Message

- Metam is not always successful for *Verticillium*.
- Alternatives did not reduce *Verticillium* or *Colletotrichum*.
- Salibro/Bexfond/Quadris/Vydate improved yield.
  - Caution: 4-month plant back interval for non-labeled crop (e.g. winter grain)
- Our yield data compromised from hail damage?

- (Chloropicrin added to the trial for 2025.)

Management Practices for Improved Soil Health

Rationale

1. Despite frequent use of fumigation, pressure from soil-borne diseases is increasing over time.
2. Soil productivity is declining

Trial Site Details – SCRI Soil Health Trial

Soil Characteristics

% Sand: 84	% OM: 1.05
% Silt: 12	pH: 7.8
% Clay: 4	CEC: 7.8

Salts (mmhos/cm)	0.6	Organic N (lb/acre)	40	Calcium (meq/100 g)	5.1
Chlorides (ppm)	9	Ammonium-N (ppm)	3.7	Magnesium (meq/100g)	1.9
Sodium (meq/100g)	0.20	Nitrate-N (ppm)	5	Zinc (ppm)	1.1
Excess Lime (%)	0.7	Phosphorus (ppm)	20	Iron (ppm)	5.9
		Potassium (ppm)	176	Manganese (ppm)	4.8
		Sulfate-S (ppm)	7	Copper (ppm)	0.7
				Boron (ppm)	0.44

Fertilizer Applied

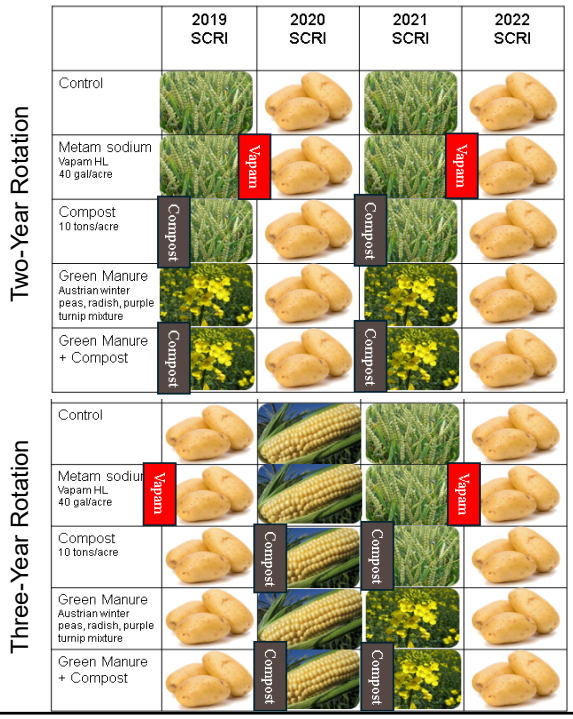
N	380	S	43
P_2O_5	150	B	1.1
K_2O	225	Zn	1.6

Date	Fertilizer	Composition	Rate/acre	Method	Units Applied
05 May 22	Ammonium phosphate	11-37-0	22.5 gal	Planter	30 N, 100 P_2O_5
	Boron 10%	0-0-0-10 B	1.0 gal		1.1 B
	Zinc Citre Che	0-0-0-10 Zn	1.5 gal		1.6 Zn
10 May 22	Urea	46-0-0	185 lb	Tyler air cart	85 N
	MAP	11-52-0	87 lb		10 N, 50 P_2O_5
	Muriate of Potash (KCl)	0-0-60	167 lb		100 K_2O
	Sulfate of Potash (K_2SO_4)	0-0-50-17 S	250 lb		125 K_2O, 43 S
10 Jun to 2 Aug 22	UAN (x 9)	32-0-0	72 gal	Fertigation	255 N

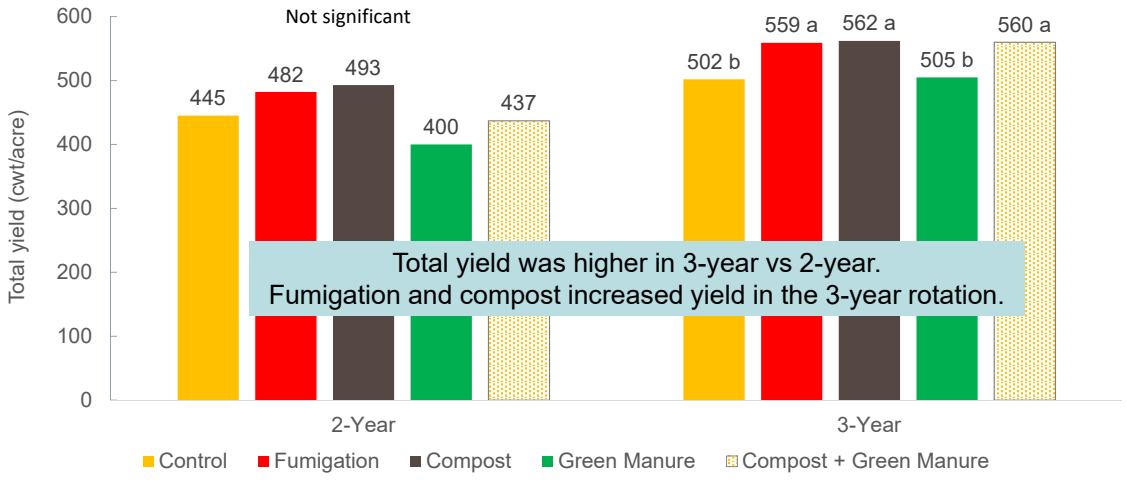
2019 Trial Site

Two-Year Rotation

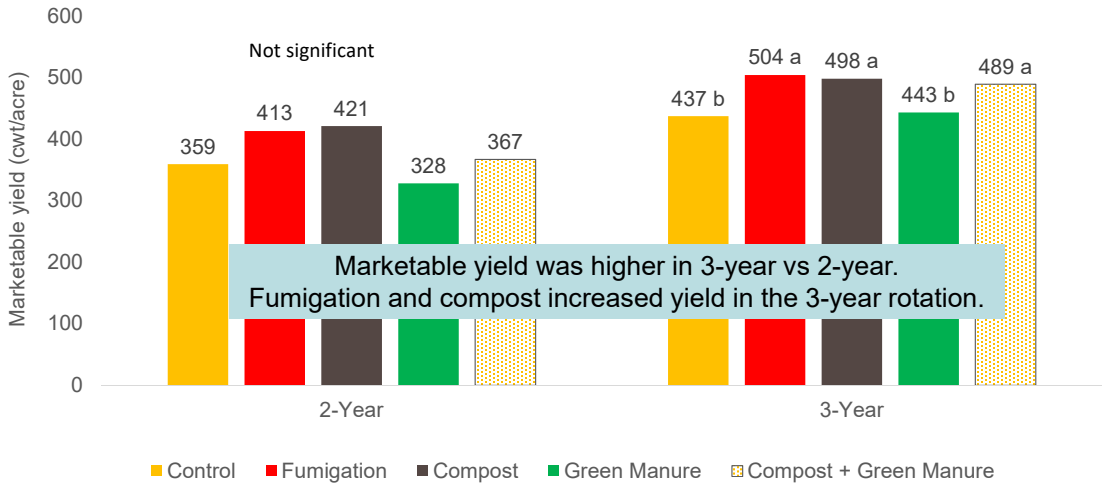
Three-Year Rotation



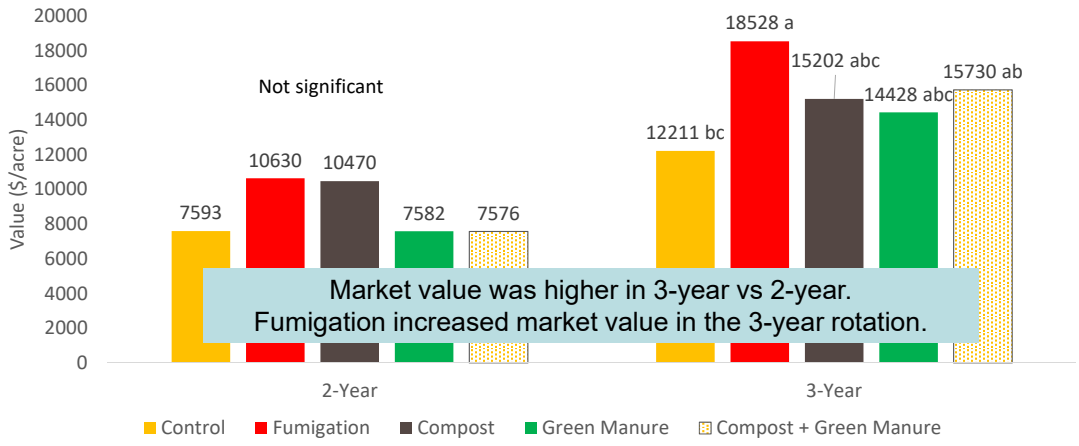
Did rotation length, fumigation or organic amendments impact total yield?



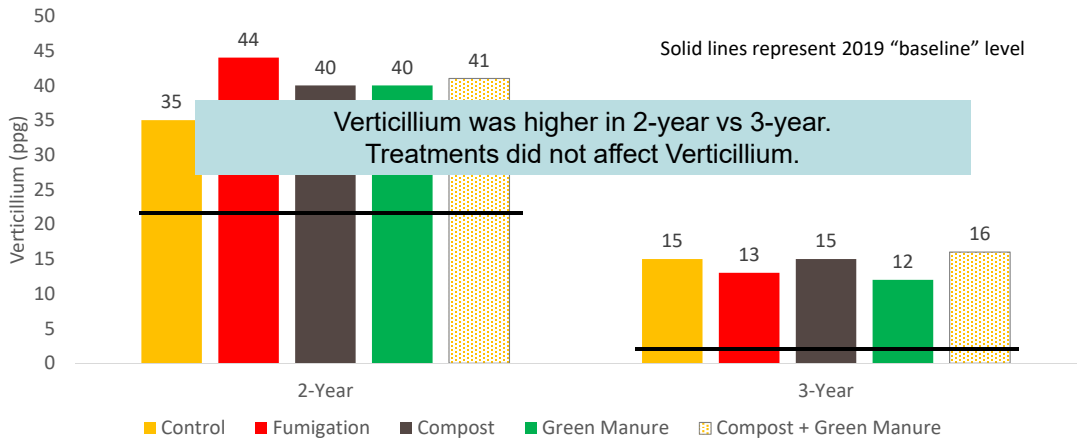
Did rotation length, fumigation or organic amendments impact marketable yield?



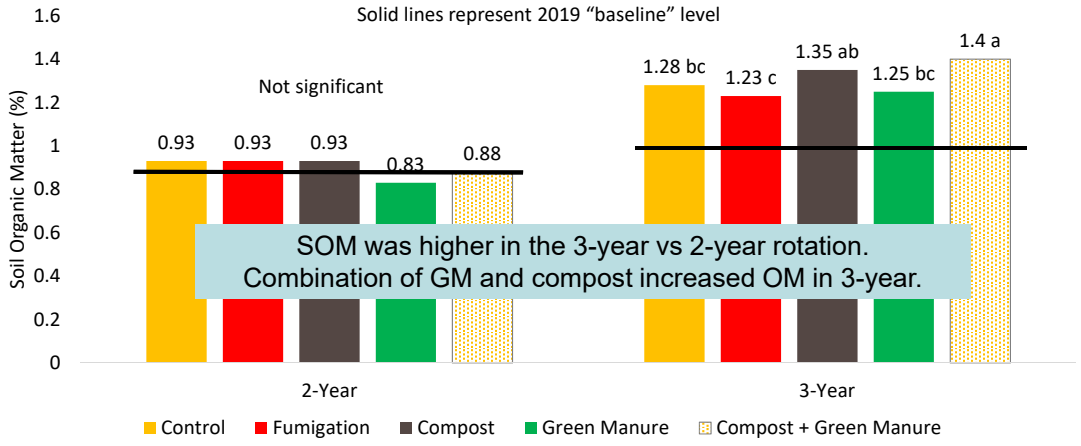
Did rotation length, fumigation or organic amendments impact fresh market value?



Did rotation length, fumigation or organic amendments impact Verticillium populations?



Did rotation length, fumigation or organic amendments impact soil health?



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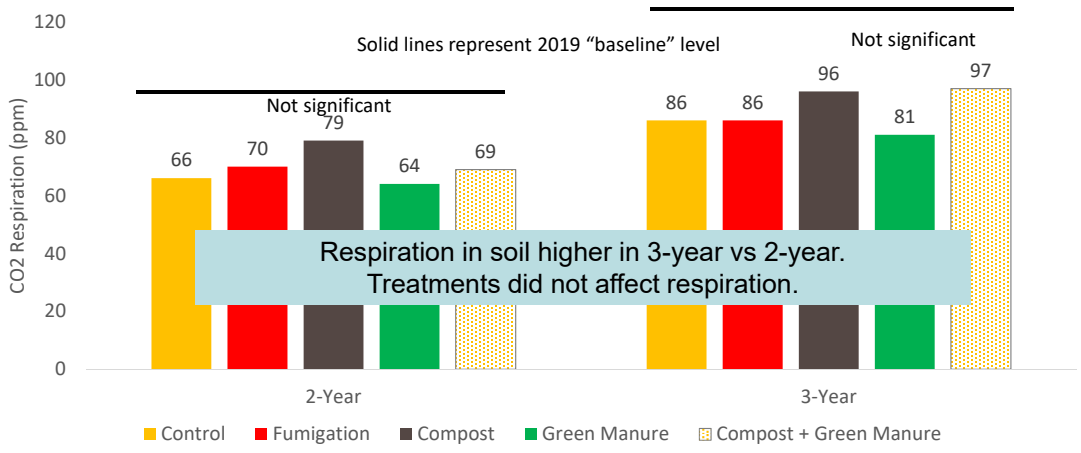
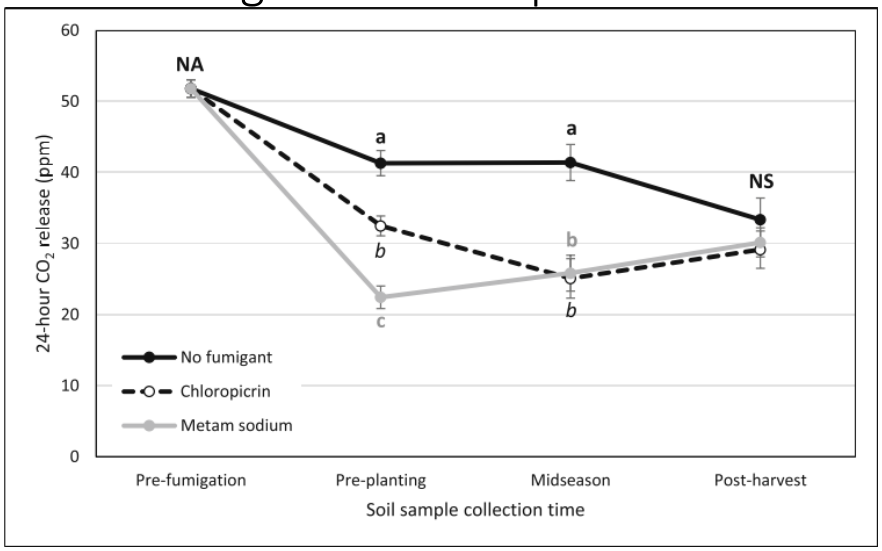


Effect of Fumigation on Respiration in Soil



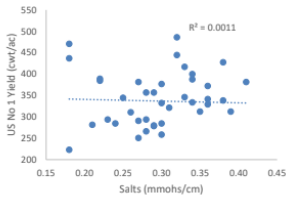
From Crants et al., 2021. Am. J. Potato Res. 98:285-303

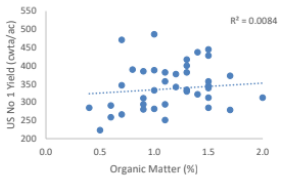
Objective 2 – Field Survey Results

- Yield negatively correlated with *Verticillium* (MN and ID).
  - Soil health indicators did not correlate to yield.

Are any of these factors related?

From Mike Thornton, University of Idaho





POTATO SOIL HEALTH PROJECT

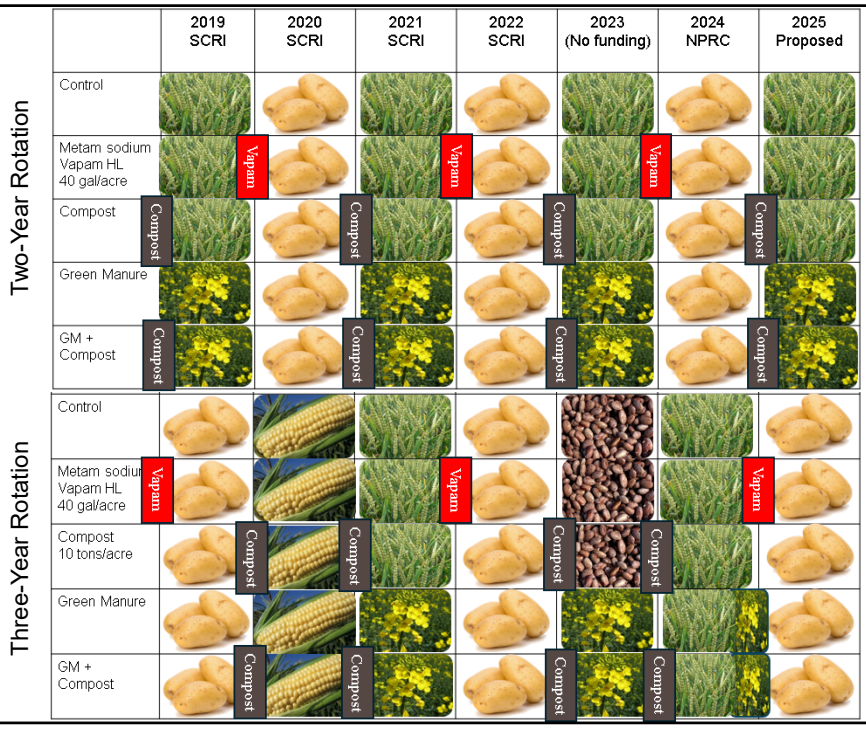
University of Idaho
College of Agricultural and Life Sciences

Dr. Brenda Schroeder
Dr. Linda Schott

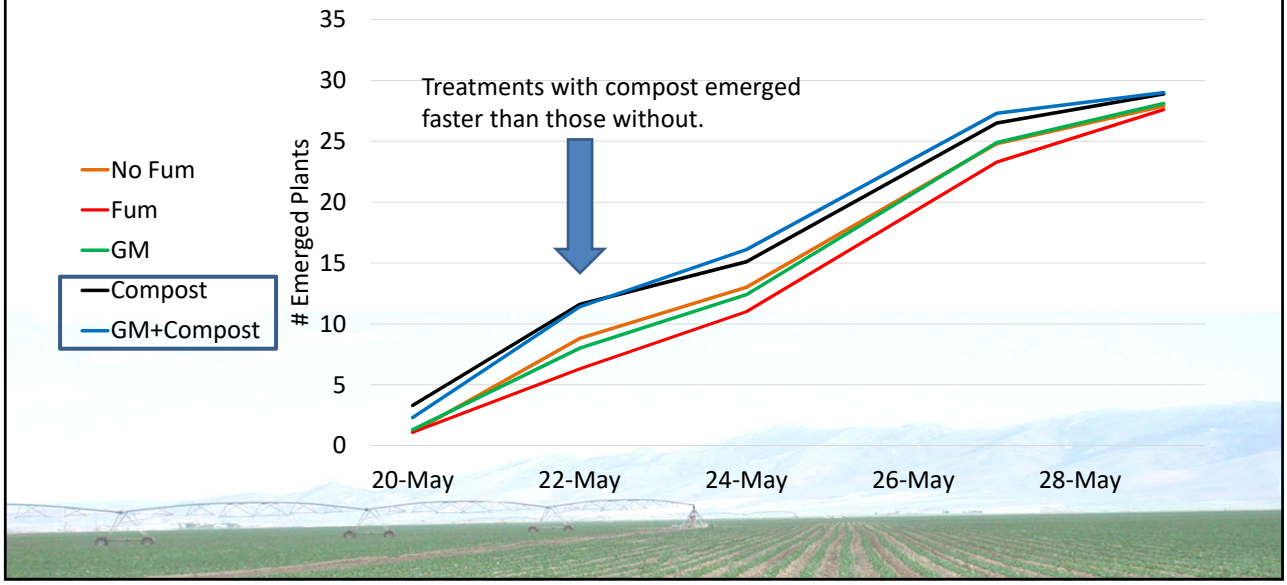
University of Idaho

Dr. Ken Frost

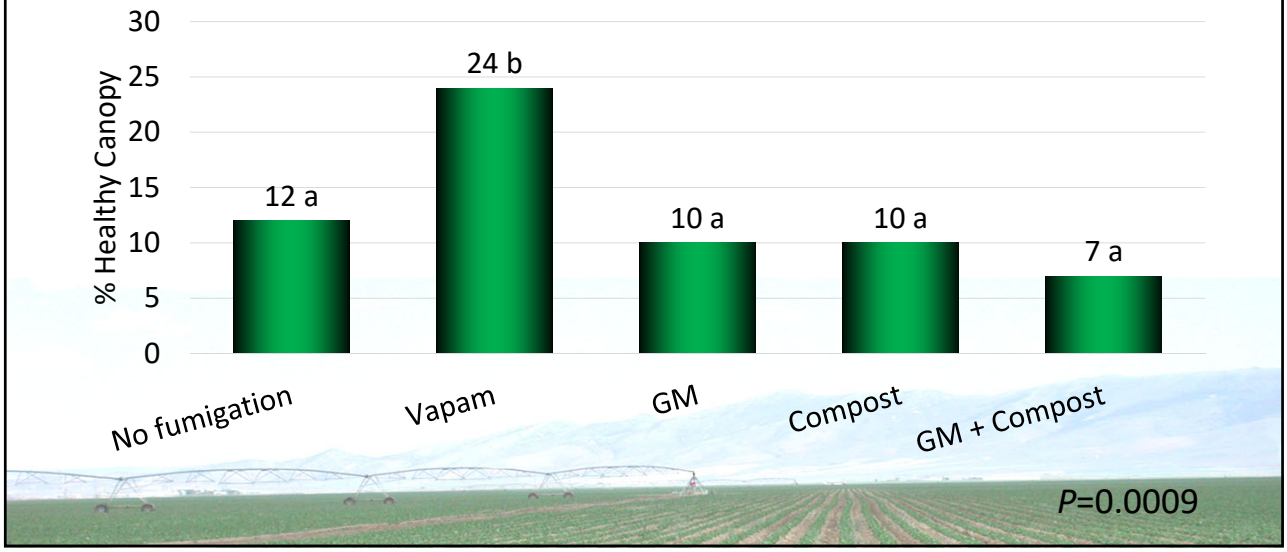
Oregon State University



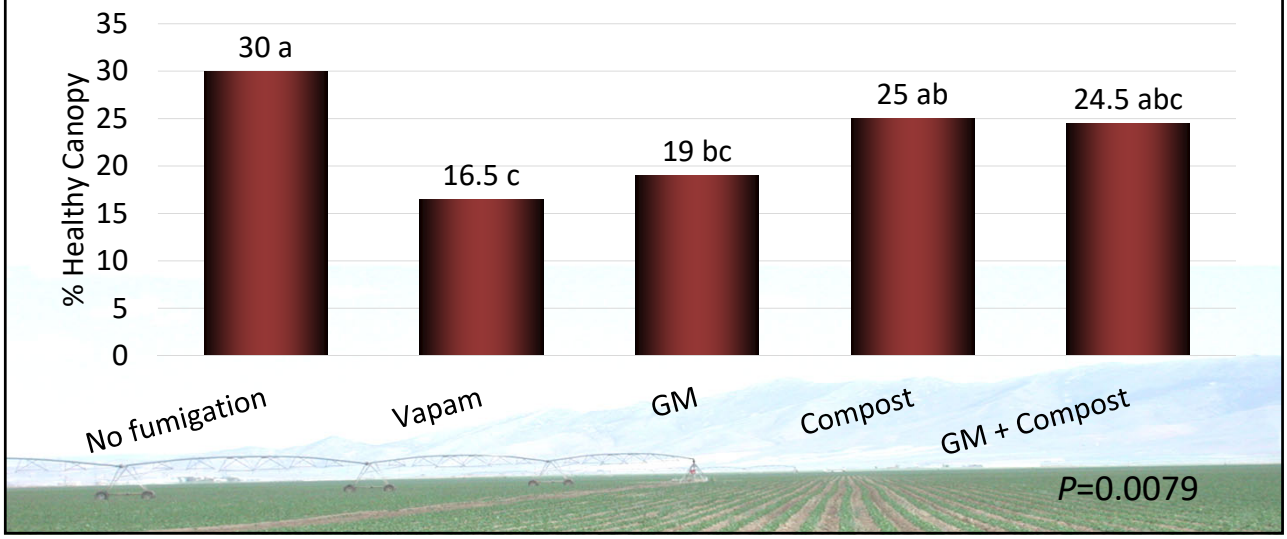
2- Year Rotation: Emergence



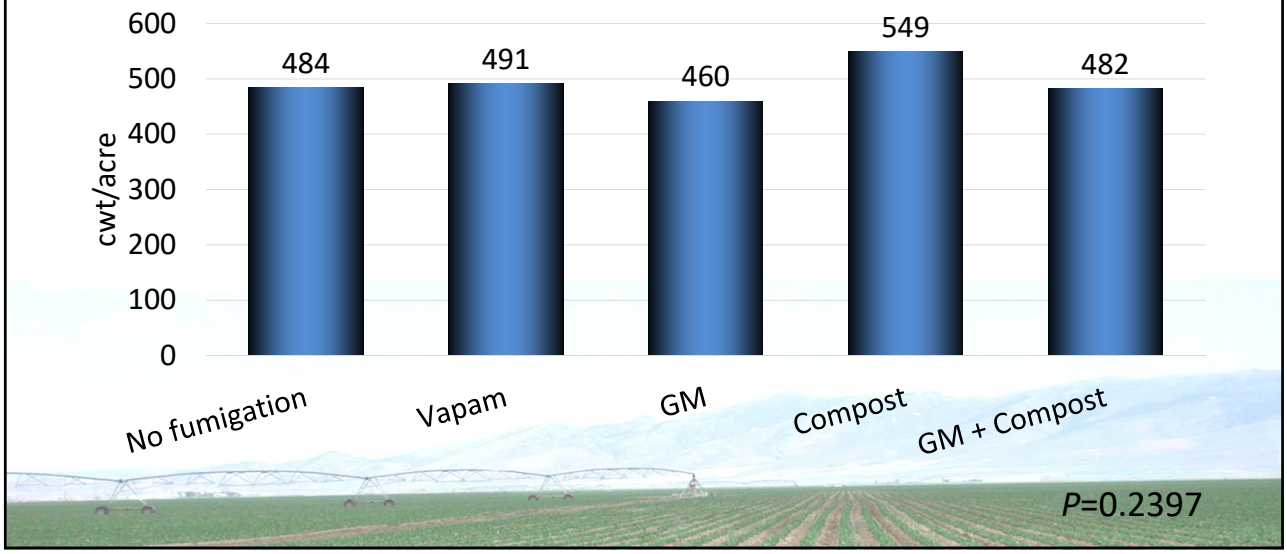
2- Year Rotation: Vigor on August 13



2- Year Rotation: *Verticillium dahliae* in the soil



2-Year Rotation: Total Yield



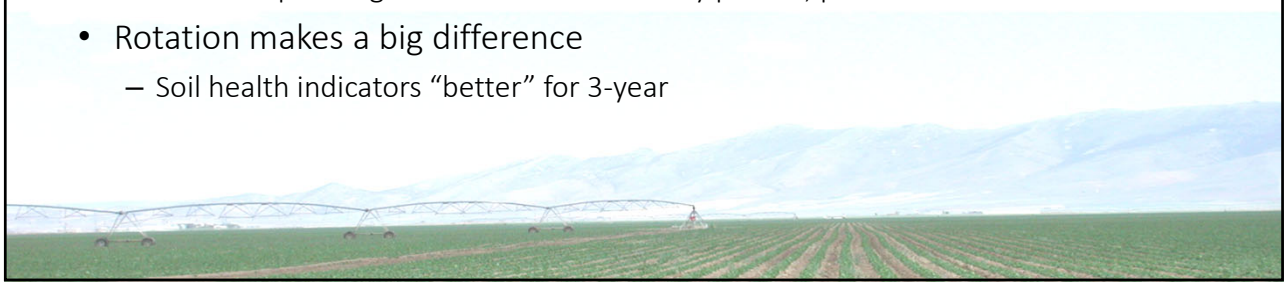
Tuber Grade

	% US#1	% > 10 oz	Avg. Tuber Size (oz)
No fumigation	86 a	55 b	8.5 a
Metam fumigation	91 a	63 a	9.2 a
Green manure (GM)	88 a	53 b	9.1 a
Compost	90 a	60 ab	9.1 a
GM + Compost	90 a	54 b	8.5 a

- No difference in US#1 tubers.
- Generally larger tubers with metam fumigation. Compost also?

Summary from the Miller Research Field Trial

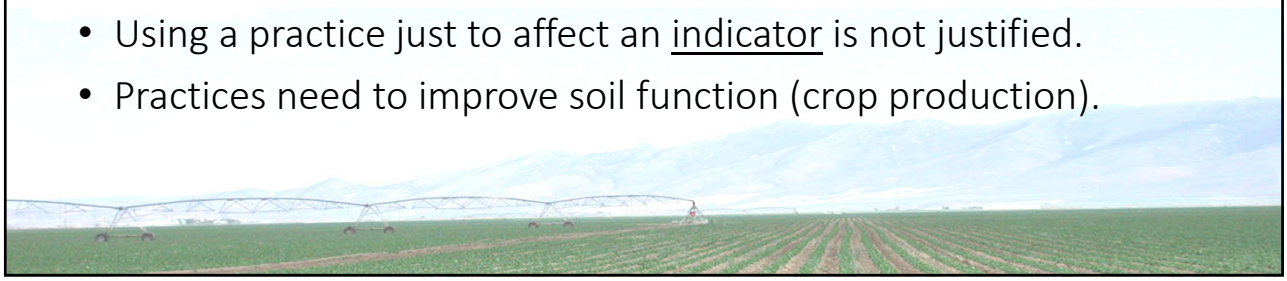
- Fumigation is providing a benefit for soil function (yield and quality)
  - Effect significant with 3-year, but not 2-year rotation
- Compost amendment improves soil function (yield and quality)
  - May not work in soil with salt issues
- Dedicated green manures did not help potato yield in this trial
  - Cover crops and green manures have many proven, positive benefits
- Rotation makes a big difference
  - Soil health indicators “better” for 3-year



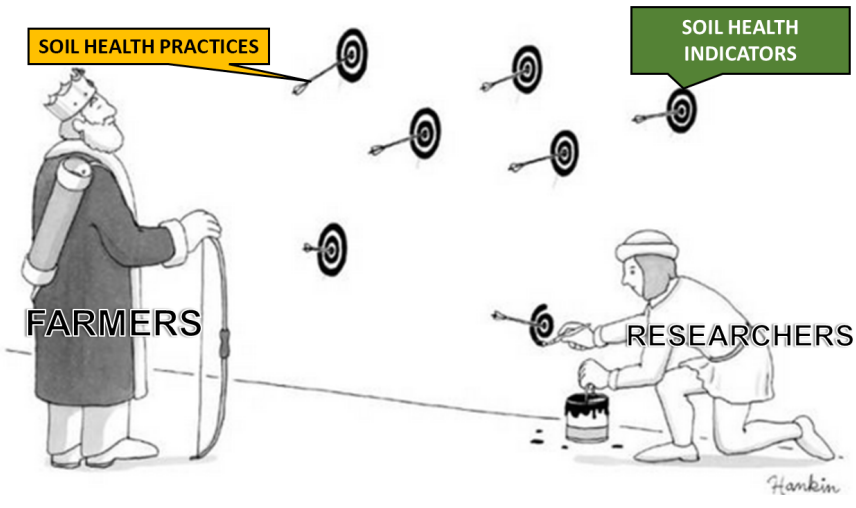
So are these true?

1. Despite frequent use of fumigation, pressure from soil-borne diseases is increasing over time (?)
2. Soil productivity is declining (?)

- More research is needed to validate "soil health" practices.
- Using a practice just to affect an indicator is not justified.
- Practices need to improve soil function (crop production).

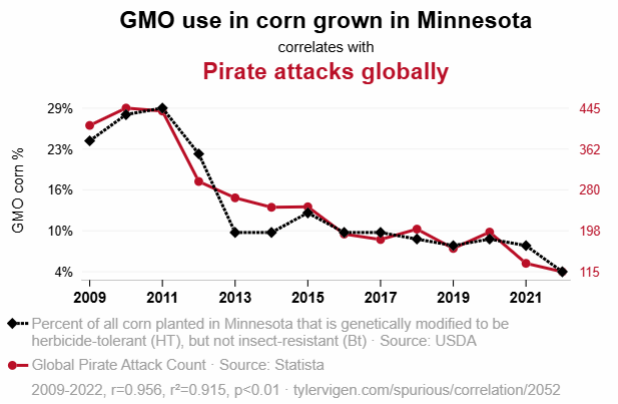


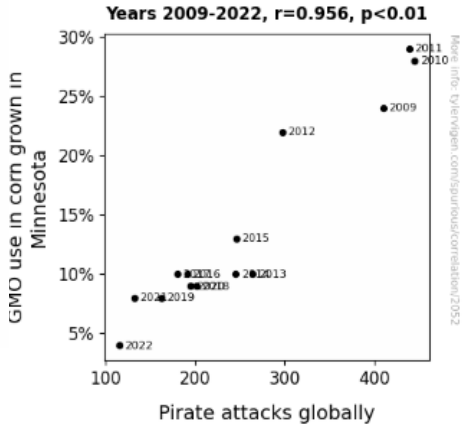
Do soil health indicators indicate soil health?



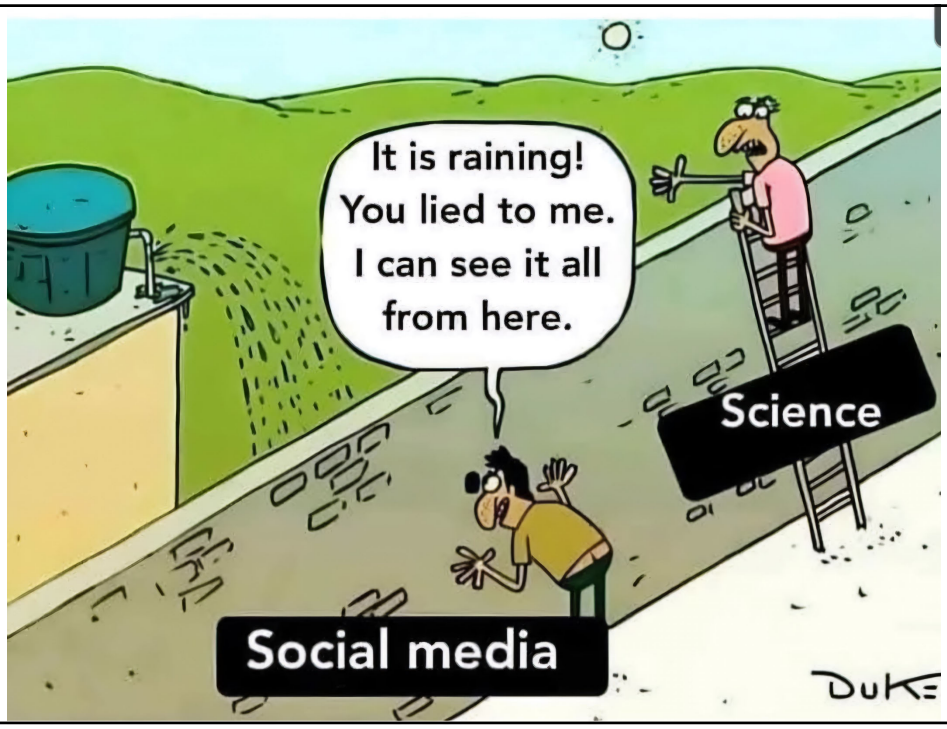
Andy McGuire, April 13, 2022
https://csanr.wsu.edu/soil-health-shorts-do-soil-health-indicators-indicate-soil-health/

Correlation is NOT Causation

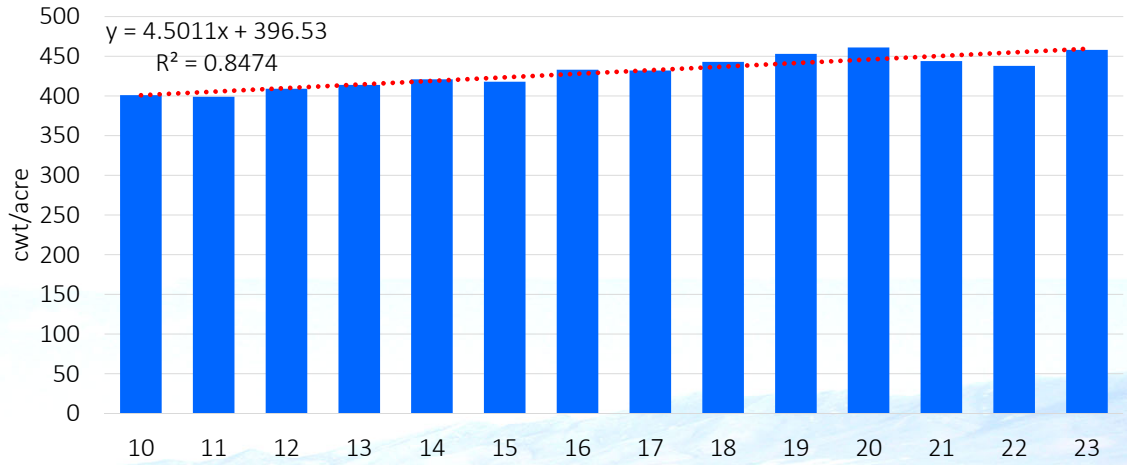




Source: Tylervigen.com



Average Potato Yields, Total US



Data from USDA, Potatoes Annual Summary

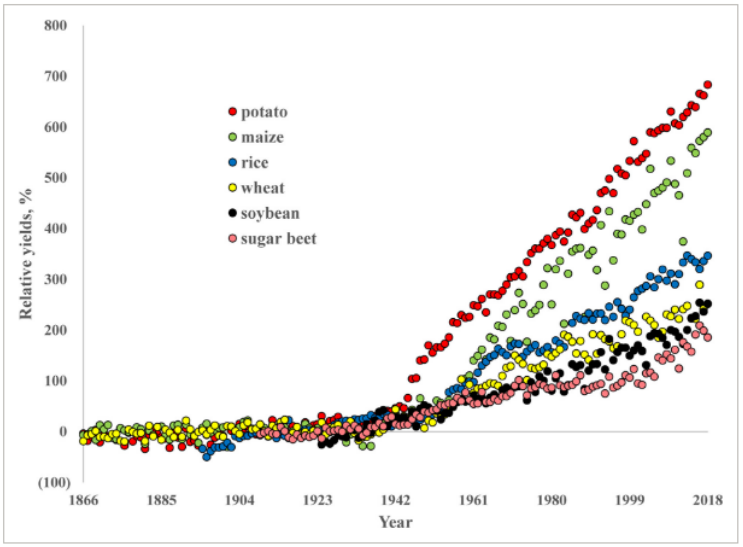


Figure 1 Open in figure viewer

Average annual yield in the United States relative to the pre–Green Revolution averages (set to equal 0) of 6.4 (potato), 1.6 (maize), 1.9 (rice), 0.9 (wheat), 1.0 (soybean), and 24.8 (sugar beet) Mg ha^{-1} (adapted from USDA-NASS, 2019).

From: Phosphorus Management in High-Yield Systems. B. Hopkins and N. Hansen. Journal of Environmental Quality 48:1265-1280.

The Apostle Paul warned us…

"O Timothy, keep that which is committed to thy trust, avoiding profane and vain babblings, and oppositions of science falsely so called:

Which some professing have erred concerning the faith…"

King James Bible, 1 Timothy 6:20-21

From BibleStudyTools.com

Questions?

Come to the 2025 Potato Association of America annual meeting!

109th Annual Meeting

July 27th - July 31st 2025

PAA 2025

July 27-31

Madison, Wisconsin